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:__________*Design of a two-legged walking platform*

____

Done by:___________*Kasymov Muhamed*_______________*PSa-16-4*___________
(Surname and initials of a student) (group)

Specialty___*5B071600 Instrumentation Engineering*________________________

Research supervisor_____*Balbaev G.K. ,PhD docent*________
(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
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Institute of *space engineering and telecommunications*
Department of *Electronics and robotics*
Specialty *5B071600 Instrumentation Engineering*

ASSIGNMENT
for execution of degree project

Student *Kasymov Muhamed Serikuly*
(Full name)
Topic of the work *Development of pattern recognition system for upper limb prosthesis control*

Approved by the order of the rector № 155 from « 23 » october 2020 y.
Deadline of the finished work « 8 » june 2020 y.
Initial data required parameters of the results and initial data:

1. *Arduino Uno microcontroller*
2. *MG995 servo*
3. *MG90S Servo*
4. *Samsung laptop*

List of issues to be developed in a degree project or a summary:
1. *Consider the control of a prosthesis based on an image recognition system*
2. *The choice of equipment, device description and principle of operation of the system*
3. *Program part*
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 57 figures and tables

Recommended basic literature:
1. *Jain, V. and Seung, S. H. (2008). Natural image denoising with convolutional networks. In NIPS'2008*

2. *Stankevich L. A., Yurevich E. I. Artificial intelligence and artificial intelligence in robotics: textbook. Saint Petersburg: Polytechnic University Press, 2012.*
3. *S. Korotkiy, "Neural networks". Saint Petersburg, 2002*

Consultants for work with indication of the relevant section

Section	Consultant	Date	Sign
Life safety	*Begimbetova A.S*	*21.05.2020*	
Economic part	*Tuzelbayev B.I*	*05.05.2020*	

SCHEDULE
Of degree project preparation

№	Title of section, list of issues to be developed	Deadline for submission to instructor	Note
1	*Theoretical part*	*16.01*	
2	*Engineering part*	*03.03*	
3	*Program part*	*14.05*	
4	*Life safety*	*12.05*	
5	*Economic part*	*23.05*	
6	*Conclusion*	*25.06*	

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

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

Supervisor: ______________________*Fazylova A.R.senior lecturer*________________
(sign) (Surname and initials)

The assignment for execution is accepted by: __________*Kasymov M.S.*_________
(sign) (Surname and initials)

Аңдатпа

Бұл дипломдық жұмыста екі аяқты адымдаушы платформа құрастырылды. Платформалардың түрлері және оның қолданылуы қарастырылды.

Екі аяқты платформаның тәжірбиелік үлгісі құрастырылды.дипломдық жұмыс барсында роботтың қозғалу принципі мен қолданылу аймақтары негізге алынды.

Бұл жобада гексапод аяғына Proteus Design Suite бағдарламасын пайдалана отырып, кинематикалық сұлбаларды визуализациялау мүмкін болды. Сонымен қатар, SolidWorks бағдарламасында екі аяқты платформаның 3D көрінісінің моделі салынды.

Өміртіршілік қауіпсіздік бөлімінде өндірістік бөлмедегі электромагниттік өрістерден қорғау және желдеткіштің механикалық ауа алмасуы есептелінді.

Экономикалық бөлімде екі аяқты платформаны жасауға кеткен шығындар мен оның экономикалық тиімділігі есептелінді.

Annotation

In this diploma work, a two-legged walking platform was built.The types of platforms and their application are considered. An experimental model of a two-track platform was developed.the thesis is based on the principles of movement and application of the robot.

In this project, it is possible to visualize kinematic schemes using the Proteus Design Suite program by the end of the hexapod. In addition, the SolidWorks program built a 3D representation model of a two-track platform.

In the section life Safety, protection against electromagnetic fields in industrial premises and mechanical air exchange of the fan were calculated.

In the economic part, the costs of creating a two-window platform and its economic efficiency are calculated.

Аннотация

В этой дипломной работе была построена двуногая шагающая платформа. Рассмотрены типы платформ и их применение. Была разработана экспериментальная модель двуногой платформы. В ходе дипломной работы за основу взяты принципы движения и области применения робота.

В этом проекте возможно визуализация кинематических схем с использованием программы Proteus Design Suite. Кроме того, в программе SolidWorks была построена модель 3D-представления двуногой платформы.

В главе безопасности жизнедеятельности рассчитал защита от электромагнитных полей в производственных помещениях и механический воздухообмен вентилятора.

В экономической части рассчитаны затраты на создание двухоконной платформы и ее экономическая эффективность.

Contents

Introduction

Currently, mobile robots are used for a variety of tasks. Their list includes: warehouse maintenance, cargo transportation, research and monitoring of complex or dangerous areas, selection and exploration. To this end, extensive robot structures have been developed and studied. Over the past decade, in many regions, walking robots are often used, that is, robots that are lost. They have properties that have clear advantages next to their wheeled or serpentine counterparts.

