MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN

Non-profit join - stock corporation

ALMATY UNIVERSITY OF POWER ENGINEERING AND TELECOMMUNICATION named after G. Daukeev

Department of *Electronics and robotics*

«Allowed to defence»

The head of department of «Electronics and robotics»

Chigambayev T.O. c.t.s., associate professor

(Full name, academic degree, rank)

____«____» ________________2020 year

(sign)

DEGREE PROJECT

On the topic: *Development of an automated irrigation system for agricultural land*

Done by: *Baizakov Damir PSa-16-3*

(Surname and initials of a student) (group)

Specialty *5B071600 Instrumentation Engineering*

Research supervisor *Yusupova S.A. c.t.s., senior lecturer*

(Surname, academic degree, rank)

______«____» ________________2020 year

(sign)

Consultants

on economic part: *Tuzelbayev B.I. Ph.D, associate professor*

(Surname, academic degree, rank)

______«____» ________________2020 year

(sign)

on life and environmental safety part: *Begimbetova A.S. Ph.D, senior lecturer*

(Surname, academic degree, rank)

______«____» ________________2020 year

(sign)

Compliance supervisor: *Fazylova A.R.senior lecturer*

(Surname, academic degree, rank)

______«____» ________________2020 year

(sign)

Almaty, 2020

MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
Non-profit join - stock corporation
ALMATY UNIVERSITY OF POWER ENGINEERING AND TELECOMMUNICATION named after G. Daukeev

Institute of *space engineering and telecommunications*
Department of *Electronics and robotics*
Specialty *5B071600 Instrumentation Engineering*

ASSIGNMENT
for execution of degree project

Student *Baizakov Damir Kakimuly*
(Full name)
Topic of the work *Development of an automated irrigation system for agricultural land*

Approved by the order of the rector № 155 from « 23 » october 2020 y.
Deadline of the finished work « » june 2020 y.
Initial data required parameters of the results and initial data:

1. *Arduino Nano microcontroller*
2. *Resistive sensors*
3. *LCD 1602*
4. *HP laptop*

List of issues to be developed in a degree project or a summary:

1. *Irrigation of agricultural crops*
2. *The principle of operation and organization of the information and measurement system*
3. *Development of algorithms and software*
4. *Development of life safety measures*
5. *Economic justification of the project*

List of graphical material (with precise indication of mandatory drawings);
This degree project contains 50 figures and tables

Recommended basic literature:

1. *Thompson, G. A review of creativity principles applied to engineering design. Proceedings of the Institution of Mechanical Engineers / Thompson G., Lordan M. Part E: Journal of Process Mechanical Engineering, 1999. – V. 213. – №*
2. *Khramtsov, A.V. Device for automatic plant watering / A.V. Khramtsov- Tomsk, 2016-5 p.*
3. *Dietmar, D-LON technology: building distributed applications / Dietmar Dietrich; translated from German. O. B. Nizamutdinova. Perm: Zvezda, 1999, 424 p.*

Consultants for work with indication of the relevant section

Section	Consultant	Date	Sign
Life safety	*Begimbetova A.S*	*16.05.2020*	
Economic part	*Tuzelbayev B.I*	*18.05.2020*	

SCHEDULE
Of degree project preparation

№	Title of section, list of issues to be developed	Deadline for submission to instructor	Note
1	*Theoretical part*	*29.01*	
2	*Engineering part*	*05.03*	
3	*Program part*	*15.05*	
4	*Life safety*	*16.05*	
5	*Economic part*	*18.05*	
6	*Conclusion*	*06.06*	

Date of issue of the assignment *« 20 » 01 2020 year*

The head of department ____________ *Chigambayev T.O.* ____________
(sign) (Surname and initials)

Supervisor: ____________ *Yusupova S.A. c.t.s., senior lecturer* ____________
(sign) (Surname and initials)

The assignment for execution is accepted by: ____________ *Baizakov Damir*
(sign) (Surname and initials)

Аннотация

Тема данной дипломной работы является разработка системы автоматического полива. В данной работе ведут описание технологического процесса системы полива, построение принципиальной технологической схемы.

Разработана системна-структурная схема автоматизации, осуществлен выбор необходимого оборудования, произведены расчеты параметров и программ системных автоматизаций проекта.

В экономической части был рассчитан расход автоматизированной системы и заработная плата рабочего персонала.

В разделе безопасности жизнедеятельности были рассчитаны анализ условий труда, исскуственное освещение и время эвакуации.

Аңдатпа

Бұл дипломдық жұмыстың тақырыбы автоматты суару жүйесін әзірлеу болып табылады. Бұл жұмыста суару жүйесінің технологиялық процесі, принципті технологиялық схеманы құру, сипатталады.

Автоматтандырудың жүйелік-құрылымдық схемасы әзірленді, қажетті жабдықты таңдау, параметрлердің есебі және бағдарламалардың жүйелі автоматтандыру жобасы жүргізілді.

Экономикалық бөлімде автоматтандырылған жүйенің шығыны және жұмысшы персоналдың еңбекақысы есептелген.

Өміртіршілік қауіпсіздігі бөлімінде талдау есептелген жарықтандыру және эвакуациялау уақыты.

Annotation

The topic of this thesis is the development of a system automatic watering. In this paper, the description of the technological process of the irrigation system, the construction of a basic technological scheme.

Developed a system-block diagram of automation, implemented selection of the necessary equipment, calculations of parameters were made and the project's system automation programs.

In the economic part, the expenditure of the automated system and the wages of the working staff were calculated.

In the section of life safety the analysis was calculatedworking conditions, artificial lighting and evacuation time.

Content

Introduction

Water is a very precious resource and must be properly utilized. Agriculture is one of those areas which consume a lot of water. Irrigation is a time consuming process and must be done on a timely basis. The aim of this study is to develop an auto irrigation system which measures the moisture of the soil and automatically turns on or off the water supply system.

The project requires very less human involvement once installed. The circuit is based on Arduino and also a soil moisture sensor. A properly configured soil moisture sensor can save up to 60 percent of water used in irrigation. Irrigation system uses valves to turn irrigation ON and OFF. These valves may be easily automated by using controllers and solenoids. Automating farm or nursery irrigation allows farmers to apply the right amount of water at the right time, regardless of the availability of labor to turn valves on and off. In addition, farmers using automation equipment are able to reduce runoff from over watering saturated soils, avoid irrigating at the wrong time of day, which will improve crop performance by ensuring adequate water and nutrients when needed. It also helps in time saving, removal of human error in adjusting available soil moisture levels and to maximize their net profits. A lot of research has been done by many authors (Dukes et al. 2003; Suriyachai et al. 2012; Smajstrla and Locascio, 1996; Phene and Howell, 1984; Nogueira et al. 2003; Dursun and Ozden, 2011; Prathyusha and Suman, 2012; Gracon et al. 2010; Dukes and Scholberg, 2005). Irrigation of plants is usually a very time consuming activity; to be done in a reasonable amount of time, it requires a large amount of human resources. Traditionally, all the steps were executed by humans.

Now a days, some systems use technology to reduce the number of workers or the time required to water the plants. With such systems, the control is very limited, and many resources are still wasted. Water is one of these resources that are used excessively. Flood irrigation is one method used to water plants. This method represents massive losses since the amount of water given is in excess of plants need.

The contemporary perception on of water is that of a free, renewable resource that can be used in abundance. However, this is not reality; in some parts of India, water consumption is taxed. It is therefore, reasonable to assume that it will soon become a very expensive resource everywhere. In addition to excess cost of water labour is becoming more and more expensive. As a result, if no effort is in invested in optimizing these resources, there will be more money involved in this process. Technology is probably a solution to reduce the costs and prevent loss of resources. The objective of this study is to design a small scale automated irrigation system that would use water in a more efficient way, in order to prevent water loss and minimize the cost of labour.

1 Irrigation of agricultural crops

1.1Place of automatic irrigation systems in agriculture

In late decades, there is a quick advancement in Smart Agricultural Systems. Show that agriculture has great importance worldwide. Indeed, in Kazakhstan for example, about 40 % of the people relies upon the vital sector of agriculture. In the past, irrigation systems used to be dependent on the mills to irrigate the farm by conventional methods without knowing the appropriate quantities of these crops. These old systems are a major cause of the waste of large quantities of water and thus destroy some crops because of the lack of adequate quantities of water. However, with the recent technological developments, there have been innovative systems for irrigation without the farmer interfering in the irrigation process .

Indeed, smart systems have proven their capability to regulate the irrigation of crops. It also works to stop the waste of water in irrigation. Furthermore, it will work to minimize number of employees which lead to saving money.

Agriculture is developing from mechanized by simple methods in the twentieth century to being automated in the 21st century. There is evolving in field operation in agriculture section, which request a high accuracy in processes to optimize output and quality of the crops, in addition, limiting the production cost. To reach these prerequisites, automation systems must be introduced. It is important that producer considers on the early framework periods of mechanics and actualizes, so can achieve an elevated level of automation .

In this project, we try to solve the problems of irrigation such as errors caused by farmers and the consumption of large quantities of water. These errors affect trees as their fungi may also affect the overall stock of water.

It is necessary to make effective effort and contribution to achieving the desired objectives of this system. Therefore, the effort should not be limited to individual effort. In addition farmers must be very important to achieve the high efficiency of modern irrigation systems.

With the increase of world population, the need for farming yields is increasing instantaneously. Further, the farmer's potential and abilities in the agriculture filed are reducing, this is regarding different enterprises that attract workers away from the farming zone (28% of farmers in Japan are over 65 years old). The income in agriculture needs to continue 5 development regarding the prediction of world population increases from 6.8 billion in 2013 to over 10 billion by 2050.Efficiencies become an essential demand with the declining of farmers potential.

Expected objectives of this project are facilitated and simplify the irrigation system by installing and designing the whole automatic irrigation system, increase crop performance by reducing overwatering from saturated soil. It can prevent irrigation happening on the day at the wrong time, to switch engine ON or OFF by utilizing the irrigation system, the controller will work to switch the engine, so no need for employers, to reduce mistakes of operation due to employees as much as possible and to preserve water from waste

In the era before Our era, farmers understood how much effort and time can be saved by automatic irrigation of land. But although the demand for automatic irrigation systems for cottages and began to grow since the late 90s, now many gardeners do not dare to organize automatic watering and spend several hours a week with a hose in their hands, mistakenly considering drip irrigation systems and sprinklers are not economical and expensive. Let's see why this is not the case and why automation is more profitable than manual irrigation.

There are two main types of automatic irrigation systems:

– Irrigation - for irrigation from above;

– Drip - for root irrigation.

Automatic irrigation system is a large engineering and technical complex, it allows you to perform automatic irrigation of the site according to the required schedule more professionally and efficiently than during manual irrigation. The task of a person is to select the desired mode of automatic watering. All other work falls on the irrigation system and is performed by it independently.

At the same time, a huge saving of money, water and time is provided due to the most optimal, timely, and accurate amount of irrigation for all types of plants on a given site. Sprinklers from the ground appear only during watering and in the future when mowing the lawn and being on the site do not interfere, and do not violate the harmony and aesthetics of the landscape.

The advantages of such automatic irrigation systems over many other irrigation methods are obvious. It is not possible to distribute water evenly over the entire area using a hose when watering. The lawn itself can eventually change a beautiful emerald color to a mottled one. In addition, a large water pressure can not damage the crowns of powerful trees, but rather adversely affect the delicate flower petals, severely damaging them or even cutting them off. Noticeable damage will also be caused to young plantings. With the automatic watering system that is in effect now, absolutely all plants get as much moisture as they need and at a time (morning, night, evening) when water drops on the leaves will not be able to cause sunburn (watering can be programmed for any time of the day).

Simultaneous irrigation of a huge territory requires a large supply of water, which the local standard water supply can not always provide. For this reason, the plot is divided into irrigated zones in turn. With proper and competent placement of irrigation systems on the territory, you can enable the "smart rain" program separately for each zone, taking into account not only the needs of crops in water, but also the size of the plants themselves. Automatic irrigation system allows you to fully regulate the entire volume of life-giving moisture, and the frequency of its distribution (for example, 2-3 times a day). This is quite important, for the reason that a large number of plants do not need daily watering, but the water in any case must penetrate to a sufficient depth for these species. If you often water, but in minimal portions, then the humidity will not reach the root layer and quickly evaporate, and a crust will be formed on the very surface of the soil.

The environment for using such automatic irrigation systems is quite diverse: from private small cottages and dachas, to parks and urban municipal territories, greenhouses and agricultural farms, as well as fields of different sizes (tennis courts, football fields, Golf courses, etc.) and sports grounds.

The modern automatic irrigation system has many components included in it. As a rule, it has an extensive network of pipelines, a pump that supplies water to the pipes, electromagnetic valves, stationary sprinklers, each of which regulates the use of water in its own area, and a garden mini-computer (namely, a controller) that manages all this. The controller controls the entire water supply network of Your garden.

The controller is fully programmed, can run for 365 calendar days, and can cover a couple of watering zones at the same time, also perform more dvkh watering per day, and it is well protected from large power surges. In addition, a storage tank is installed for water, which is used, first, for heating water in the air, water from a water pipe or well for plants is cold enough, and secondly, it provides good watering even in the absence of optimal water pressure (head) in the entire water supply system. At the same time, the controller, which fully controls the irrigation, turns off and on all watering zones in turn, and waters the lawn at the optimal time of day for this, for example, at night. The controller also monitors changes in weather conditions if special weather sensors are attached to it. Sprinklers are selected based on the type of vegetation of the territory to be irrigated (trees, flower beds, bushes, lawn, etc.), the characteristics of the existing water supply system, the composition of the area and the soil to be covered by irrigation. In addition, it is necessary to take into account the compatibility of sprinklers, the possibility of grouping them.

The existing range of sprinklers that are used for automatic irrigation is quite diverse. Each type of sprinkler has its own application area. The main types of sprinklers – it is retractable static (spray) sprinklers (type spray - "spray"); the rotor (also called rotating) sprinklers (they can be retractable ratchet or impulse); funds for drip irrigation and balleri – jet (with a small radius of irrigation or full lack of it) or with a small amount of precipitation. Any automatic system can be complicated or simplified by adding devices with the necessary functions to the configuration itself, depending on the needs of the irrigation area itself.

The automatic irrigation system is simple to operate, although it will require some effort and skill during design and installation. The automatic irrigation system on the site is placed in strict accordance with the created technical project, it must fully take into account which plants and in what quality need watering. It is important to install this system in such a way that it is possible to provide both General irrigation and irrigation of any individual sections. Winter is the best time to design your automatic irrigation system.

You can start installing the automatic watering system directly from may to the end of September. Absolutely all installation work can be divided into the following stages: laying trenches, installation of sprinklers and pipelines, installation of the pressure unit and automation units, and commissioning. It is desirable to perform these works before landscaping the territory itself. Before winter, planned winter conservation of the entire irrigation system, complete drainage of the pipeline network using compressed air, and preparation for storage of control devices and pumping equipment should be performed. In the spring, the planned launch of this irrigation system takes place, complete cleaning of all working parts of the sprinklers from various melt layers.

The wear and service life of the components of irrigation systems varies from a couple of years to a couple of decades, provided that regular and correct preventive measures are strictly observed.

1.2 Requirements for irrigation

Requirements are conditionally divided into agrobiological, agro-soil and meliorative, organizational requirements.

Agrobiological requirements provide optimal water supply to plants. To do this, irrigation equipment must ensure the supply of water in the right amount, the necessary quality and in the required time in accordance with the biological phases of plant development, uniform distribution of water on the field and on the soil horizons in accordance with the placement of the root system of plants, the positive impact of irrigation on the environment of the plant and the creation of the required air, heat and food regimes in the soil and microclimate corresponding to the physiological characteristics of plant development, exclusion of mechanical damage to plants (breakage of stems, etc.) and the negative impact of water current or raindrops on them (lodging, suppression of seedlings, violation of flowering and pollination).

Agro-soil and land reclamation requirements are reduced to the preservation and improvement of the microrelief, structure, mechanical state of the soil and land reclamation condition. To do this, irrigation equipment and irrigation technology should not allow water erosion of the soil, destruction of the structure and compaction of the soil; water losses for deep filtration and discharge, secondary salinization of waterlogged lands.

Organizational and economic requirements are reduced to the rational organization of the territory, highly efficient use of irrigation equipment, water and labor on the irrigation site. Watering is carried out in the most favourable sowing period without deteriorating other agricultural machines for a rational organization of the territory, the use of irrigation equipment at an appropriate level of reliability, a high level of productivity of irrigation, as well as a progressive change in the nature and conditions of work compared to previously used techniques.

Zonal irrigation features

In some areas of the country, it is not possible to use agricultural land without irrigation due to lack of moisture. Five zones of natural moisture are accepted, which are characterized by the following indicators.

The zone is dry, located in the Aral-Caspian basin and Transcaucasia. This zone of continuous irrigation, the amount of precipitation is 100-300 mm per year, so agriculture is possible only with constant artificial irrigation. The main crops of irrigated agriculture in these areas are cotton, rice, vegetables, cereals and vineyards.

The acutely arid zone includes the most arid regions of the Volga region, the North Caucasus, and the foothills of the Eastern Transcaucasia. The climate of the zone is characterized by unstable and insufficient moisture. The average annual precipitation is 200-500 mm. The main crops of irrigated agriculture are technical crops (sugar beet, tobacco, etc.), cereals, vegetables, and garden crops

The arid zone occupies a strip running from the Western edge of the Tsy to the Ob river. It is located North of the acute arid zone and includes the Western part of the North Caucasus, the Central black Earth regions (Kursk, Voronezh and Tambov), and the southern Urals. There are some dry areas in Eastern Siberia and Yakutia.

The aridity of this zone is due to both the lack of precipitation (350-450 mm) and their unfavorable distribution over time. Precipitation falls mainly in the summer months and in the form of showers. Main crops: grain, sugar beet, garden crops, vineyards, forage crops. The use of agrotechnical methods of dry farming and humidification (snow retention, etc.) gives a great effect in this zone. However, irrigation is necessary for a number of crops to produce sustained high yields.

The zone of unstable moisture is located in a strip from the Western border of Russia to the Kuznetsk basin. It includes Penza, Chelyabinsk, Omsk regions, as well as Eastern Siberia and Yakutia. In this zone, in some years, there is an excess or lack of moisture for the cultivation of major crops, so irrigation gives a significant increase in yields. The main crops of irrigated agriculture: vegetables, potatoes, cereals, forage crops.

The rest of Russia is a zone of sufficient and excessive moisture. This zone is characterized by a large distribution of wetlands and waterlogged land. In some periods, vegetable and some technical crops lack moisture.

More than 60% of agricultural land, 58% of arable land, 93% of pastures and 46% of hayfields are located in areas that need irrigation.

Irrigation areas are mainly used for industrial crops (cotton, beet, tobacco, etc.), alfalfa, vegetable crops, vineyards, rice and corn.

The layout of the fields

Irrigated fields after harvesting have various types of irregularities: the remains of temporary irrigation systems and exit furrows, turn lanes, holes and potholes, individual mounds. After ploughing the field appear on the open furrows of the ridges up to a height of 17-20 cm and the breakup of the furrow to a depth of 20-30 cm, large clods and lumps of earth. All these irregularities are subject to planning and alignment.

Field planning is carried out in the dry season — in the summer, in the autumn after plowing the field for the cold or in the spring before sowing once and

2-3 years. Planning is preceded by clearing areas of grassy vegetation and loosening the soil to a depth of 10-15 cm. You can not plan on very wet soil, as in this case, the top layer of soil is strongly compacted, which leads to a decrease in yield. Clay soils stick to the dump and are not leveled, and the tractor is overloaded and skids. It is not recommended to carry out planning and on very dry soil, because in this case the soil is strongly sprayed. Heavy and medium in mechanical composition of the soil is best planned at a humidity of 70-75% of the lowest moisture content (HB), and light soils — at 60-65% of the HB.

Clearing areas of grassy vegetation is carried out with mowers, loosening the soil with plows or a cultivator-Ripper.

Plowing of the field is carried out, to a depth of 15-30 cm in a corral way with plows with pre-ploughs. To reduce the number of split furrows and piled ridges, it is recommended to make the paddocks large, and plowing in adjacent paddocks is carried out either waddle (from the edges of the paddock), or waddle (from the middle of the paddock).

It is more expedient to carry out plowing in the Shuttle way with reverse plows. These plows are designed for smooth (without split furrows and pile ridges) plowing of soils to a depth of 25 cm. A tractor with a plow, moving the Shuttle method that performs the work of laying layer in the same direction.

Work on the continuous layout of the field is preceded by preparatory work, which consists in leveling the pile ridges and camber furrows, local irregularities on the edges and corners of the field. Planners are used for this purpose. Levelling of pile ridges and collapse furrows is carried out in two passes-there and back. When leveling, the blade of the planner grader is set at the lowest angle to the direction of movement so that its center coincides with the line of the furrow or ridge. The sides of the blade are removed.

When planning the edges and corners of irrigation areas, the grader-planner blade is equipped with sidewalls and installed at an angle of 90° to the direction of movement. As a grader-planner, it is also advisable to plan small fields.

The deviation should not exceed 5 cm on non-slope fields (for example, rice checks), 5-8 cm on slopes of 0.001—0.005 and 8-10 cm on slopes of 0.005—0.01.

The middle line of an unplanned field is drawn as close as possible to the existing marks of the unplanned section profile. The planning ability of a planner is determined by its design and the length of the base, and also depends on the length of the irregularities.

In one pass, the long-base planner cuts off irregularities up to 5-8 cm in height with their length not exceeding two base lengths (22-30 m). With a greater extent of irregularities, the efficiency of planning work is sharply reduced. Irregularities up to 30 cm in height are eliminated with three or five passes of the planner. The average height of irregularities is calculated from the average plane after one pass of the planner.

For the first passes, the planner bucket is set 3-4 cm above the zero line (the line connecting the lower points of the wheels), for each subsequent pass, the bucket is lowered by 2-3 cm, and for the last one, it is set at the zero line or 12 cm higher. During the first pass, the largest volume of soil is moved-up to 60-70 m3 / ha, and the subsequent volumes are reduced. In most cases, the number of scheduler passes is 3-4.

Depending on the complexity of the micro relief and the configuration of fields, the following methods of planning by long-base soil planners are used.

The corral single-track method is used on fields of any configuration with small irregularities. The passages of the scheduler when this method is performed in the direction of irrigation.

The diagonal single-track method in combination with the paddock method is used on fields with a complicated microrelief, when two passes of the planner are required to align the field. The first passes are made along the diagonal of the field, and the second—in the direction of irrigation by the corral method.

The diagonal-cross method in combination with the corral method is used on fields with complex microrelief, when three or more passes of the planner are required to align the field. The first two passes are made along the diagonal of the field in mutually intersecting directions, and the last one is necessarily in the direction of irrigation by the corral method.

The diagonal-cross method can be used both on fields of a square shape or close to it, and on fields of an elongated (elongated) shape. This method requires advanced driver skills.

1.3 Methods and types of irrigation

To obtain high and stable yields in irrigated agriculture, irrigation must be carried out taking into account the biological characteristics of crops and soil and climatic conditions. This can be achieved by strictly observing the required irrigation regime.

The irrigation regime for agricultural crops is a combination of the number, timing, and norms of irrigation. It is expressed by the irrigation scheme and is characterized by such indicators as the irrigation rate and irrigation rate.

The irrigation rate is the amount of water given per irrigation, in cubic meters per 1 ha.

The irrigation norm is the total amount of water that is consumed when watering a crop over the entire period of its vegetation.

The irrigation modes of individual crops, following the order determined by the rotation of all crop rotation, make up together the irrigation system in the crop rotation.

To form a unit of dry matter of the ground mass of the crop, plants use a certain amount of water. The amount of water consumed by a plant to form a unit of absolutely dry mass of organic matter is called the transpiration coefficient. however, in the field, water from the soil is consumed not only by plants through transpiration, but also by the soil itself through surface evaporation. Thus, for field conditions, the most important practical value is the total water consumption per unit area by both plants (for transpiration) and soil (for surface evaporation) for the formation of a crop, which is called total water consumption.

The water consumption coefficient is the total, both productive and non-productive water consumption in cubic meters per ton of main products. So, on a fertilized background for the conditions of the North Caucasus, the coefficient of water consumption per 1 ton of winter wheat grain is 1180 m3, for corn-550, for summer potato tubers — 280 m3. The coefficient of water consumption of these crops without fertilizers was much higher. For the South of Ukraine, the coefficient of water consumption per 1 kg of winter wheat grain with a yield of 40 C/ha is 90-80 m3, and with a yield of 50 u/ha — 75-65 m3.

Irrigation method: surface, sprinkling, intra-soil, drip irrigation, fine irrigation.

The surface method is carried out by furrows, strips and flooding.

Furrow irrigation is carried out mainly when cultivating row crops, with a tape method of sowing field, vegetable crops, as well as fruit and berry plantations. Furrows are small — 8-12 cm, medium-12-16, deep -22 and very deep-more than 22 cm. The distance between the furrows, depending on the depth and texture of the soil can be 0,6—0,7; 0,7—0,9 and 0,9—1,1 m Length of irrigation furrows depends on soil permeability, slope of the irrigated area is 100-300 m.

Disadvantages of this method of watering: high labor intensity, low productivity of the irrigator, the impossibility of watering with small standards. In addition, if the saline horizons are located shallowly, then it is possible that the interbeds may become saline as a result of moisture evaporation.

Irrigation by stripes is used for water charging, irrigation of solid crops, less often wide-row, method of sowing, gardens.

This method of irrigation is used in fields with calm terrain, with a uniform longitudinal slope from 0.002 to 0.015. The cross slope should not exceed 0.005 on narrow and 0.003 on wide lanes. The width of the bands varies from 3.6 to 20-30 m, the length - from 50 to 400 m or more. Long strips are cut on well-planned fields with a longitudinal slope of 0.001—0.003 and low water permeability of the soil.

With this method of irrigation, almost the entire surface of the irrigated area is wetted. This is especially important for obtaining friendly uniform full shoots of agricultural crops. This method of irrigation with large irrigation norms provides a downward flow of irrigation water, which does not allow the rise of salts to the soil surface, if the ground water lies at a great depth. The productivity of the irrigator in this method is higher than when watering on furrows.

The disadvantage of this method of irrigation is the compaction of the soil over the entire area and the formation of a surface soil crust. If watering is delayed, cracks may form in the soil, which leads to a rupture of the root system of plants. To loosen the soil, harrowing with tooth harrows or processing with a rotary hoe or needle harrow is required. After irrigation, soil aeration decreases sharply, which is accompanied by a temporary decrease in microbial activity in the soil and the formation of nitrates, and the previously accumulated nitrates are washed deep into the irrigation water. These phenomena temporarily worsen the nitrogen nutrition of plants. The disadvantages of this method of irrigation should also include the destruction of the soil structure and uneven depth of soil moisture in the irrigation area.

Flooding irrigation is carried out in areas (checks), limited by earthen rollers. It requires a large initial cost for the construction of checks, especially careful planning and, in some cases, for the device of the drainage network. Prolonged exposure to water in this method of irrigation leads to erosion, silting and strong compaction of the soil.

This method of irrigation is used for rice cultivation, for water charging, for estuary irrigation, and for washing saline soils. Sometimes this method of watering is used when watering perennial grasses, corn. The slope of the irrigated area should not exceed 0.001 or it should be completely absent.

Disadvantages of this method of watering are as follows. First of all, a large amount of water is consumed. Due to long-term flooding of checks, the soil is separated from the surface layer of air, gas exchange between soil and atmospheric air is stopped for a long time, the aerobic process slows down and the conditions of plant nutrition deteriorate. With this method of irrigation, a lot of water is spent on its evaporation from the surface of the irrigated area.

Sprinkler irrigation consists of spraying water over the surface of the irrigated area with special sprinkler units. This is the most effective method, since it brings the conditions created closer to natural hydration. In this case, not only the soil is moistened, but also the surface layer of air and plants. With this method, you can adjust the irrigation standards in a wide range and apply it not only for pre-sowing and vegetation, but also for special watering: refreshing, fertilizing, anti-frost.

This method of irrigation eliminates the possibility of waterlogging and sharply reduces the risk of salinization, along with water, it is convenient to apply non-root top dressing and combine watering with spraying solutions of drugs for the destruction of pests. Some insects are washed off the leaves with irrigation water. In plants, turgor is quickly restored, the degree of opening of stomata increases, resulting in an increased intensity of assimilation and improved air nutrition of plants.

Sprinkling allows not only to get high yields,but also to significantly improve the quality of vegetable and other crops.

The disadvantages of irrigation include uneven degree of soil moisture when the wind is more than 3 m / s, small depth of soil washing, damage to immature plants(seedlings), flower buds with large raindrops.

To prevent surface water runoff and soil flushing on heavy clay soils, the rain intensity should not exceed 0.1—0.2 mm/min, on medium loam — 0.2—0.3 and on light soils — 0.5—0.8 mm/min.

Intra-soil (subsurface) irrigation is carried out by supplying water to the soil through the pores-holes or joints of tubular humidifiers, as well as from moles made in the soil at a depth of 40-50 cm. The distance between humidifiers in field and vegetable crop rotations is 1,0-1,2 m, in gardens 1,8— 2,0, in vineyards 2,0—2,5 m.

Water is supplied to humidifiers from open channels or pipes. Then, as a result of capillary lifting of water up, the active layer of soil is moistened. This method of irrigation allows you to maintain soil moisture close to the capillary moisture capacity. In this method, the soil surface is not subjected to flushing and erosion, no soil crust is formed, much less than in other methods, moisture is lost for evaporation, there is no irrigation network, which allows you to conduct field work at any time, and the cost of irrigation is reduced.

Disadvantages of intra-soil irrigation: insufficient moisture of the topmost layer of the soil, leaving part of the water deep beyond the root layer of the soil, raising salts on saline soils up, high cost.

Drip irrigation is the delivery of small portions (drops) of water directly to the zone of the root system of plants using Pipes laid shallow in the soil, or on the soil surface through micro — outlets-droppers. This method ensures that the soil humidity is close to optimal throughout the growing season. This method is used in perennial plantings: gardens, vineyards and in plantings of some other crops on soils with complex terrain and high water permeability.

The peculiarity of this method of irrigation is that water is supplied continuously and evenly throughout the vegetation of plants.

Drip irrigation has a number of advantages over other methods: low irrigation costs, the ability to dose the water supply for evaporation and filtration outside the root layer, eliminates surface runoff and saves water. It is possible to apply locally nutrients with irrigated water, create favorable water-air and nutrient regimes of the soil. This method of irrigation eliminates the possibility of raising ground water and secondary salinization of the soil.

Fine-dispersed, or aerosol, irrigation provides moisture to the surface layer of air, plants and partially the soil surface. The size of water drops reaches 200-300 micromillimeters, which do not roll off the leaves, but remain on them until complete evaporation. Such water drops are formed when the water jet is crushed by fog-forming installations. During the day, crops and plantings are moistened up to 10 times, spending 100-200 l / ha per irrigation.

Fine-dispersed irrigation reduces the temperature of the surface layer of air and plants by 5-10 °C, while increasing the humidity of the air. This reduces the water consumption for plant transpiration and increases their photosynthetic activity.

Irrigation method - a set of measures and techniques for distributing water in the irrigation area and converting the water flow into soil and atmospheric moisture.

There are the following methods of irrigation:

– surface-distribution of water on the surface of the earth using furrows, stripes and flooding checks;
– sprinkling - creating artificial rain; aerosol humidification (fine sprinkling) spraying the smallest drops of water to regulate the temperature and humidity of the surface layer of air above the field;
– intra-soil-water supply directly to the root zone of the soil by humidifiers or raising the level of soil and ground water;
– drip-local irrigation using micro-top-UPS, irrigation drippers.

Irrigation - a single artificial moistening of the soil and (or) the surface layer of air. Irrigation technique - parameters of the irrigation technology (length of furrows, strips, expenses, flight range of the sprinkler jet, distance between humidifiers, etc., i.e. technical implementation of irrigation with a particular method of irrigation.

Irrigation equipment - technical means (machines, mechanisms and tools)for irrigation.

Surface irrigation depending on the nature of the distribution of irrigation water across the field and the method of conversion to soil moisture, surface irrigation is carried out: by flooding, along strips and along furrows.

Flooding irrigation is one of the most ancient methods of surface irrigation. Currently, flooding irrigation is limited to rice cultivation, estuarine irrigation, and in some cases, water-charging and vegetation irrigation for field crops. Flooding is also used in the cultivation of crops that tolerate short-term flooding with a layer of water (alfalfa, corn, oats, sorghum, wheat, barley, etc.). the Use of flooding irrigation is favored by a flat or low - slope terrain and sufficient water supply of the irrigation source.

The irrigation rate, depending on the size of the receipt, ranges from 1500 to 4000 m3/ha.

Irrigation in strips is used for irrigation of crops of continuous sowing. Water with this irrigation moves on the surface of the soil, bounded on both sides by rollers.

15...25 cm, layer 2...3 cm Width of the bands is consistent with the width of farm equipment and adopted a smooth and 3.6...4.2 m or multiples of it. Irrigation by stripes is more often used for vegetation irrigation of crops of narrow-row seeding (cereals, perennial and annual grasses, etc.), fruit plantations and vineyards, as well as pre-sowing, water-charging and washing irrigation for any crops.

The irrigation rate for irrigation in strips ranges from 800 ... 1500 m3 / ha.

Furrow irrigation is the most advanced method of surface gravity irrigation and the most common method of watering row crops (corn, sunflower, beet, cotton, potatoes, etc.), vineyards, orchards and vegetable crops.

Irrigation water when watering furrows is distributed not by continuous flooding of the surface of the field, but along the grooves cut in the rows of row crops-furrows.

The irrigation rate for furrow irrigation ranges from 400 ... 1500 m3 / ha.

Sprinkling is the most common method of irrigation in the Russian Federation. The essence of sprinkling irrigation is that irrigation water, under the influence of artificially created pressure with the help of special devices or nozzles, is sprayed into small drops. Under the influence of gravity, raindrops fall on the irrigated area, while moistening the surface layer of air, plants and soil.

Advantages of sprinkler irrigation: a high level of mechanization, partial or full automation of the irrigation process; the ability to use on areas with both straight and reverse slopes or a flat surface; smaller, compared to the surface irrigation method, the volume of planning work; the ability to maneuver irrigation standards in a wide range from 50 to 900 m3/ha.

Disadvantages of sprinkling: high energy consumption; large metal costs; negative influence of wind, etc.

Depending on the type of nozzles or devices, sprinklers and installations are divided into short-jet, medium-jet and long-jet

Short-jet sprinklers. Irrigation of grain, vegetable, fodder, industrial crops, berry bushes, fruit nurseries, meadows and pastures located on relatively flat areas and allowing the device of open sprinklers is carried out with a two-pole sprinkler unit DDA-100MA.

During irrigation, the tractor moves along the channel road and takes water from a temporary sprinkler or tray.

The productivity of the machine for 1 hour of clean operation at a watering rate of 600 m3 / ha is 0.78 ha.

Medium-sized sprinklers and installations. Sprinklers and installations equipped with medium-jet sprinklers - "Fregat", "Volzhanka", "Dnipro", etc. The radius of the area covered by rain for such devices varies from 15 to 35 m.

The dksh-64 "Volzhanka" sprinkler wheel pipeline is intended for irrigation of grain and fodder crops (except high - stemmed ones-corn, sorghum, sunflower, etc.), vegetables, melons, potatoes, beets, meadows and pastures. The sprinkler is a multi-wheel self-propelled pipeline of front movement. It consists of two wings, sprinkling with a length of 400 m. In the middle of each pipe, as on the axis, attach the running wheels. The pipeline is located at a distance of 0.89 m from the field surface.

Productivity when watering from one position-1.44 ha, 0.72 ha under each wing, for 1 hour of clean work at a watering rate of 600 m3 / ha is 0.39 ha.

Long-range sprinklers. Long-range sprinklers DDN-70 and DCN-100 are widely used in the practice of irrigation of highly profitable agricultural crops, and with appropriate equipment - gardens and nurseries. They are mounted on tractors DT-75 and DT-75M (DDN-70) or T-150, T - 4A and DT-75 (DCN-100). Water consumption by the machine DCN-70-65 l / s, DDN-100— 100 ... 115 l / s.

Irrigation is carried out positionally with water intake from temporary sprinklers or from low-pressure pipelines.

Long-range sprinklers are sensitive to the negative influence of wind on the quality of irrigation. When the wind speed is up to 1.5...2 m/s, it is better to water in a circle, and at a higher speed (up to 6 m/s) - in the sector. With a watering rate of 600 m3 / h for 1 hour of clean operation, the machine provides irrigation of the area DDN-70-0.39 ha, DDN-100-0.7 ha.

Intra-soil (subsurface) irrigation-a method in which water is supplied to the root layer through pipes

- humidifiers laid in the soil at a depth of 40 ... 60 cm from the ground surface. Through the holes in the pipes, capillary water flows to the roots of plants, without moistening the soil surface.

With VPO, full mechanization of irrigation is possible, strict rationing of water supply and fertilizers dissolved in it in accordance with the needs of cultivated crops, labor costs for processing crops, fertilization, and weed control are reduced.

VPO systems are used for growing high-yield crops - vegetable and fruit crops, grapes, cotton, etc. Construction of the VPO system is relatively expensive and pays off only after 3 ... 6 years, so this method is not yet widespread, although its advantages are obvious.

Irrigation norms for VPO vary from 250 to 750 m3/ha, and irrigation from 2400 to 5500 m3 / ha.

Drip irrigation is a method of local soil moisture, i.e. the zone of direct location of the root system. With drip irrigation (CO), water is supplied directly to plants through special micro - vents-droppers with very low flow rates (4...20 l/hour). At the same time, only the root distribution zone is moistened, and the row spacing remains dry. If necessary, fertilizers are supplied along with irrigation water. The fertilizer solution is injected into the main pipeline using an injector.

The most important advantage of CO is a large saving of irrigation water as a result of a significant reduction in water losses for filtration outside the root zone, evaporation, surface runoff, as well as due to the elimination of uneven irrigation. Numerous experiments have shown that with drip irrigation of cotton, potatoes, tomatoes, cucumbers, oranges, grapes and other crops, the irrigation rate decreases by 41...47% compared to sprinkling and by 52...60% - with surface irrigation.

The KO system is environmentally safe and is used on land with high slopes (up to 0.35), with limited water resources, on unproductive (stony-sandy) soils, and rugged terrain, where traditional irrigation methods are practically not applicable. Drip irrigation provides the highest utilization rate of irrigation water-80 ... 95% (for sprinkling-70 ... 80%, for surface irrigation-30 ... 60%).

The irrigation rate for drip irrigation ranges from 40 m3 / ha to 300 m3 / ha.

Aerosol (fine) sprinkling is designed to increase the humidity of the surface layer of air and reduce the temperature of plant leaves under adverse environmental conditions (air droughts and dry weather). In this method, water is sprayed on the smallest drops of 0.4...0.6 mm, which are well held on the leaf surface, remaining on them until complete evaporation, cooling the leaf surface and increasing the humidity in the plant environment.

It is carried out when the air temperature exceeds the physiological optimum, it is conventionally taken for 25°C.

Fine sprinkling is used to increase the efficiency of photosynthesis, protect plants from frosts, fight with dead plants, pests, regenerate the root system of frozen plants, etc.

The one-time moisture rate for MDD is in the range of 100 ... 600 l/ra per hour, depending on the temperature and humidity of the air. In this case, the irrigation rate varies within 3...5 m3 / ha, and the irrigation rate does not exceed 180 m3/ha. which is 2 ... 16 times less than with other irrigation methods.

1.4 Factors affecting productivity

Many decisions made during the cultivation of agricultural crops are based on the accounting of yield. Data on the yield of a particular crop in a particular field allows the producer to make more correct and reasonable decisions about the doses of fertilizers, to draw conclusions about how effective production is in this field.

Commodity producers, agronomists and researchers divide the factors that affect productivity into natural and anthropogenic (table 1.1). It is quite difficult to rank factors by their degree of influence on productivity, since they change from year to year. In addition, many of them interact with each other in both time and space.

For example, changing the depth of the arable layer affects not only the water-holding capacity of the site, but also the content of nutrients available to the plant, soil aeration, root formation, etc. The presence of moisture, including both its excess and deficit, significantly affects the yield of agricultural crops. Soil scientists and agronomists are well aware that the yield is proportional to the amount of water absorbed by the plant or evaporated. Thus, a model of plant development based only on the absorption of moisture by the plant explains 69% of the variability of the soybean crop in Iowa .

Field yield mapping has recently become a common practice among us producers. Some fields already have a three-to five-year history, represented in yield maps.

The value of maps depends on how well they are analyzed. The main goal of interpreting yield maps is to increase profitability by better understanding the natural and anthropogenic causes that cause yield variability within a single field. It is obvious that the information presented on the map has a certain error that can be corrected. The errors should be separated from the actual yield variability across the field for a more accurate interpretation of the map. For successful interpretation of maps, additional information about the field is involved. To effectively assess the impact of the entire set of factors on productivity, GIS is used that establishes a link between productivity and other characteristics of the field.

On the basis of data on productivity, the producer can judge the advantages or disadvantages of a particular technology for cultivating a given crop. By studying the variability of yield within a single field (on elementary plots), the producer can determine the reasons for this and eliminate them.

The most convenient form of presenting information about yield variability is the yield map, which shows the yield on individual plots with a strict reference to a specific coordinate system.

Table 1.1 - Factors influencing variability of yield

The sources of variability in the yield	Examples
1	2
Natural factor	
Weather	- amount of precipitation and its frequency - solar radiation - wind - temperature
Interaction between soil and moisture	- drainage - thickness of the soil layer - water holding capacity
Physical and chemical properties	- structure (sand, clay) - structure and density - depth and interaction of layers - availability of nutritional elements - pH, organic matter, salinity - cation exchange
Slopes and other site characteristics	- intensity of erosion processes - soil temperature - property of soil
Pest infestation	- weeds, insects, diseases, macroflora
1	2
Factors related to management decision	
The condition of crops	-selection of hybrid or variety (potential yield) - density of standing and uniformity of plant arrangement - application of fertilizers and plant protection products
The history of the field	- crop rotation - tillage and compaction of soil - the previously used technology of cultivation

Over the past five years, the number of grain harvest monitors installed on grain harvesters in North America has increased from 100 to 25,000. Almost half of them are connected to DGPS receivers for yield mapping. This equipment, together with a computer, printer, and corresponding mathematical software, allows the producer to make color yield maps that reflect the variability of the crop during the transition from one site to another. Producers hope to use this information to reveal the secrets of yield variability within a single field, improve their production efficiency and increase their net profit. Despite the fact that the maps have become available to many manufacturers, their interpretation is much more difficult than they expected and their consultants.

Many factors that affect productivity are interdependent. The key to interpreting the maps is to better understand the causes of crop changes and identify those that are caused by the actions of the producer himself during the cultivation of the corresponding agricultural crop. Yield mapping is only effective when this information is used for more informed decision-making. Work is currently underway to automate the yield mapping process using the latest advances in electronics and global positioning. Despite the fact that the technology of making yield maps is widely implemented in the life of commodity producers, many technical issues remain unresolved. For example, determining the yield and coordinates of the aggregate is associated with many random and systematic errors. Therefore, when drawing up a map, you must take measures to avoid errors. The current mathematical software corrects the yield data before presenting it as a map. To get the information needed to build a yield map, a number of sensors are installed on the harvester (figure 1.1).

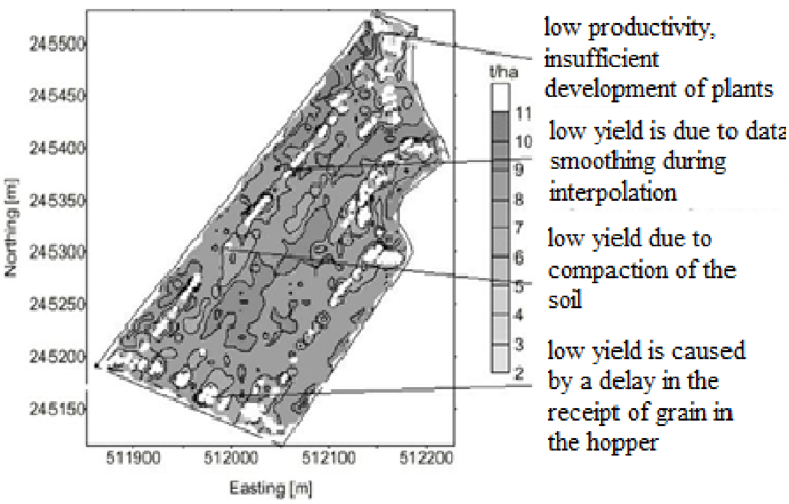

Figure 1.1 - Yield map

More efficient use of the yield map can be achieved by combining yield information with other field information, such as terrain, distribution of food elements, etc.

But even taking into account the existing errors in determining the yield of agricultural crops on the yield map, it is possible to determine the causes that caused the variability of yield across the field The heart of the mapping system is the yield sensor, which measures the yield either directly by weighing or indirectly. Currently, there are many different sensors for determining yield. To get reliable information about the yield, high-precision sensors are needed. However, even with an accurate estimate of the mass of grain entering the hopper, it is not always possible to accurately determine the yield. This is due to a number of reasons:

- change the geometry of the grain flow;
- violation of the sensor characteristics, for example, due to changes in the ambient temperature or vibration of the combine;
- changes in grain moisture or density;
- clogging of the grain flow with various inclusions.

The choice of irrigation method largely depends on the following indicators:

Soil conditions:

– the rate of water absorption by the soil;
– the level of occurrence and degree of mineralization of ground water;
– quality of water used for irrigation;
– the content of nutrients in the soil;
– terrain of the territory, etc –

Natural and climatic conditions:

– features of the wind mode;
– precipitation and evaporation parameters;
– the probability of return of cold weather and early frosts;
– average monthly temperatures, etc.

Features of agricultural crops:

– type of root system, features of distribution of active root mass;
– moisture-loving;
– thermophilicity;
– drought resistance;
– sensitivity to weeds;
– need for feeding, etc.

So, for example, strawberries are very moisture-loving, need constant watering, can not grow on heavy clay soils, requires a well-lit area with a height difference of no more than 5 degrees. It is not suitable for sprinkling, but drip irrigation is the best choice.

For crops of a large family of lettuce and lettuce vegetables, you can use microsprinklers, but they are also categorically not suitable for potatoes, peppers, tomatoes because of the wide surface area of wetting, which can lead to the formation of mold and fungal diseases, etc.

Let's look at what types of plant watering are most popular today, what are their advantages and disadvantages.

2. The principle of operation and organization of the information and measurement system

2.1 Advantages of automatic irrigation

By using the concept of modern irrigation system a farmer can save water up to 50%. This concept depends on two irrigation methods those are: conventional irrigation methods like overhead sprinklers, flood type feeding systems i.e. wet the lower leaves and stem of the plants. The area between the crop rows become dry as the large amount of water is consumed by the flood type methods, in which case the farmer depends only on the incidental rainfalls. The crops are been infected by the leaf mold fungi as the soil surface often stays wet and is saturated after irrigation is completed. Overcoming these drawbacks new techniques are been adopted in the irrigation techniques, through which small amounts of water applies to the parts of root zone of a plant. The plant soil moisture stress is prevented by providing required amount of water resources frequently or often daily by which the moisture condition of the soil will retain well. The diagram below shows the entire concept of the modern irrigation system. The traditional techniques like sprinkler or surface irrigation requires / uses nearly half of water sources. Even more precise amounts of water can be supplied for plants. As far as the foliage is dry the plant damage due to disease and insects will be reduced, which further reduces the operating cost. The dry rows between plants will leads to continuous federations during the irrigation process. Fertilizers can be applied through this type of system, and the cost required for will also reduces. The erosion of soil and wind is much reduced by the recent techniques when compared with overhead sprinkler systems. The soil characteristics will define the form of the dripping nature in the root zone of a plant which receives moisture. As the method of dripping will reduce huge water losses it became a popular method by reducing the labor cost and increasing the yields. When the components are activated, all the components will read and gives the output signal to the controller, and the information will be displayed to the user (farmer). The sensor readings are analog in nature so the ADC pin in the controller will convert the analog signals into digital format. Then the controller will access information and when the motors are turned On/Off it will be displayed on the LCD Pane

There is an urgent need for a system that makes the agricultural process easier and burden free from the farmer‟s side. With the recent advancement of technology it has become necessary to increase the annual crop production output entirely agro-centric economy. The ability to conserve the natural resources as well as giving a splendid boost to the production of the crops is one of the main aims of incorporating such technology into the agricultural domain of the country. To save farmers effort, water and time. Irrigation management is a complex decision making process to determine when and how much water to apply to a growing crop to meet specific management objectives. If the farmer is far from the agricultural land he will not be noticed of current conditions. So, efficient water management plays an important role in the Irrigated agricultural cropping systems.

Automatic irrigation looks like a system of engineering solutions and equipment that provides regular supply of the necessary amount of water to green spaces without direct human involvement. The traditional method of watering using a garden hose can not replace automatic watering, as it is a difficult controlled process, in addition, it is often complicated by a large area of land.

In areas where the owners take care of the plants and carefully monitor their condition, automated irrigation will pay off in a short time due to the reduction of labor costs and the preservation of an attractive type of green space. It is also worth noting that without an automatic system, a dry summer can easily ruin your lawn, ruining many years of work on its creation.

Among the advantages of automatic irrigation systems are the following:

- Reliability and durability. Pipes and system parts are made of low-pressure polyethylene or, as it is also called, high-density polyethylene, which has good impact strength and resistance to loads.
- The quality of irrigation. Automatic systems are installed in such a way that they allow for high-quality irrigation of vegetation throughout the site, including the most inaccessible places, which is extremely difficult to achieve with manual irrigation.
- Saving. Using the system allows you to significantly reduce the time and labor costs required for watering the territory, as well as saves water and electricity.
- Easy operation. When properly installed, automatic systems are quite easy to handle and maintain and usually do not require additional maintenance costs.
- Programmability. The systems allow you to set the required amount of irrigation during the day, as well as the duration of each irrigation, controlling water consumption. It is possible to set the exact time of switching on and off and provide both General irrigation and irrigation of individual areas of the territory. In addition, thanks to the presence of humidity sensors, the system reacts to the weather and independently regulates its operation. The use of the system also ensures the uniformity of irrigation throughout the site.Advantages of automatic irrigation systems

- Aesthetic appeal. This system is almost invisible to the eye, since all communications are hidden underground, it does not violate the design of the landscape and the integrity of the lawn, and sticking out watering heads can have an original and attractive appearance, organically fitting into the landscape and decorative composition.
- Quick installation. If you have special knowledge and relevant experience, the automatic system is installed and started in a short time. For example, for professionals from the company Aqua-installation, this time for a plot of no more than 20 acres is from 3 to 6 days.

Automatic irrigation system, unlike many decorative garden structures, will never be an unnecessary, optional element on your site. If you are the owner of a neat lawn or a connoisseur of landscape compositions, if you want your garden to benefit, and the lawn to please the eye with bright colors, then you definitely need automatic watering. It will help your site quickly get the best look, preserving it throughout the season.

A perhaps in large field with complex topography, where it is absolutely impossible to apply any surface irrigation is Well suited for watering a huge number of crops. It is possible to use water sparingly and sparingly, increase yields, and improve irrigation efficiency.

Provides extensive mechanization of absolutely all agricultural work and their precise execution in a fairly short time.

A wide range of choice of the desired nozzle size of sprinklers greatly facilitates the adjustment and design of irrigation intensity:

– Provides an accurate calculation of water consumption on the territory.
– Increases the coefficient of land use.
– Huge mobility of irrigation systems.
– Suitable for all existing auxiliary watering systems.
– Great for flushing any fields in the profile.

It is possible to achieve an exact and uniform watering intensity on the irrigated area (a clear and uniform distribution of water on the field).

Good convenience of applying fertilizers with irrigation water.

2.2 The principle of operation of automatic irrigation

Let's look at the rules of equipment of the irrigation system, which will guarantee that the crop will please you. To do this, it needs proper care. This is especially important if the season is dry and the grass, not having enough moisture, begins to fade and turn yellow, forming an unpleasant look withered spots. The optimal solution in this situation is automatic watering. Let's consider the basic rules of its installation, types, advantages and disadvantages.

Need for irrigation

When engaged in agriculture, you need to remember that it needs water in quantity, and surface irrigation will not be enough. In order for it to be considered correct and of high quality, it is necessary to ensure that water penetrates into the soil at a distance of at least 5-6 cm, which will help maintain soil moisture.

Not everyone has the opportunity to pay a lot of attention to watering and waste water. Here comes to the aid of automatic lawn watering, caring for the juicy greenery of the lawn yourself. You only need to carefully configure its automation according to the instructions.

Variation of irrigation

There are fundamentally different designs that are mounted separately in different cases:

– for large sections;
– for flower beds and greenhouses
– entire suburban areas.

Optimally selected irrigation system can increase productivity and reduce water consumption, in addition, it will greatly improve the appearance of plants planted on the site. This largely depends not only on regular, but also on the uniform watering of the site.

The landscape irrigation system contains the following components:

– hoses;
– cranes;
– valves;
– controllers;
– sprinklers.

All this functions thanks to specially configured programs that work according to their clearly set schedule.

The automatic watering system is installed even before sowing the grass mixture. This is because laying pipes requires removing the top ball of turf. An alternative option is considered to be a drip irrigation system.

Initially, automatic lawn watering is divided into agricultural and landscape.

On private land, landscape automatic irrigation is used:

Automation-the work schedule is included in the program and watering takes place strictly according to it.

Manual-enabled manually.

Combined-the operation can be programmed or controlled manually.

We offer you the main systems. This information will help you choose the best one for your site:

- Drip and micro-drip.
- Soil and basal.
- Sprinklers.
- Fog-forming.

Micro-drip irrigation in the country is an ideal solution on land with limited water supplies. It is carried out using a structure that directs water to the roots. This allows you to irrigate the soil as much as possible, using minimal water.

Subsurface and root irrigation of the lawn supplies water directly to the roots of plants. A special feature is the location of the system in the ground. This guarantees maximum efficiency of the structure and the fact that it will not be visible from the outside, that is, it will not spoil the appearance of the site.

Sprinklers create the appearance of summer rain. This automatic watering system in the country delivers moisture to the roots, and humidifies the air around the plants.

The misting system involves creating the visibility of fog, which provides watering with the smallest drops. It is considered the best for the care of "tropical guests".

Installation of automatic irrigation

Automatic watering of the lawn must be installed before starting to plant the lawn.

The process is performed in several stages:

- The top layer of earth is removed (about 40 cm)
- Pipes are being laid

If the lawn is already planted, its turf layer must be carefully cut and, having installed the irrigation system, put in place.

It is recommended to group the growing plants before starting the installation of automatic watering. They are planted in groups, taking into account the amount of moisture they need. The site is zoned and put water sprinklers with the necessary capacity for a particular site.

When the system is installed in an area where bushes or trees grow, it is recommended to install sprinklers with a jet of counter irrigation.

Sometimes, for quality, the equipment must be additionally equipped. For example, if the ground water in the region is polluted or its technical characteristics do not allow use without pre-treatment, you will need to install additional filters.

Even before the onset of frost, it is necessary to drain the remaining water in the system. This will prevent the pipes from bursting during the onset of frost.

The automatic watering system performs the task as efficiently and autonomously as possible, without your participation. The source that supplies water resources is a home water supply system or an underground well.

To save on installing the system, you can try installing it yourself. To do this, you will need the following equipment:

- Controller
- Solenoid valve
- Filters
- Pumping plant
- Pipes
- sensors

Each of these components provides a certain stage of operation of the device. The most important thing is the controller.

This is a kind of computer of reduced size, in fact, it is the brain of the entire automatic irrigation system, providing all its work. The controller performs the following functions:

- Control device
- The program sets the number of waterings
- Disables watering in the rain
- The controller can be installed both outside and inside the room.
- The main function of the solenoid valve is to ensure optimal water supply to pipes and sprinklers.

Filters ensure a long service life of the system and purify water from blockages that can lead to the need for its repair. The pump is used in the case of water supply from a well. It creates the optimal pressure function in the system for full lawn watering, which drives a mechanism consisting of sprinklers and injectors.

The pipes provide water delivery to irrigation sites from the reservoir. The cross section of pipes and their sizes are selected according to the system placement zone. Polyethylene pipes made at low pressure are considered the best.

A sprinkler with a nozzle is a special device that performs irrigation. Installed under the ground. It is supplied with water under pressure, the mechanism pushes the nozzle and through it the water spreads in a cascade of a million drops.

In General, watering is performed as follows:

- Commands entered into the system allow the controller to control the solenoid valves
- From them the water passes into the pipes
- Reaching the watering heads, the water irrigates the plot

To start installing the irrigation structure, perform the following preparatory steps:

- Create a project
- Calculate the cost
- Set
- Launch

At the design stage, you need to make a plan for the entire site where you plan to water. The scheme is also called an arboretum, where all the plants are marked. The area of the plot is measured with a tape measure and a plan with paths, buildings and plants is drawn on a paper sheet.

This is then transferred to millimeter paper with the recommended scale of 1: 100. Here it is necessary to observe all the accuracy. The drawing is zoned, and then the places where sprinklers are installed are marked on it. It is important to keep in mind that water is not sprayed on the house or other buildings.

All elements of the structure are marked on the diagram and approximate zones of its operation are drawn. This will help you choose the optimal watering heads. When planning the installation sites of sprinklers, do not forget that the largest amount of water is spilled far from them.

The arboretum is marked by plants, water reservoirs, electricity sources, water supply and drainage systems. You will be able to install the controller and other elements of the structure in the optimal places for this purpose.

It is also important to take into account changes in soil height and composition. It is necessary to conduct the analysis on the hydraulic load.

Performing hydraulic calculations is necessary in order to make the correct choice of pipe diameter, count the required number of valves and determine the desired water pressure for lifting the irrigation nozzles.

Installation is carried out after carrying out all calculations. When laying pipes, the site is excavated and marked:

- It is recommended to mark places for sprinklers with wooden pegs.
- Set the location of the pump (if it is intended).
- In places where the Central pipes pass, 30–cm trenches are torn out. If earthworks are planned on this site, the depth will have to be increased to 50 cm.
- Dig trenches connecting pipes and sprinklers.
- Place the Central pipes
- The main pipe is cut and connected with a special tee-splitter with the pipes of the middle line (so-called bends are made)
- Connect pipes that go to sprinklers or sprinklers.

– To the end of the last, with the help of a tap, attach a hinged knee that regulates the height of watering. This is how all lines are worked out.
– All sprinklers are fitted with nozzles and all screws are tightened.
– Sprinklers are attached to the articulated knees, trenches are buried, except for those located near the sprinklers, which are placed level with the ground.

The purpose of this section is to find a successful solution for creating an automatic plant watering system based on the Arduino microprocessor platform. The structural diagram of the system is shown in figure 2.1.

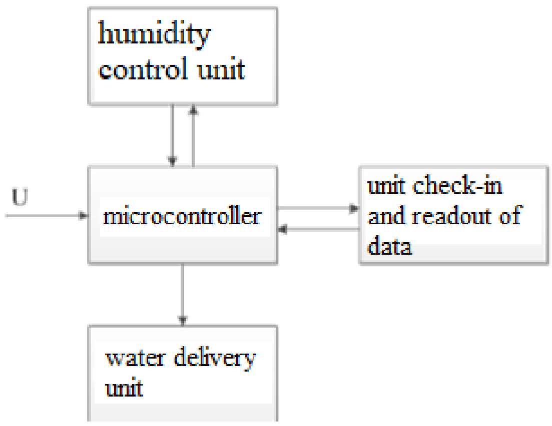

Figure 2.1-Block diagram of automatic irrigation

2.3 Arduino hardware platform

As the initial data for the work, I received a platform of the Arduino family called the Arduino Nano (figure 2.2). the Arduino Nano is a full – featured miniature device based on the ATmega328 microcontroller (Arduino Nano 3.0) or ATmega168 (Arduino Nano 2.x), adapted for use with layout boards. It is optimally suited for layout using solderless layout boards, since all contacts are output on two lines at the edges of the Board, the pin pitch is 2.54 mm, the distance between the lines is 15 mm. Built-in bootloader and USB <> COM Converter based on the CH340 chip, allows you to update the firmware without using a programmer, with a single click on the computer. However, if necessary, it can also be "flashed" by any standard programmer with a standard 6-pin ISP interface. The technical characteristics of the platform are shown in table 2.1

Figure 2.2-Arduino Nano Hardware platform

The characteristics of the Arduino Nano Board are shown in table 2.1. most of the Board parameters are determined by the microcontroller used.

Table 2.1-Characteristics of the Arduino Nano Board

Type microcontroller	ATmega168	ATmega328
Architecture	AVR	
The supply voltage of the microcontroller	5 V	
Rated power supply voltage of the Board	7 – 12 V	
The maximum allowable voltage of power Board	6 – 20 V	
Clock speed	16 MHz	
Program memory capacity (FLASH)	16 KB	32 KB
The amount of random access memory (SRAM)	1 Kbyte	2 Kbyte

The Board can receive power in two ways:

- via the computer connection cable from the USB port;
- from an external power supply with a voltage of 6-20 V.

The voltage may not be stable, but with a low ripple level. The external power supply voltage is stabilized at 5 V using the LM1117IMPX-5.0 chip (figure 2.3). The computer's USB port voltage is connected to the stabilizer output via a Schottky diode (with a low voltage drop).

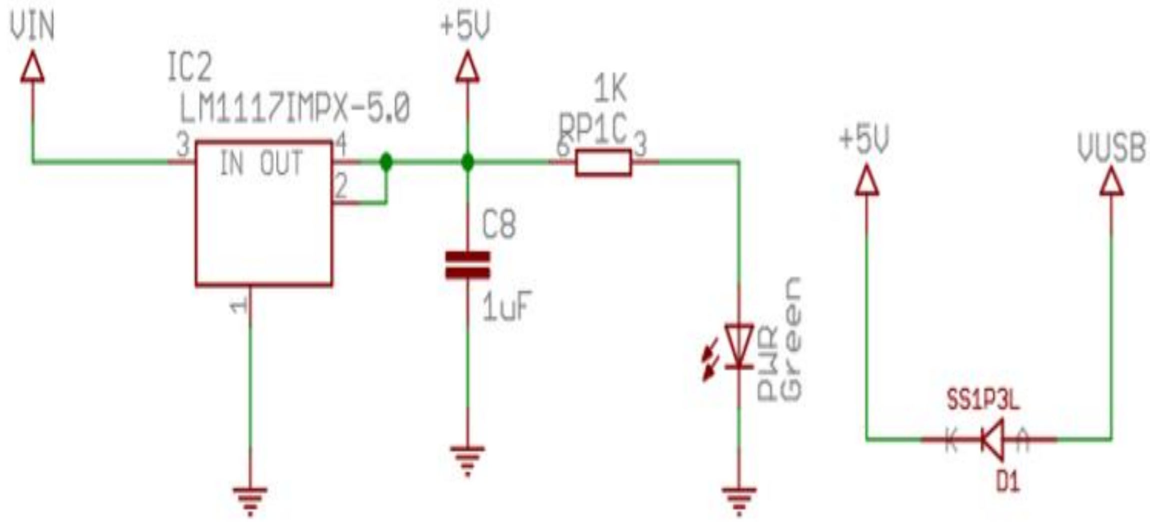

Figure 2.3 – integrated circuit LM1117IMPX-5.0

Thus, when both sources are connected simultaneously, the Board is powered from a high-voltage source. The 5 V pin can be used to power an external device. It is important to remember that the load current should not exceed 500-800 mA for different boards. The 3.3 V pin can be connected to 3.3 V external devices. The load current must not exceed 180 mA. The inputs and outputs of the Board are shown in figure 2.4, and their purpose in table 2.2.

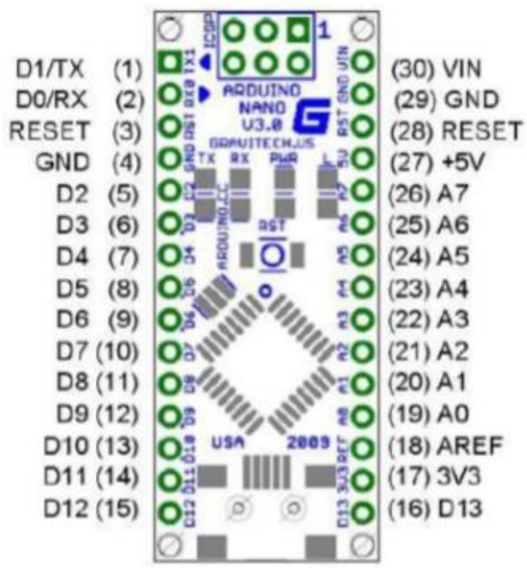

Figure 2.4-Arduino Nano Pins

Table 2.2-pin Assignment

No. output	Name	Type	Description
1-2, 5-16	D0–D13	I / o	Digital I / o ports
3, 28	RESET	Input	Reset (active low)
4, 29	GND	Power	Total power
17	3V3	Output	+3.3 V from FT232 chip
18	AREF	Input	Reference voltage ADC
19-26	A0–A7	Input	Analog input
27	+5V	Input output	+5 V To the output from the regulator on the Board or +5 V input from external power source
30	VIN	Power	supply Voltage

The Board has 14 digital pins, each of which can work in input and output modes. Some conclusions still have alternative functions. Serial UART interface: pins 0(RX) and 1 (TX) are used for data exchange over the UART interface. These pins of the Board are directly connected to the corresponding pins of the microcontroller. The signals of the interface Converter are connected to them via resistors with a resistance of 1 kOhm.

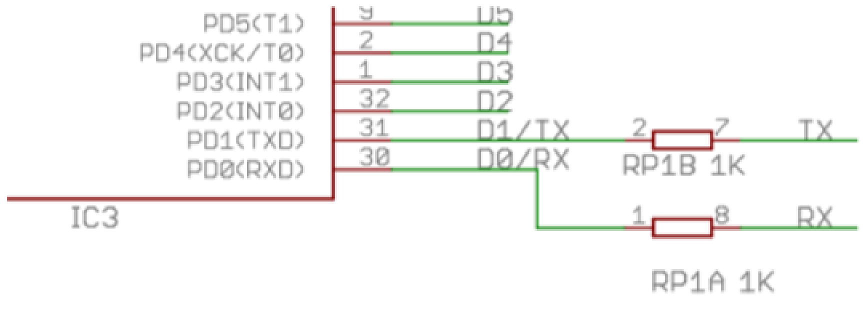

Figure 2.5-UART Serial interface

Thus, the Board outputs have priority over the signals of the interface Converter. When loading the program into the Board or exchanging data with the computer, the RX and TX pins must remain free.

External interrupts: pins 2 and 3. Outputs that can be used to generate external interrupts.

PWM: pins 3,5,6,9, 10, 11. these pins can be used to generate a PWM signal by hardware.

SPI serial interface: pins 10 (SS), 11 (MOSI), 13 (SCK). SPI hardware interface outputs.

Led: pin 13. The led shown on the l Board is connected to this pin. Lights up when the signal level is high.

Analog inputs: A0...A8. 8 analog inputs for voltage measurement using the built-in ADC. The ADC bit rate is 10 bits.

I2C interface: pins 4 (SDA) and 5 (SCL). I2C.

AREF hardware interface signals are the Reference voltage for the ADC of the microcontroller. Defines the voltage measurement range for analog inputs.

RST – reset Signal of the microcontroller. A low level causes the system to restart.

The Board has 4 LEDs, shown in table 2.3, which show the status of the signals.

Table 2.3-Arduino Nano Board LEDs

Designation on the Board	At what signal level does it light up	Appointment
TX	low	Signal TX active
RX	low	Signal RX active
PWR	5 V	Power supply Yes
L	high	General purpose Led

2.4 Humidity control Unit

The main part of this block will be a resistive sensor that detects changes in the electrical resistance of the hygroscopic medium (soil).

Since the goal is to find a low-cost, affordable and compact solution, the humidity detection module was chosen, consisting of two parts: the contact probe

YL-69 (figure 2.5) and the sensor YL38 (figure 2.6), which is also optimized for use on Arduino.

A small voltage is created between the two electrodes of the yl-69 probe. If the soil is dry, the resistance is high and the current will be less. If the ground is wet, the resistance is less, the current is slightly more. The final analog signal indicates the degree of humidity. The yl-69 probe is connected to the yl-38 sensor via two wires. See section 1.5.3 for more information on the operating principle and features of resistive sensors.

Figure 2.5-Yl-6 contact probe

The yl-38 sensor is based on the LM393 comparator, which outputs voltage to the D0 output according to the principle: wet soil – low logical level, dry soil – high logical level. The level is determined by a threshold value that can be adjusted using a potentiometer. An analog value is sent to pin A0, which can be passed to the controller for further processing, analysis, and decision-making .

The yl-38 sensor has two LEDs that indicate the presence of power coming to the sensor and the level of the digital signal at the output D0. The presence of digital output D0 and led level D0 allows you to use the module independently, without connecting to the controller.

Figure 2.6-yl-38 Sensor

In addition to the probe connection contacts, the yl-38 sensor has four contacts for connecting to the controller:

– Vcc-sensor power supply;
– GND-ground;
– A0 – analog value;
– D0-digital value of humidity level.

The technical characteristics of the module are shown in table 2.4, and the connection diagram of the sensor to the microcontroller is shown in figure 2.7

Table 2.4-technical characteristics of the module

Supply voltage	3.3-5 V
Current consumption	35 mA
Outputs	digital and analog sensor
Size	16×30 mm
Probe Size	20×60 mm
Total weight	7.5 g

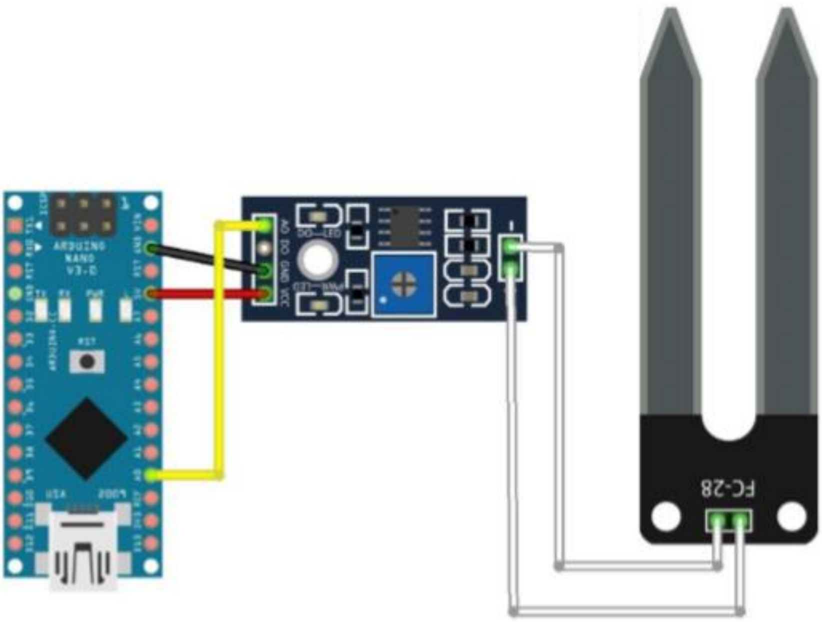

Figure 2.7-connection Diagram of the module to the Arduino Nano

2.5 Water delivery Unit to the soil

The main part of the block will be the cwx-15Q electric ball valve (figure 2.8) and the l293d driver chip. The operation of this unit is closely related to the previous two blocks and consists in the following: when it is time for watering, the humidity sensor is interrogated; if the humidity value is below the set threshold value, a PWM signal is sent to the l293d engine driver chip, which in turn sends a signal of a certain polarity to the ball valve, after which the tap valve opens, passing water from the tank and performing watering. The valve closes after the reverse polarity signal is given at the end of watering. The duration of watering is set by the user.

The valves are connected to the water supply by means of a cross, fittings are installed on the free ends, and on them hoses that go to the sprinklers or directly to the soil.

Figure 2.8-CWX-15Q Ball valve

The principle of operation of the valve: one contact is connected to a voltage source of 12 V, the second – to the "ground", after which the solenoid pulls the valve, passing water through the pipe. When one of the contacts is disconnected, the spring returns the valve to its place, preventing water from passing through. The task of the microcontroller is to supply the voltage of the desired polarity in time. The technical characteristics of the crane are shown in table 2.5.

Table 2.5-Technical characteristics of the cwx-15Q crane

Supply voltage	12 V
Input power	max. 3 W
Working pressure	0-1 MPa
Working current	<80 mA
Temperature	0-100 ºC
Valve turn Time	3 s
Material	brass, stainless steel, fluoropolymer
Product Life	100,000 times

The valves are connected to the water supply by means of a cross, fittings are installed on the free ends, and on them hoses that go to the sprinklers or directly to the soil.

To control the opening/closing of the tap valve, a signal of a certain polarity must be applied to it. The microcontroller can't provide this, so you need to use a special motor driver.

One of these drivers is the popular l293d chip. The appearance of the chip is shown in figure 2.9.

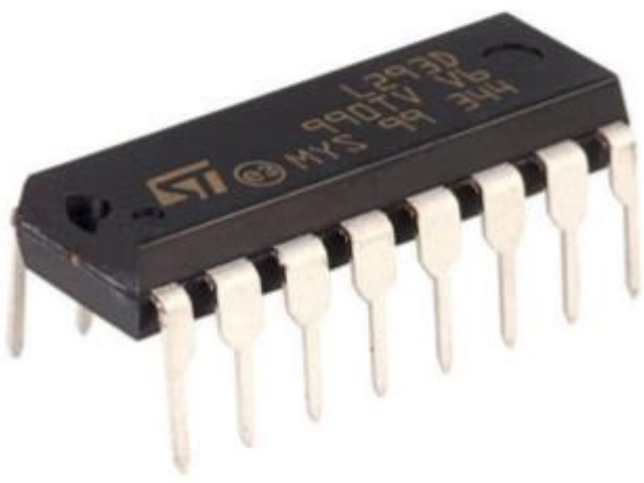

Figure 2.9 - l293d driver Chip

L293D contains two drivers at once for controlling small-power motors (four independent channels combined in two pairs). It has two pairs of inputs for control signals and two pairs of outputs for connecting electric motors. In addition, the L293D has two inputs for enabling each of the drivers. These inputs are used to control the rotation speed of electric motors using (PWM). The pin diagram of the chip is shown in figure 2.10. the pin Assignment is shown in table 2.6.

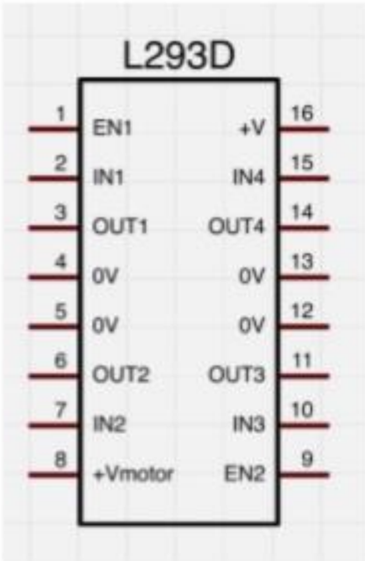

Figure 2.10 - pin Diagram of the l293d chip

Table 2.6-pin Assignment of the l293d chip

Output designation	Purpose
+V	chip power, 5 V
+ Vmotor	motor power, up to 36 V
0V	ground
En1, En2	on/off outputs of H-bridges
In1, IN2	control outputs of the first H-bridge
Out1, Out2	outputs for connecting the first motor
In3, In4	control outputs of the second H-bridge
Out3, Out4	outputs for connecting the second motor

The L293D provides power separation for the chip and for the motors it controls, which allows you to connect electric motors with a higher power supply voltage than the chip. Separation of the power supply of chips and electric motors may also be necessary to reduce interference caused by voltage surges associated with the operation of motors.

The connection diagram of the unit to the microcontroller and the schematic diagram of the unit are shown in figures 2.11 and 2.12, respectively.

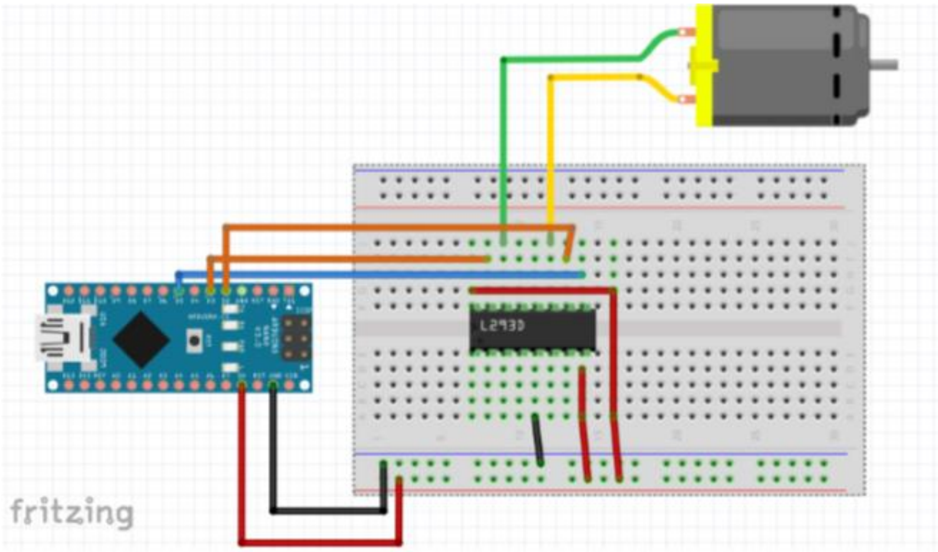

Figure 2.11 - connection Diagram for L293D and CWX-15Q to Arduino

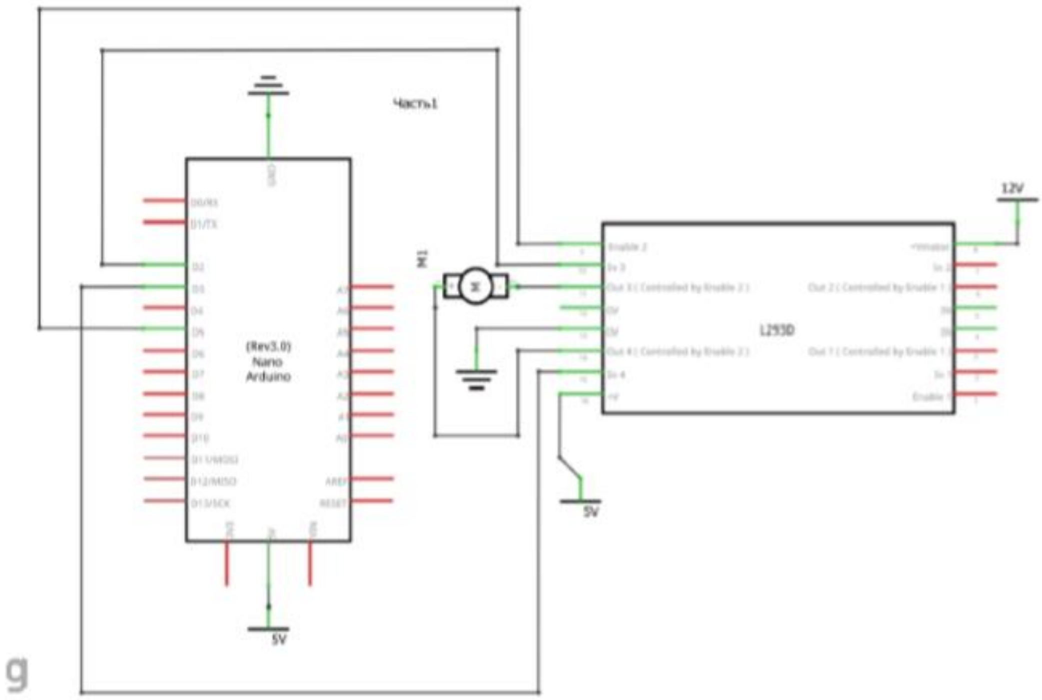

Figure 2.12-block Diagram

2.6 Data recording and display Unit

The main parts of this unit are: a liquid crystal (LCD) indicator showing the current level of soil moisture, a personal computer, and a block of buttons for entering data. The block diagram is shown in figure 2.13.

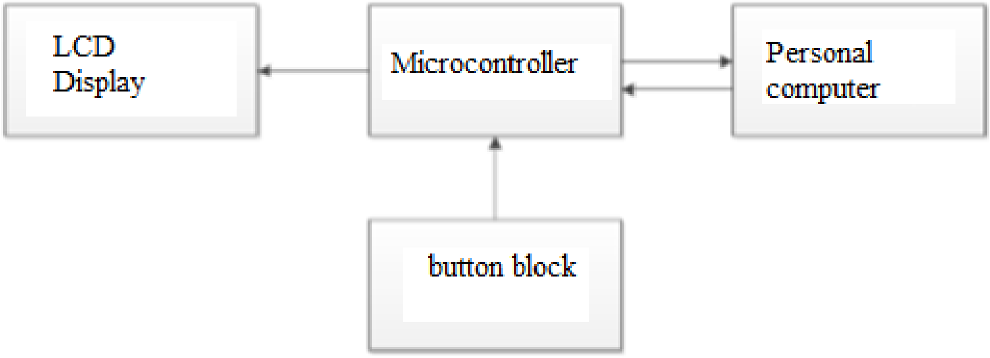

Figure 2.13-Block diagram of the control interface block

Using the controller, you can fully automate the watering process. The block diagram shows that in order to manage the entire process, you need a personal computer that connects to the microcontroller via a USB interface, which allows you to monitor changes in soil moisture, buttons to set the threshold humidity level and duration of irrigation, as well as a liquid crystal indicator to display the entered and measured parameters, service information.

Liquid crystal display is a flat screen that reproduces an image using liquid crystals (figure 2.14).

Figure 2.14-Monochrome LCD display

Table 2.8 - connecting the display to the Arduino hardware platform

Display output	Port of the Arduino
VSS	GND
VDD	5V
V0	5V (if control is required, connected via a variable resistor)
RS	D7
RW	GND
E	D6
D4	D5
D5	D4
D6	D3
D7	D2
A	5V
K	GND

The display connection diagram and the schematic diagram for connecting the LCDscreen to the Arduino Nano are shown in figures 2.15 and 2.16, 2.17, respectively.

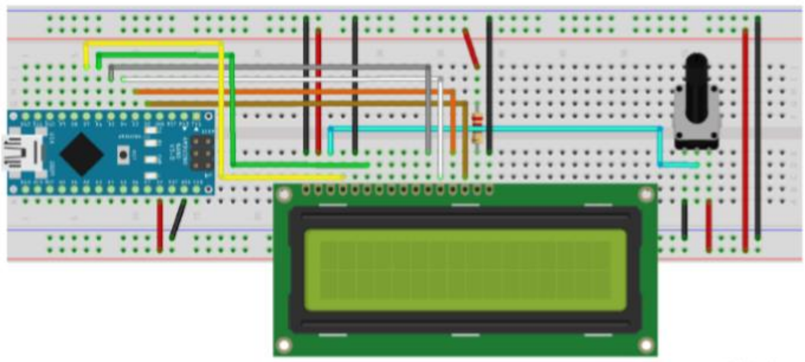

Figure 2.15-connection Diagram of the LCD screen to the Arduino Nano platform

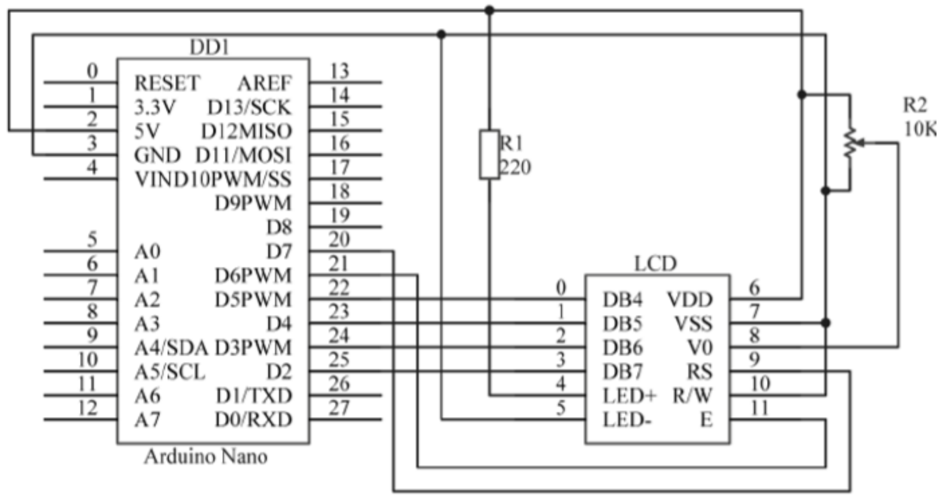

Figure 2.16-Schematic diagram of connecting the LCD screen to the Arduino Nano platform

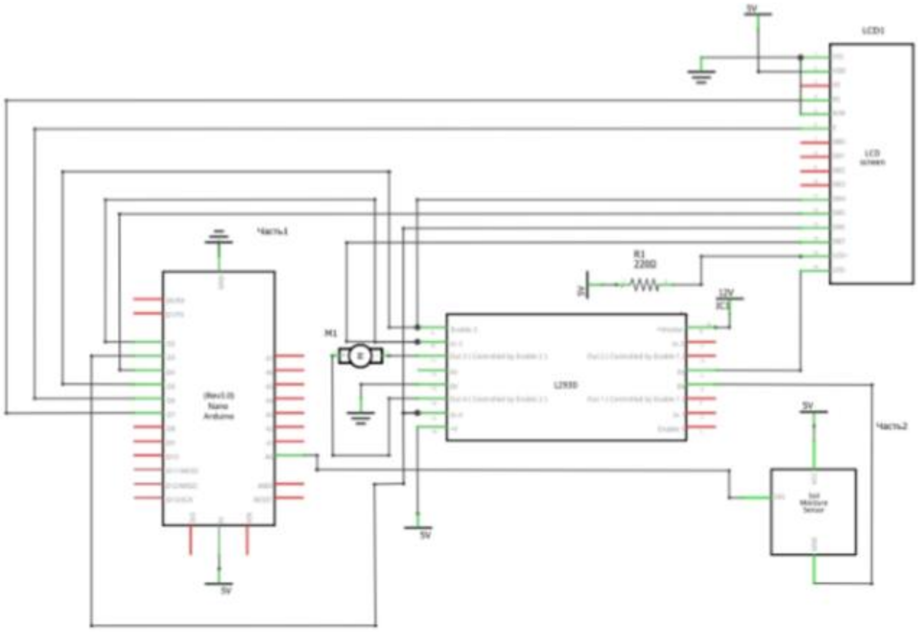

Figure 2.17-Schematic diagram of the automatic irrigation system

3 Development of algorithms and software

3.1 Arduino development Environment

To make the platform work, you need to download and install the Arduino IDE shell from the developer's site with the device drivers for docking via the computer's USB port. The Arduino development environment consists of a text editor, a message area, a text output window (console), a toolbar, and several menus (figure 3.1).

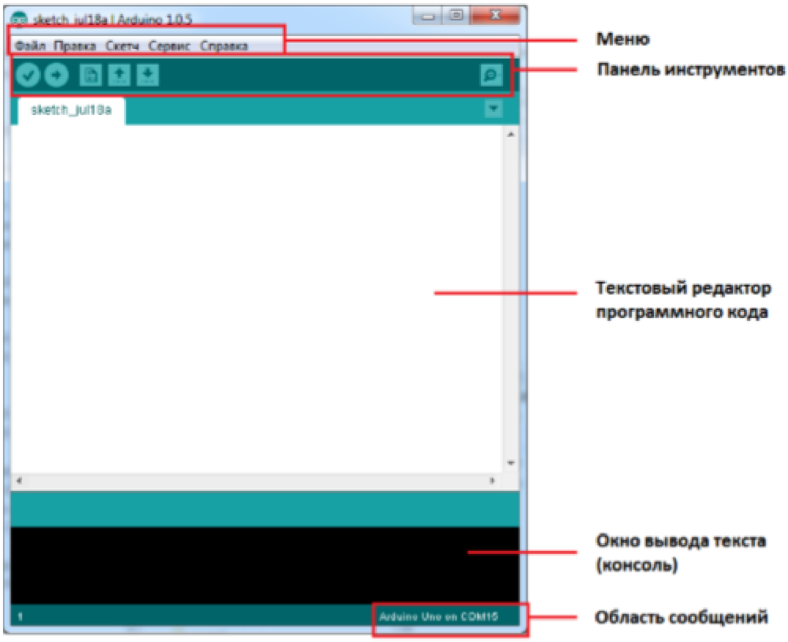

Figure 3.1-Arduino development Environment

To work, first of all, in the shell, you need to select the port number to which the platform is connected, and select the model of the microcontroller Board.

The program code is written in a C++ - like language called Processing/Wiring in the Arduino IDE shell text editor, which has tools for copying, pasting, searching and replacing text. When exporting and saving program code, the message area displays explanations and errors that occur. File Menu. Omitting the obvious menu items, I would like to mention such an item as"Folder with sketches". By default, the Arduino IDE saves each sketch to a separate folder. The folder name matches the name specified for the sketch when saving. You can change the working directory for folders with sketches in the "Settings" menu item.

Menu "Sketch". This menu duplicates the command from the control panel "Check/Compile"(figure 3.2)., which will lead to checking the code for errors, and if there are no errors, to compilation. The "Show sketch folder" menu item opens the working directory of the Arduino IDE specified in the settings. "Add file..." allows you to open a text file (or sketch) in a separate tab.

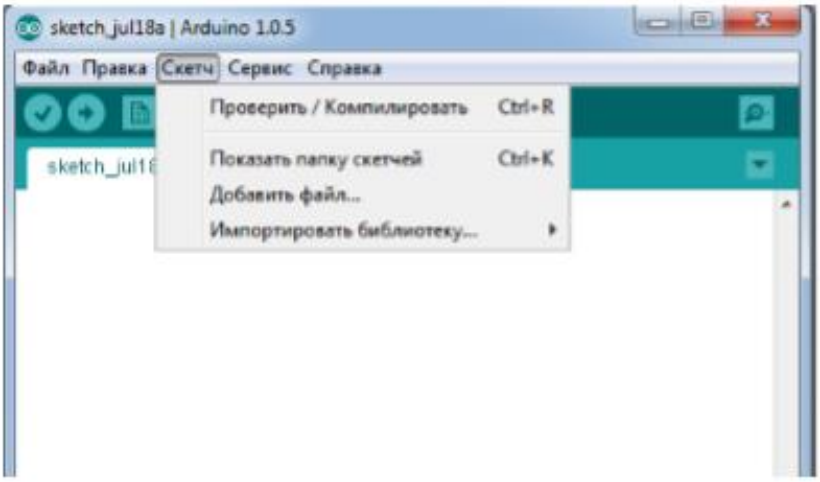

Figure 3.2-Sketch Menu

After the first launch, two sections are available in the Arduino IDE window: void setup (), which executes all the commands contained in it once, and void loop (), which cycles all the commands in this section – ring mode . Before loading the program into the microcontroller, the program is checked for syntax and cyclic errors using the built-in compiler. After checking for errors, the program (sketch) is saved as a text file with the Ino extension on the hard disk of your personal computer. The Arduino IDE shell has a serial port monitor that allows you to display on the screen of the PC monitor the results of measurements of analog signals of current, voltage, speed, temperature.

Many of the sketches (programs) to work with libraries. The library makes it easier to work with a specific module or one of the module types. For example, when displaying text on the LCD display without connecting the library you have to pass a few bytes of commands and data, which takes a few lines of code, and most importantly, you must know the type of the microcontroller managing working LCD display, the purpose of the commands which it is governed, to know the architecture of his memory, addresses, and designation registers, which will require you to find and read its datasheet. While when writing code using the library, it allows you to display text by calling just one library function: lcd. print ("my text"). Loading third-party libraries into the Arduino IDE is shown in figure 3.3.

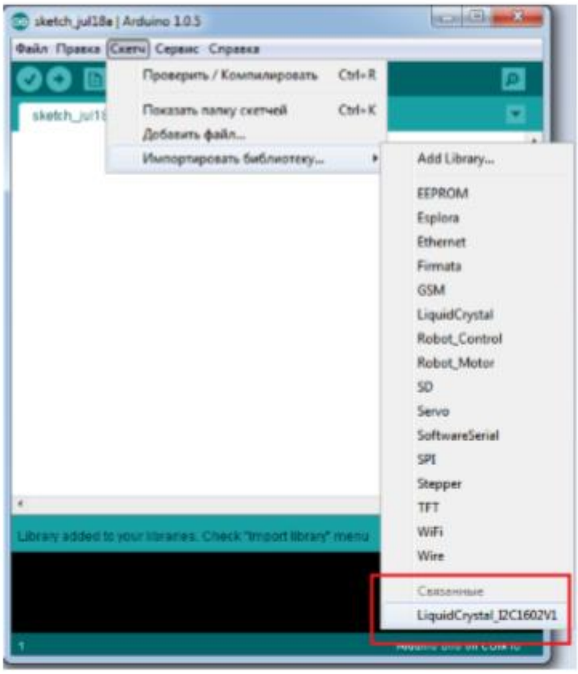

Figure 3.3-Importing the library to the Arduino IDE

To connect the library, you only need to write one line at the beginning of the sketch: "#include <file.h>", for example:

#include <iarduino_4LED.h> / / Connecting the iarduino_4led library for working with 4 segment LED indicators.

Some libraries work using the methods and functions of other libraries, then you need to connect two libraries, first connect the one whose methods and functions are used by the second one, for example:

#include <Wire.h> / / Connecting the Wire library to work with the I2C bus

#include <LiquidCrystal_I2C.h> // include the library LiquidCrystal_I2C for the LCD display on I2C bus

// uses the LiquidCrystal_I2C Library methods and library functions Wire

To work with most libraries, you need to create an object (instance of a class library) which are available, their functions and methods, such as:

LiquidCrystal_I2C lcd (0x27, 20, 4); / / lcd is an object of the LiquidCrystal_I2C library // the library functions and methods are accessed via the object

3.2 Programmer's Guide

The simplest algorithm of the program in the form of a flowchart is shown in figure 3.4. the Full code of the program is presented in Appendix A.

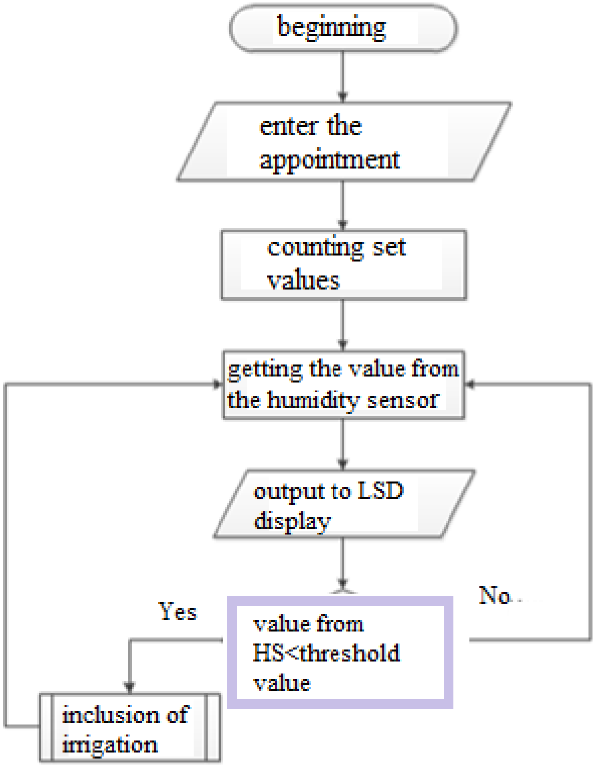

Figure 3.4-Algorithm of the program operation in the form of a flowchart

The developed device includes the following operating modes:

Stationary mode – the device is not active (the indicator shows the value of the current soil moisture).

Operating mode – the device displays the following readings on the LCD indicator: the level of current soil moisture, threshold soil moisture, time elapsed since the last watering, and the time for which the ball valve will open. If the device is in operation mode and the current soil moisture value falls below the threshold soil moisture value, the device will switch to watering mode.

Watering mode – the device displays the number of seconds until the end of watering on the LCD indicator, and also sends a PWM signal to the l293d engine driver chip, which includes the CWX-15Q ball valve. The duration of watering is set by the user (table 3.1).

To implement these modes, the following functions and libraries are used:

digitalRead Function – the function reads the HIGH or LOW values from the specified input.

DigitalWrite function (output number/high or LOW value) – sends the HIGH/LOW value to the digital output.

If the pin was set to output mode by pinMode (), the corresponding input/output voltage for HIGH is 5V (3.3 V for 3.3 V boards), and 0V(ground) for LOW.

If the input / output (pin) has been set to input mode, the digitalWrite function with the value HIGH will activate the internal 20K load resistor. The low feed in turn disables this resistor. The load resistor is enough to make the led connected to the input light dimly. If suddenly the led is working, but very dim, you may need to set the output mode with the pinMode () function.

Example of using a function in the code to control a valve:

```
void OPEN_KLAPAN(){
if ( open_flag == 1 ){ digitalWrite(ENABLE1, HIGH);
digitalWrite(IN2, LOW);
digitalWrite(IN1, HIGH);
delay(time_clouse);
digitalWrite(ENABLE1, LOW);
delay(need_time);
digitalWrite(ENABLE1, HIGH);
digitalWrite(IN1, LOW);
digitalWrite(IN2, HIGH);
delay(time_clouse);
digitalwrite(enable1, low);
second = 0; minute = 0;
open_flag = 0; }
// clearing the screen
// opening the valve
// waiting for the set time
// closing the VALVE
```

The humidity sensor readings are read by calling the analogRead function (output number). The function returns a number from 0 to 1023, where:

– 0...300 - wet soil;
– 300...500 - moist soil;
– 500...800 – dry soil.

To work with symbolic graphic displays, the LiquidCrystal library is included in the standard set of the Arduino IDE and is designed to work on an 8-bit (4-bit) parallel interface.

Library function:

begin(cols,rows,[char_size]); – initialization of a display indicating the number of columns, rows and size of the symbol;

clear(); – clears display from cursor to position 0,0;

home(); – set the cursor to position 0,0;

display(); – fast turn off of the display (without changing the data in RAM);

noDisplay(); – fast turn-off of display (without changing the data in RAM);

noDisplay(); – fast turn-off of display (without changing the data in RAM);

blink(); – enable blinking cursor (with a frequency of about 1 Hz);

noBlink(); – disable blinking cursor;

cursor(); – enable underscore cursor;

scrollDisplayLeft () – - scroll the display to the left. Shift the display coordinates one column to the left (without changing RAM);

scrollDisplayRight () – - scroll the display to the right. Shift the display coordinates one column to the right (without changing the RAM);

leftToRight (); - indicates further shift the cursor position, after output of the next character, one column to the right;

rightToLeft () – - indicates further shift the cursor position, after output of the next character, one column to the left;

noAutoscroll () – - indicates further align the text to the left of the cursor position (as usual);

autoscroll (); - specifies to align the text to the right of the cursor position in the future;

createChar(num, array) – - writing a custom character in the display CGRAM with the specified number;

setCursor(col, row); – setting the cursor to the position indicated by the column and row number;

noAutoscroll () – - indicates further align the text to the left of the cursor position (as usual);

print(text); – displaying text, symbols, or numbers on the display screen. The syntax is similar to the same function of the Serial class.

setCursor(col, row); – setting the cursor to the position indicated by the column and row number;

Table 3.1-connecting the LCD display

The tire	Code example	Parameter
4-wire bus	#include <LiquidCrystal.h> LiquidCrystal lcd(RS , E , D4 , D5 , D6 , D7); void setup(){ lcd.begin(col , row); }	RS: no. of the Arduino pin to which the RS pin is connected E: no. of the Arduino pin to which the e pin is connected D0...D3: no. of the
8-wire bus	#include<LiquidCrystal.h> LiquidCrystal lcd(RS , E , D0 – D7); void setup(){ lcd.begin(col , row); }	Arduino pins to which the D0-D3 pins are connected D4...D7: no. of the Arduino pins to which the D4-D7 pins are connected col: number of columns implemented in the display row: number of rows implemented in the display

Example of using the image output code:

```
// output the image
if ( count_lcd < 20 ) count_lcd++;
else{
 real_humidity = analogRead(D_VLACHNOSTI);
lcd.clear();
 lcd.print("R.Hum ");
 lcd.print(real_humidity);
 lcd.print("  ");
lcd.print(minute);
lcd.print(':');
lcd.print(second);
lcd.setCursor(0,1);
lcd.print("N.Hum ");
lcd.print(need_humidity);
if ( real_humidity < need_humidity ) open_flag = 1;
count_lcd = 0;
 }
```

3.3 User's Guide

The user can control the developed device by entering values using three buttons. Use the "A1" and "A2" buttons to decrease or increase the adjustable value. The button " A3 "has a lock, i.e. when the position is logical" 1", humidity is set, when the position is logical" 0 " – setting the time intervals for turning on irrigation.

In this mode, the user can manage the following parameters:

1) Setting a threshold value for soil moisture, after which the device should switch to watering mode. By pressing the " A1 " button, you can increase the level, and by pressing the "A2" button, you can lower it.

2) Setting the duration of watering. After the threshold humidity is set, press and hold the buttons again for more than two seconds and the LCD display shows the watering time, which can also be changed by pressing the "A1" or "A2" buttons, see above.

The button status detection function is shown below:

```
ISR ( TIMER2_OVF_vect ){
if ( button_timer == 3 ){
if ( digitalRead(SET_PIN) != 0 ) mode = 1;
else mode = 0;
// humidity setting
if ( digitalRead(BUTTON_PLUS) != 0 && mode != 0 ) need_humidity++;
if ( digitalRead(BUTTON_MINUS) != 0 && mode != 0 ) need_humidity--;
// setting up time intervals
if ( digitalRead(BUTTON_PLUS) != 0 && mode == 0 ) need_time+=50;
if ( digitalRead(BUTTON_MINUS) != 0 && mode == 0 ) need_time-=50;
button_timer = 0;
}
button_timer++;
```

The user can also use the program "PLX-DAQ Spreadsheet" to monitor changes in soil moisture over time by plotting, which will allow you to judge the degree of required frequency of watering plants.

The application receives data via the COM port and processes it. Then the received values from the humidity sensor are written to the text document line by line. The first line shows the humidity value from the sensor, and the second line shows the date and time when the data was received. Every 24 hours, the app sends a new point to create a graph.

When you launch the app, an excel worksheet opens with the macro already running. To communicate with arduino, you just need to specify which com port to listen to, and at what speed data is transmitted. The transfer speed must match the one specified in the arduino:

Serial.begin(9600);

After configuring the port and data transfer speed, you need to click the "connect" button and immediately start receiving and output data from the arduino. An example of how the program works is shown in figure 3.5.

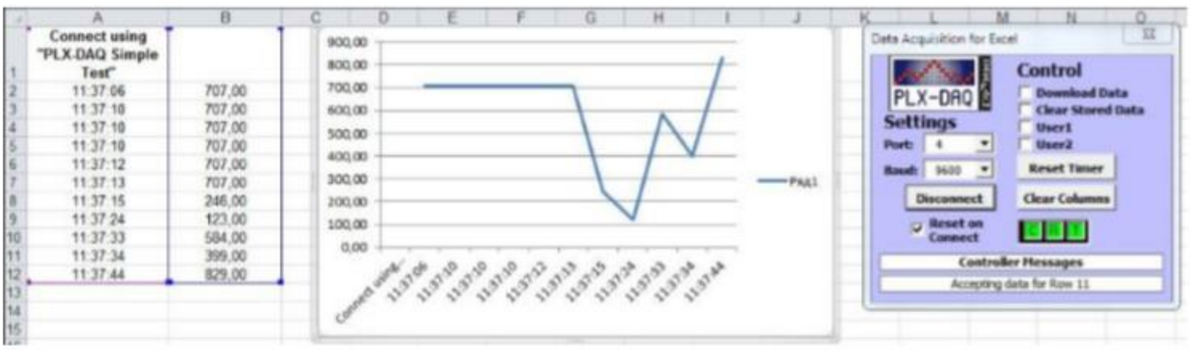

Figure 3.5-plotting humidity changes

3.4 Checking the program's performance in the Proteus environment

Figure 2.18 shows a General schematic diagram of a system for maintaining optimal humidity. Using the Proteus Design Suite, a software package for computer-aided design (CAD) of electronic circuits developed by Labcenter Electronics, we will assemble our diagram figure 3.6.

The Proteus VSM Software package allows you to assemble the circuit of any electronic device and simulate its operation, identifying errors made at the design and tracing stage. The program consists of two modules. ISIS-editor of electronic circuits with subsequent simulation of their operation. ARES is a printed circuit Board editor equipped with an Electra autorouter, a built-in library editor, and an automatic system for placing components on the Board. In addition, ARES can create a three-dimensional model of the printed circuit Board.

Proteus VSM includes more than 6000 electronic components with all reference data, as well as demonstration and familiarization projects. The program has USBCONN and COMPIM tools that allow you to connect a virtual device to the computer's USB and COM ports. When connecting any external device to these ports, the virtual circuit will work with it as if it existed in reality.

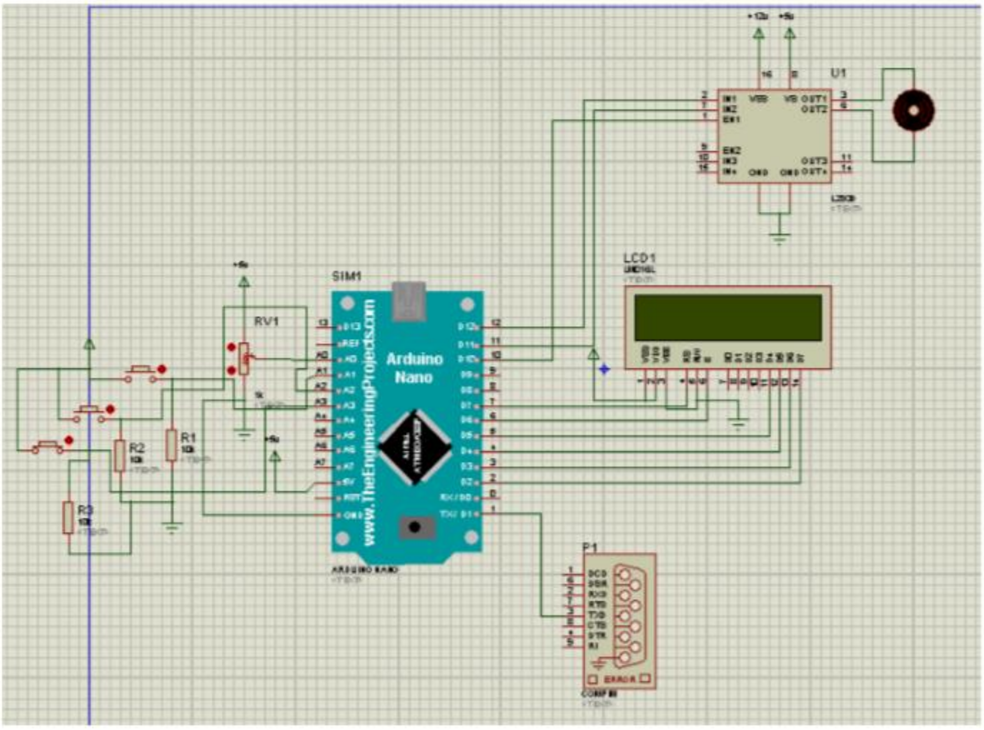

Figure 3.6-Schematic diagram of the entire system in the Proteus environment

Resistors R1, R2 and R3 are connected to the corresponding buttons A1, A2 and A3. The humidity sensor is displayed as an RV1 variable resistor, which we use to set the actual humidity. U1 refers to a water supply unit consisting of a l293d driver chip and an engine animation. The LCD displays as LCD1. Under P1 is a data cable to the com port.

System startup

When power is applied, the lcd display is activated figure 3.7.

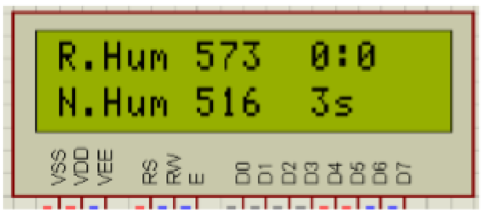

Figure 3.7-LCD display

The LCD display shows 4 parameters R. Hum (real, measured humidity at the moment), N. Hum (set humidity threshold), as well as the time elapsed since the previous watering (top right) and the time for which the tap valve will open (bottom right). The first time you enable it, information from the previous session is displayed.

To set the desired values for the system, use the button block (see section 3.3 of the user's Guide for how the button block works). For example, set the threshold humidity level to 516 and the watering time to 7 seconds (figure 3.8).

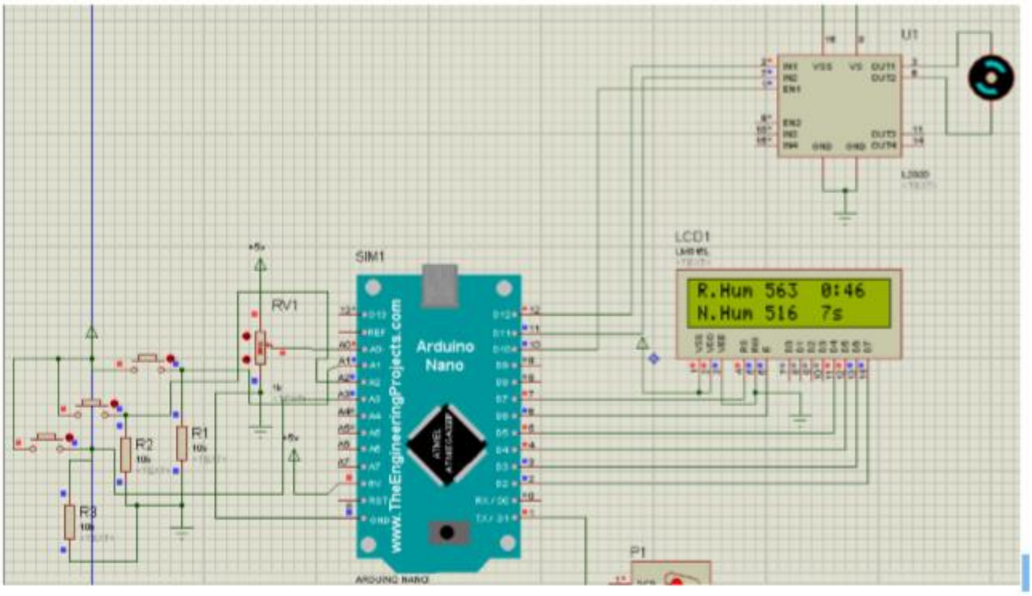

Figure 3.8-Starting the system

In order for the automatic irrigation system to be activated, the actual humidity value must fall below the threshold value. We simulate this process using the RV1 potentiometer (figure 3.9).

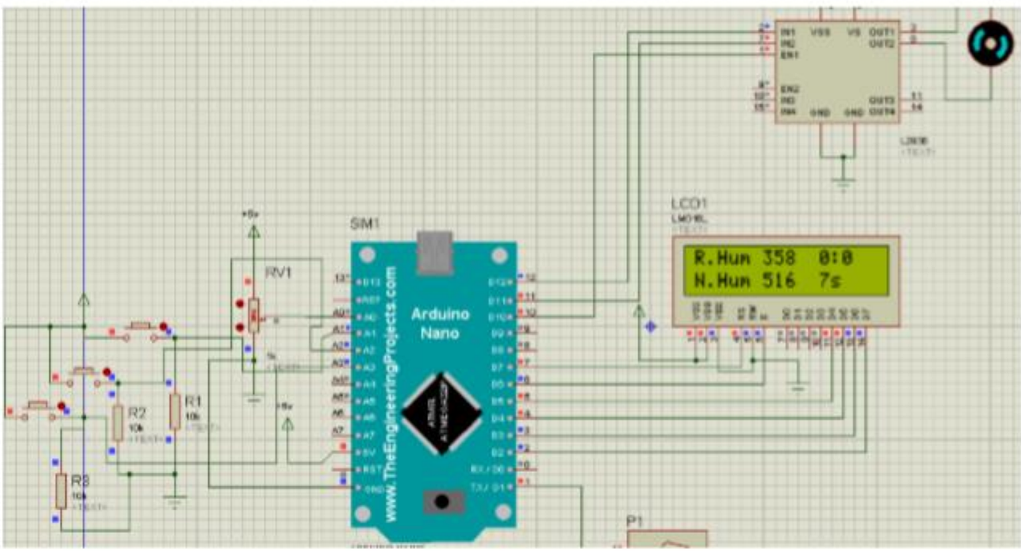

Figure 3.9 – Inclusion of irrigation

As you can see from figure 4.4, when changing the position of the RV1 potentiometer, the actual humidity level dropped sharply, the animation of the tap valve U1 changed, and the time since the last watering was reset, which indicates that the irrigation is turned on and the program is working correctly.

After 7 seconds, the animation of the tap valve changes again, indicating that it is closed, the actual humidity level becomes higher than the threshold value, and the countdown begins again (figure 3.10).

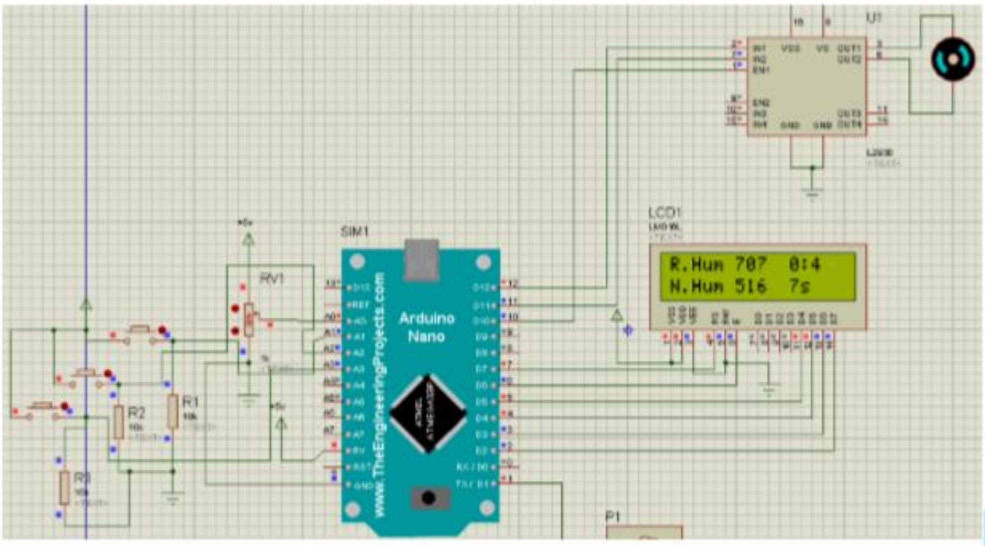

Figure 3.10 – the end of the irrigation

After conducting tests in the Proteus automatic design system, I made sure that the program was working correctly, there were no problems or errors, and concluded that my system was ready for full-scale implementation.

4 Life safety

4.1 Analysis of work condition on workplace

Labor protection is the legal protection of an employee from the dangers that arise for his health in the workplace, as well as related to the economic superiority of the employer. This includes rules governing working hours and other working conditions. The employer is primarily responsible for compliance with labor protection rules. Labor protection also includes measures to protect the employee's health taken during working hours.

Working conditions – a set of factors that affect the performance and health of a person in the course of production activities.

For the analysis of working conditions, the object of research is an office space. The office space is divided into three parts: an engineer's office, a programmer's office , and a dressing room . The total area of the office is 32mi, the ceiling height is 2.5 m. The office is designed for four jobs. All workplaces are equipped with computers, soldering irons and everything necessary for efficient work during the working day.

The main feature of the engineer's work is that the work is performed mainly by sitting at a computer monitor and working with various electrical devices that negatively affects the health of the employee. Therefore, you need to do everything possible to make it convenient and comfortable for the employee to work. Each workplace is equipped with a computer table and chair, which allows you to use the workplace by an employee of any complexion and height, as well as to use a comfortable working position and a pose for relaxation. In addition, each desktop has a liquid crystal monitor, which does not allow the eyes to get tired during the working day and is not so harmful to vision.

My office is located in a four-story building. The office is located on the fourth floor. It is small room to work 3-4 people. Office diagram we can see in figure 4.1

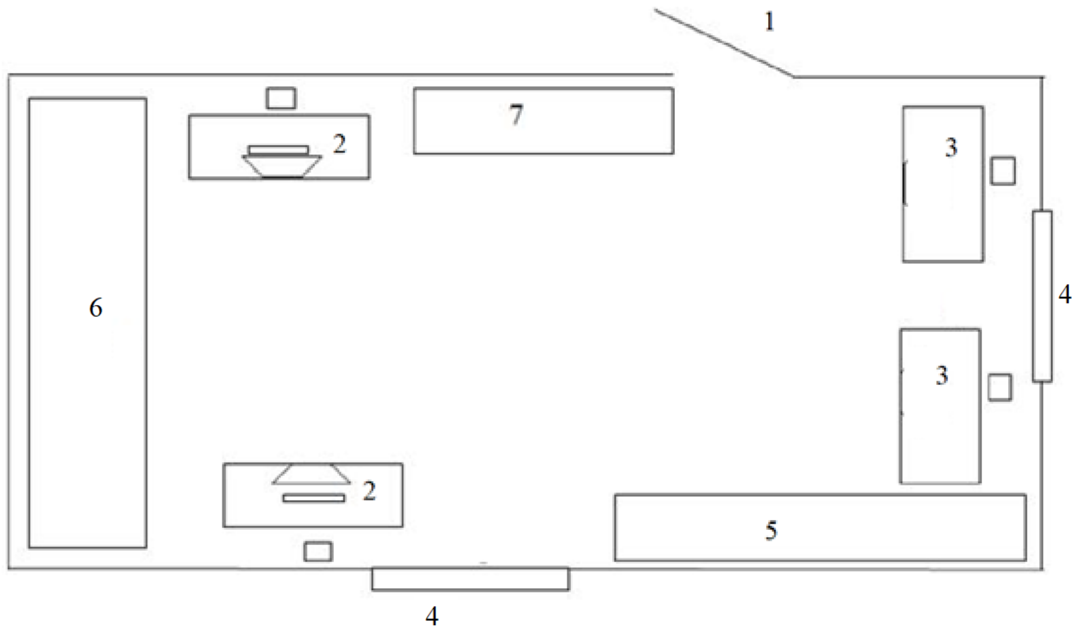

Figure 4.1 – Office diagram

The diagram of the office premises is shown in the figure

Symbols:

1-door

2 - work place with computer,

3 - workplace ,

4 - window openings,

5 - tool racks,

6,7- cabinets for documentation.

Since there is a computer at every workplace, and the computer is a source of electromagnetic radiation, as a result of which a person is affected by high and ultra-high frequency fields. The effect of ultra-high frequency on a person is manifested in disorders of his nervous system, headaches, rapid fatigue during work and drowsiness. In order to eliminate the harmful effects of frequencies, liquid crystal monitors were purchased for employees. If you can do without computers, they are put in standby mode, and from time to time small breaks are made for rest. Since office workers are engaged in mental labor, it is necessary to constantly ventilate the premises to increase working capacity.

The results of the management process research are presented with actual and normative values of potentially dangerous and harmful factors.

These factors are acceptable in their normative value and do not harm the health of employees.

Given the specifics of the work, to create favorable working conditions, only General sanitary facilities are provided: a washbasin and a restroom. The sanitary and hygienic category of production from which the object in question can be attributed is the processes that cause contamination with substances of the 3rd and 4th hazard classes 1A. According to this category, pollution occurs only by hand. This category also assumes the presence of a wardrobe, as well as the presence of household premises in the form of a washbasin and toilet. Since there are several departments in the analyzed organization, the dressing rooms are located in each Department in the form of wardrobes for outerwear.

There is no toilet on the floor where the room is located, but the toilet is located on the first floor of the building. In addition, the restroom is shared by both men and women. Restrooms are presented as separate rooms with an area of 10 mi. Each bathroom is equipped with a washbasin and toilet. For hygienic conditions, each bathroom always has paper towels and soap. According to the conducted research, we can say that the buildings are almost equipped with all necessary sanitary facilities.

In addition, there is a room for eating and a rest room in the building. The eating room is divided into two parts. In the first part there is a washbasin, so that the worker can wash his hands before eating, and there is also a garbage can for food waste. The second part is intended for eating, where tables and chairs are located, and it is also equipped with a microwave oven, disposable dishes.

In the premises, the duties of organizing labor protection are assigned, taken part-time, by an engineer for labor protection. When you look at the documentation, which is maintained by an engineer for labor protection, you can say that the organization of labor protection is well conducted. This is evidenced by the following orders: "on labor protection and compliance with safety regulations", "on the introduction of internal labor regulations", "on the creation of measures to prevent disease".

When organizing labor protection in the following works are carried out:

- development and approval of instructions;
- systematic verification of work on the implementation of labor protection measures;
- inspection of persons employed;
- accident investigation and accounting (which is extremely rare);
- drawing up lists for workwear, protective devices;
- maintaining documentation and reporting.

Based on the analysis of all indicators, you can suggest the following measures for labor protection:

- to reduce the effects of harmful and dangerous factors: organize cleaning of the premises and so-called subbotniks. Since many employees work at the computer, they should be provided with protective equipment in the form of glasses, as well as the provision of additional leave for three days.
- to improve sanitary and hygienic conditions: compliance with sanitary and epidemiological standards.
- to reduce injuries and morbidity: conducting professional examinations of employees, vaccination, compliance with safety regulations, creating conditions for occupational safety, using first aid kits, visual AIDS for first aid.
- to improve labor protection: creating job certification, conducting training on three-step labor safety.

4.2 Artificial lightning calculation

To calculate artificial lighting, one of three methods is used: the coefficient of light flux utilization, the point method, and the specific power method. When calculating the overall uniform lighting, the main method is to use the light flux created by the light source, and taking into account the reflection from the walls, ceiling, and floor. The calculation of lighting begins with the selection of the type of lamp, which is accepted depending on the environmental conditions and the class of premises for explosion and fire hazard.

Artificial lighting is divided into working, emergency, security and duty.

Working lighting - provides the necessary conditions for normal operation of the OU, it is mandatory in all rooms and open spaces.

Security lighting - a type of work lighting installed along the protected borders of industrial enterprises ' territories.

Emergency lighting - divided into safety lighting and evacuation lighting.

According to the SNiP, security lighting must create illumination of at least 5% of the normalized illumination, but not less than 2 Lux in the premises and 1 Lux outside. Illumination of more than 30 Lux for discharge lamps and more than 10 Lux for incandescent lamps is allowed to be created if there are appropriate justifications.

The number of lamps is calculated using the formula:

$$N = \frac{E * S * k * z}{\eta * n} \tag{4.1}$$

N- the number of lamps;

E - normalized illuminance, Lux;

S - illuminated surface ;

K - the safety factor;

z - the ratio of the minimum illumination of incandescent lamps and XRD z=1,15, for fluorescent lamps z=1,1;

η - coefficient of use of light;

n - the number of lamps in the luminaire.

The number of rows is determined by the method of area distribution (hanging) to achieve uniform illumination. The main parameter for hanging lamps is the ratio of the height of the suspension (HP) to the distance between the lamps or rows (L), which creates uniform lighting. The ratio of HP/L is taken in the range of 1.4÷2.

The coefficients of light flux utilization for the accepted type of lamp are determined by the room index i and the reflection coefficients of the ceiling (PN), walls (PC), and floor (PP) .

The index of the room:

$$i = \frac{A*B}{H*(A+B)} \tag{4.2}$$

where A and B - respectively the length and width of the room, m; H-the height of the suspension of lamps, m.

The calculation part

Description of the room

Room characteristics:

- length 10m ;
- width 3,5 m;
- height 4,5 m;

interior: white ceiling, walls painted light yellow, floor covered with linoleum light brown.

The main method of calculation is based on the light flux utilization coefficient, which determines the flux required to create a given illumination of a horizontal surface with a General uniform illumination, taking into account the light reflected by the walls and ceiling. The calculation of lighting begins with the selection of the type of lamp, which is accepted depending on the environmental conditions and the class of premises for explosion and fire hazard. Select the type of lamp-LSP 02, the number of lamps n2=2.

Normalized illuminance (Eh) take a SNiP 23-05-95-2010, in accordance with the lighting system and the conditions of visual work and is accepted by SanPiN 2.2.1/2.1.1.1278-03 - 400 LK.

Ratio minimum illumination (z) for fluorescent lamps 1.1.

The illuminated surface S is calculated=10*3.5*4.5= 157.5; in accordance with GOST 6825-74, the lamp type is selected-LB with a power of 80 watts, the luminous flux FL = 5220 LM.

Since LSP02 was chosen as the lamps, in order to provide illumination of 400 Lux, it is necessary to take 15 lamps with 2 lamps of the LB80 type in each, arranged in three rows. The coefficients of light flux utilization for the accepted type of lamp are determined by the room index(figure 4.2).

The index of the room:

$$i = \frac{A*B}{H*(A+B)} \quad (4.2)$$

where A and B - respectively the length and width of the room, m;

Hp-the height of the suspension of lamps, m.

$$i = \frac{10*3.5}{4.5-13.5} = 0.57$$

To achieve uniform illumination of the room rows of lamps are placed at a distance from each other in accordance with the criterion:

$$L\frac{H}{2} = \frac{4.5}{5} = 2.25m$$

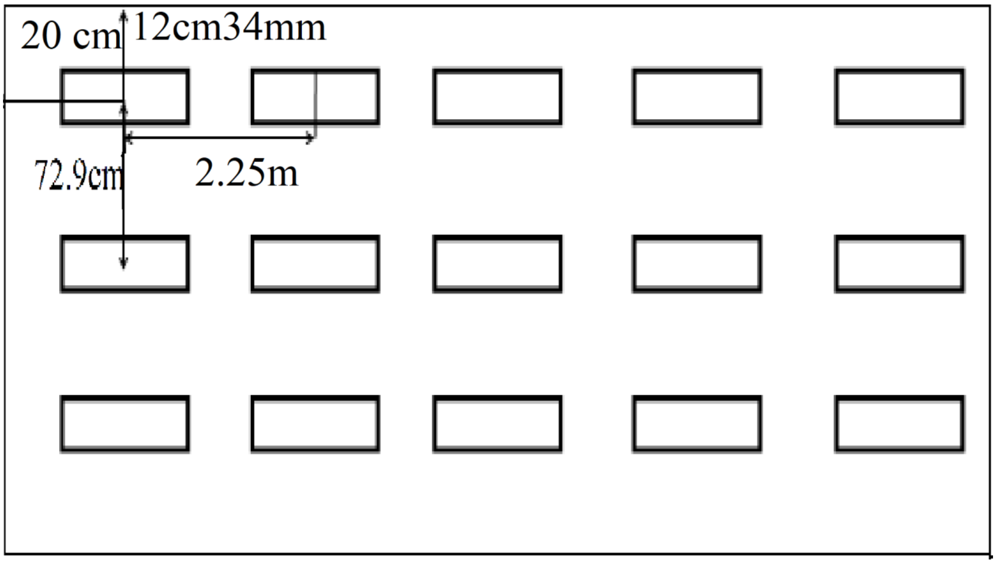

Figure 4.2- Illumination of the room rows

4.3 Calculation of the time of evacuation from the building during an emergency

One of the main ways to protect against the damaging factors of emergencies is the timely evacuation and dispersal of the personnel of facilities and the population from dangerous areas and disaster zones.

Evacuation – a set of measures for the organized withdrawal or removal of personnel from the emergency zones or the probability of an emergency, as well as life support for evacuees in the area of accommodation.

To analyze the organization of fire safety, the following data is required: the name of the object - an office building; the maximum number of employees in the office is 46 people; the height of the building is 12 m; the area of the building is 502 mi; the volume of the building is 6024 ml.

According to the normative document NPB-105-95, the building where our office is located is classified as a" D " room for explosive and fire hazard.

Primary fire extinguishing agents in the office are chemical foam (air-foam, liquid) fire extinguishers with a capacity of 10l. in an amount of 6 PCs.; carbon dioxide hand extinguishers with a capacity of 10l.in an amount of 3 PCs.

Degree of fire resistance of the building: V.

Floor plan of the room where the office space is located, indicating the evacuation routes, placement of fire alarms, communications and primary fire extinguishing equipment (figure 4.3).

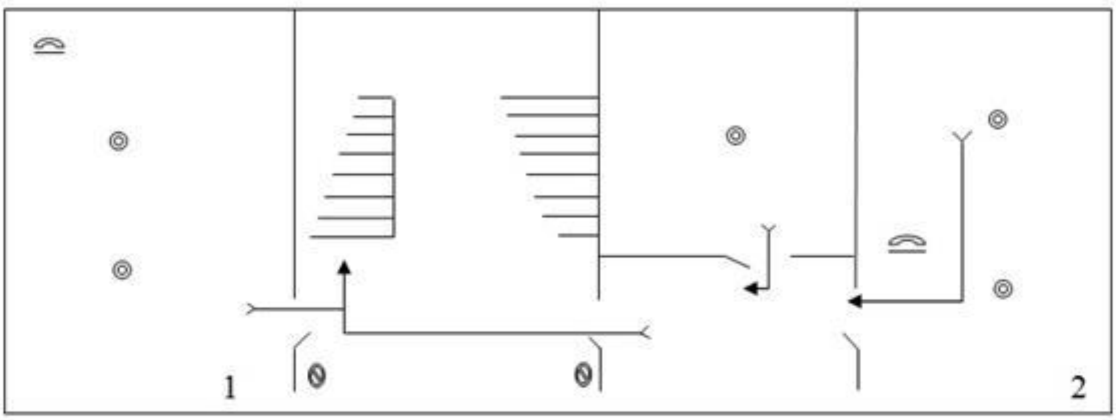

Figure 4.3- Floor plan of the room

Input parameters:

t_0:= 20 - initial room temperature, °C;

Q:= 16.7 - net calorific value, $MJ \cdot kg^{-1}$

C_p:= 0.001068 - specific isobaric heat capacity of gas MJ / kgK;

φ:= 0.6 - heat loss coefficient;
η := 0.95 - combustion factor;
α:= 0.3 - coefficient of reflection of objects on escape routes;
l_{ext}:= 20 - extreme range of visibility in smoke, m;
D_m:= 60.6 - smoke generating ability of burning material, $Np{\cdot}m^2{\cdot}kg^{-1}$;
L_{O2} := 2.56 - specific oxygen consumption, $kg{\cdot}kg^{-1}$;
h:= 2.2 - working area height, m;
H:= 3.2 - room height, m;
Ψf:= 0.0244 specific mass burn up rate, $kg{\cdot}m^{-2}{\cdot}c^{-1}$;
υ:= 0.0071 - linear flame velocity, $m{\cdot}c^{-1}$;
n:= 3.

$$Z := \frac{h * \exp(1.4 * \frac{h}{H})}{H} \tag{4.3}$$

Z=0.818

$$B := \frac{353 * Cp * V}{(1 - \varphi) * \eta * Q} \tag{4.4}$$

$B=5.347x10^3$

$$A := 1.05 * \Psi f * \upsilon^2 \tag{4.5}$$

$A=1.292x10^{-6}$

$t_{kpc0} := 2.961x10^3$i under the sign of the logarithm is a negative number

As a result, the required evacuation time is 7,8 minutes.

When designing buildings and structures, one of the tasks is to create the most favorable conditions for human movement in a possible emergency and ensure its safety. Forced movement is associated with the need to leave a room or building due to a hazard (fire, accident, etc.).

What is the required evacuation time?

The required evacuation time is the time from the moment of the fire, during which people must be evacuated to a safe area without causing harm to life and health as a result of exposure to fire hazards;

What are fire hazards?

Fire hazards that affect people and property include:

-flames and sparks;

-heat flow;

-increased ambient temperature;

-increased concentration of toxic products of burning and thermal decomposition;

-reduced oxygen concentration;

-reduced visibility in smoke.

A telephone is available to notify the fire Department in the event of a fire or fire.

In order to calculate the water consumption for internal and external fire fighting, the following data is required: the degree of fire resistance; the building category for fire hazard; the height and volume of the building.

Calculation of water consumption for internal fire fighting

$$Q = \frac{q * n * t * 60}{100} = \frac{2 * 5 * 10 * 60}{100}$$

q - is the water flow rate per jet, l / s;

n - is the number of jets;

t - fire extinguishing time, min; t = 10 min.

Water consumption for external fire fighting = 30L/s.

The source of water for fire fighting is a Central fire hydrant located on the territory of the organization.

Fire gaps between buildings and structures are 18 m.

5 Economic part

In this chapter, I conduct detailed calculations that I make and study the device, that is, the robotoma – the economic component of the business plan. To do this, first, I will give a brief overview of the business plan as a whole.

A business plan is a category of market management, the main tool for managing an enterprise and increasing its profitability in a competitive and free enterprise environment. It defines the company's goals and ways to achieve them.

It is compiled in the following cases:

– justification and implementation of investment projects;
– implementation of individual commercial operations;
– issue of securities;
– determining the company's development prospects;
– implementation of reorganization measures;
– financial recovery and recovery from the temporary economic crisis.

The most extensive are the business planning of current activities (for the upcoming year or other period) and the business plan for creating a new enterprise.

A well-developed, scientifically-based business plan is necessary for many participants in the commercial business: founders-owners, business partners, potential investors, banks, administrative bodies, etc.

5.1 Summary

A detailed financial and production analysis of the company precedes the development of the business plan.

Financial analysis includes an assessment of the current state of the enterprise, analysis of its balance sheet, asset structure (fixed and working capital), characteristics of material resources, buildings and structures, social infrastructure, equipment (residual value and degree of wear), construction in progress, inventory, dynamics of output and sales, profit and profitability of the enterprise.

In the process of production analysis evaluate the quality of products and services, level of technology, level of production costs, personnel qualifications, location of energy sources and suppliers of materials, components, etc.

Description and analysis of the state and diagnostics of enterprise development in the business plan solves two tasks:

1) study of the state and trends of development of the enterprise as an object of investment;

2) obtaining initial information for forecasting the volume of production and sales of products and services of the enterprise, taking into account competition.

5.2 The complexity of developing a software project

The main tasks of work planning are:

- mutual coordination of work and the establishment of a rational sequence of upcoming work;
- establishment of work.

Table 5.1- Total software product

SP Development Stages	Types of jobs	The complexity of development, people× h
1 stage	Domain Analysis	8
2 stage	Formulation of the problem	4
3 stage	Development of technical specifications	12
4 stage	Project assembly	12
5 stage	Equipment testing	12
TOTAL software product		48

5.3 Calculation of development costs SP

To determine the costs of developing SP, you need to make an estimate, which includes the following articles:

- material costs;
- costs to pay for the trade;
-social tax ;
-amortization of fixed assets;

5.4 Material costs

The costs of basic auxiliary materials relate to material costs. Calculation of the cost of material resources and the cost of equipment are made in the form given in 5.2 - 5.3

Any owner of plots, country house or cottager dreams of installing an automatic irrigation system for their green spaces.

Table 5.2 - the cost of hardware and software

Name	Description	Price per unit, tg	The amount, tg
A laptop	HP Pavilion g6 Notebook PC	150000	150000
operating system	Microsoft Windows 10	free	free
Arduino NANO		8600	8600
water pump	1	3000	3000
Hose	1	1000	1000
Humidity sensor	1	500	500
Temperature sensor	1	500	500
real-time timer	1	2000	2000
encoder	1	1000	1000
relay module	1	2000	2000
TOTAL hardware and software costs			169600

Table 5.3 - the Cost of material resources

Name	Description	Price per unit, тг	The amount, тг
Paper	A4	1 100	1 100
Binding work	Diploma	1500	1 500
TOTAL hardware and software costs			2600

5.5 Electricity Costs

This chapter includes technological costs, which are provided in table 5.4. The total cost is calculated by the formula (5.1).

$$з_э = \sum_{i=1}^{n} M_i * K_i * T_i * Ц \qquad (5.1)$$

From January 1, 2019, the electricity price at the tariff of «AlmatyEnergoSbyt!» is 15.90 tg per 1 kWh, excluding Value added tax. The price of electricity, including Value added tax, will be 17.81 tg per 1 kWh.

Table 5.4 - Costs for technological needs

Name of equipment	Nameplate power kWh	Power factor	Development equipment uptime h	The price of electricity tg/ kWh	The amount, tg
A laptop	0,2	0,8	157	17,81	447,387
Total electricity costs					447,387

5.6 Labor costs

Labor costs are calculated according to the form given in table 5.5. The total cost of labor is calculated according to the formula (5.2)

$$З_{тр} = \sum_{i=1}^{n} ЧС_i * T_I \qquad (5.2)$$

The hourly rate of the employee, calculated by the formula, is -600 тг/час.

The monthly salary of a beginning electronic engineer who participated in the development of this project = 90,000 tg

Table 5.5 – the Cost of labor

Employee category	The complexity of development,h	Hourly rate, tg/h	The amount, tg
Developer	1x150	600	90 000
Total cost of labor			90 000

5.7 Social tax

Social security contributions account for 9.5% of salaries for the wages of all employees, however, pension contributions (10% of Зтр) are not subject to social tax.

Mandatory pension contributions will amount to:

ОПВ=90000*10%=9000(тенге)

From here, the amount of social tax will be:

СН=(90000-9000)*9,5%=7 695(тенге)

5.8 Depreciation of fixed assets

Under the article "Depreciation of fixed assets" are calculated depreciation charges, based on the value of fixed assets, used in the process of developing a software product, terms equipment operation and annual depreciation rates. Depreciation deductions are determined in accordance with Table 5.6. The amount of depreciation is calculated by the formula (5.3).

$$З_{ам}=\frac{Сobор*На*N}{100*12*t} \quad (5.3)$$

Where $Н_а$- depreciation rate (%);

$С_{обор}$- initial cost of equipment;

N- equipment usage time;

t- number of working days in a month.

The depreciation rate for the linear accrual method is calculated by the formula (5.4)

$$Н_{ai}=100/Т_{Hi} \quad (5.4)$$

The use of fixed assets varies from 3 to 10 years. Everything is used for 8 years. Software for 4 years. Using formula (5.4), fill out table 5.6 to display depreciation of fixed assets.

НА1=100/8=12,5 %

НА3=100/4=25

Зам=(200000*0,125*25)/(1*12*24)=2170 tg.

Зам=(8600*0,125*25)/(1*12*24)=93,31 tg.

Зам=(2400*0,125*25)/(1*12*24)=26,04 tg.

Зам=(900*0,125*25)/(1*12*24)=9,76 tg.

Зам=(1500*0,125*25)/(1*12*24)=16,276 tg.

Зам=(6000*0,125*25)/(1*12*24)=65,104 tg.

Зам=(5000*0,125*25)/(1*12*24)=54,253 tg.

Зам=(4200*0,125*25)/(1*12*24)=45,57 tg.

Зам=(9500*0,125*25)/(1*12*24)=103,08 tg.

5.9 Cost estimate for the development of software

Having calculated the costs associated with the creation of a robot, based on the calculations obtained in paragraphs 4-8, a cost estimate was made and reflected in table 5.8

Table 5.8 - Estimated development costs SP

Cost item	amount, тг
Salary	90000
Social tax	7 695
Electric power	447.387
Depreciation of fixed assets	2583.753
Hardware and software costs	169600
The Cost of material	2600
Total estimate	272926.14

5.10 Determination of the possible (contractual) SP

The value of the possible (contractual) price of software is established on the basis of efficiency, quality and terms of its implementation at a level that meets the economic interests of the customer (consumer) and contractor and is calculated by the formula (5.5).

$$Ц_c = С_j \times \left(1 + \frac{P}{100}\right) + VAT \quad (5.5)$$

P– the average level of profitability of SP is taken at a rate of 20%

VAT-value added tax, 12 %.

Cost without value added tax:

Ц (without VAT)= 272926.14*(1+0,2)=327511.368(tg).

The tax rate on the cost included from the additional project price is calculated using the following formula:

$$VAT = 327511.368 \times 0{,}12 = 39301.364$$

The amount of the agreed project price:

Ц=327511.368 +39301.364=366812.732

The cost of the full development of the project was 366812.732tenge.

5.11 Development of the main sections of the marketing plan

Businessmen who decide to start a business by selling and installing automatic irrigation systems are absolutely right, as they thereby gain a huge audience of potential buyers. Such systems, despite their convenience, are not yet very common, and therefore, if the business is properly organized, it can become quite promising. Any owner of plots, country house or cottager dreams of installing an automatic irrigation system for their green spaces. After all, such devices not only facilitate the watering process and allow you to spend less physical effort and time on it,but also provide more uniform moisture.

It is important for the founder of a business that sells and develops automatic irrigation systems to know which types of such devices exist and which of them are most in demand. Thus, irrigation systems are umbrella, fan, pulse and rotary. They differ primarily in the technology on which their work is carried out, and the choice of a particular system depends on the area of the lawn and the type of vegetation.

The work of a company specializing in automatic watering systems will be as follows:

- preparation of the necessary design documentation for the installation of a irrigation system with a parallel study of the possibilities of water flow and pressure in the system;
- if necessary, installation of additional water tanks and pumps;
- selection of pipes and other equipment in connection with the size of the site and the types of plants to be planted;
- creating a project for the future system, accompanied by cost estimates for all necessary parts and types of work.

In General, the installation of automatic irrigation systems will include a whole range of actions, starting with the construction of trenches and ending with the installation of weather sensors.

They offer installation of such systems both at the stage of initial preparation of the site, and at the end of landscape works. Companies offering automatic irrigation systems often also carry out further preventive maintenance and repair of these devices, so it is important that the company provides various types of services.

If not so long ago the main category of customers were well-off people-owners of large cottages, then thanks to the emergence of new developments and improvements in systems of this kind, now the purchase of irrigation systems has become available to many. It is only important to install them correctly, which is why you should only contact professionals. This factor will be crucial for the company that offers installation of irrigation systems.

Conclusion

The primary applications for this project are for farmers and gardeners who do not have enough time to water their crops/plants. It also covers those farmers who are wasteful of water during irrigation.

As water supplies become scarce and polluted, there is a need to irrigate more efficiently in order to minimize water use and chemical leaching. Recent advances in soil water sensing make the commercial use of this technology possible to automate irrigation management for vegetable production. However, research indicates that different sensors types perform under all conditions with no negative impact on crop yields with reductions in water use range as high as 70% compared to traditional practices.

The first chapter is an overview and theoretical part: an overview of the automatic irrigation system, identified technologies, methods, types of irrigation and what place auto irrigation occupies in rural culture. Based on this information, we understand the relevance of our thesis.

In the second chapter we described the principles of auto watering and their advantages , and the characteristics of each unit and connection scheme. The result is an Assembly of an automatic irrigation system.

The third chapter describes the programmer's guide and user. Detailed information is given about the Arduino development environment, and the algorithm of the program that I wrote the code based on is given. The result is a sketch of the program and instructions for use. Then the developed system was tested. The result is a fully functioning system that allows you to maintain the specified humidity and track its changes in real time.

Further research on this topic will focus on expanding our system. In addition to maintaining optimal humidity, you can add temperature sensors, real-time clocks, security monitoring, and more. Connecting more and more units will eventually get a full-fledged irrigation automation system.

Graduation project topic: Development of an automated irrigation systems for agricultural land

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