Thanks to the flexible choice of movement models, lost robots can move in uneven places and enter inaccessible places. In addition, they can maintain their capacity by replacing the movement model (with the appropriate design and control algorithms) in cases where they have lost one or more limbs. In this graduation project, a two-pronged robot that imitates a spider and repeats its movement was studied. Such a device has all the characteristics of robots-walking robots.

In this thesis project, I gave examples that reflect not only the developed anthropomorphic robot, but also the list of works on its compilation, as well as the safety of its life and economic efficiency.

The section life Safety provides an example of calculations and characteristics of the total illumination of a specially equipped room designed for the development of a hexagon step robot developer. In this diploma project, the following issues were considered: organization and conduct of network design work

The economic part of the diploma project also has its own characteristics. Its features are calculations used not only by a variety of topics, but also by methods of economic evaluation of research, taking into account the expected economic efficiency and cost of production costs. When performing the economic part of the diploma project, defenders use information on all sections, data obtained in previous internships, and various sources of information. It also applies the knowledge gained in the course of training in higher educational institutions. The economic part is performed simultaneously with the main section and is completed with a separate section.

1 Modern walking robots

Almost half a century ago, during its existence, robots have gone from simple mechanisms up to devices with sophisticated efficiency. They surpassed the abilities of humans in many ways. In the coming decade, robots will become the most popular human assistants and take on most of the needs of civilization. Currently, there are many types of robots. Therefore, there are a number of classification options for classifying them: size and shape, by function, type of program logic, and so on. The most important of all types of classification is the classification as far as possible movement. In it, robots can be divided into two parts: moving and stationary robots. In this project, I looked at the robots moving and including the developer antromorphic robots [1].

The developed platform can be represented as a manipulative system.

Manipulator-a mechanism for controlling the spatial position of tools, labor objects, and structural units and elements. This term appeared in the middle of the XX century, due to the use of complex mechanisms for manipulating dangerous objects in the nuclear industry. At its core, manipulators are a spatial mechanism with several degrees of mobility, they perform auxiliary work in many industries and various spheres of human activity. Manipulators are studied in the course - "theory of manipulators", which is a subsection of the theory of machines and mechanisms. In a narrow sense, the manipulator can be represented as a mechanical hand.

With the increase of the level of development of science and technology appeared in the mechanisms with parallel kinematics, such as biped, tripod, quadropod, hexapod, and others. In the General classification, such objects are called walking machines, or walking machines — a variety of machines that move with the help of legs walking. Due to the constructive complexity of the execution, they have not yet received much distribution in real life.

1.1 The analysis of walking mode

In principle, a person is able to develop nature, other types of movement, its mixed, walking with various combinations, i.e., is able to create transport and technological machines with good performance and high increased productivity, linking the construction of running mechanisms. All creatures in nature have a system of levers, not wheels, because the system of levers is more effective for driving on natural soils than wheels on uneven roads. This is facilitated by the properties of the musculoskeletal system of walking: the discreteness of the chest, i.e., the ribs and the presence of non-working zones of the lower extremities. In this case, the word discreteness of the walls is a break in the contact of the engine, on the surface of the movement zone. Under the word working area of the legs, the space around the body and the presence of points available for the support elements of the space, the running engine. These properties of the walking motor allow artificial walking movements, the possibility of upper support and profile passage.

Environments adapted for human habitation, other than places that are rough places for normal transport: narrow passageways, sharp turns, stairs.

Without careful study of natural objects, their behavior, the correspondence is not allowed to produce any suitable design which, as a rule, can apply in practice: for example, forestry machines "Tabaruk", the robot of the laboratory of transport systems of the Academy of Sciences of the USSR. These machines failed to meet the expectations of the designers and did not show the dynamic properties characteristic of insects. This formulation is similar to the physiological models of motion control in living organisms, while the compositional concept of building walking robots should be considered. And this is an analogy based on a study by Russian scientists conducted at the Institute for information transfer problems. Therefore, the compositional concept can be considered a biological approach in robotics. In accordance with this concept, the minimum level of control over the movement process can be represented as the result of the collective work of independent closed automatic control systems (regulators). There are no connections with individual controllers (horizontal links). In other words, a pedestrian robot can be represented as a single automaton by several components of a simple, independent automaton, and the process of locomotion is the result of the joint activity of this automaton. Each automaton solves its own problems and thus contributes to the formation of the motor process.

Each simple machine is an automatic control system and controls only one connection, i.e. a link. In addition, at various stages of the leg movement cycle, several different controllers can control a separate Association. The same joints of all legs control one of the movement parameters. For example, the step length refers to the height of the robot, the body, the link surface, or the speed of the robot. Control of all parts of the robot are carried out in parallel. This ensures a high level of control system. The actions of other automatic machines, as actions that cause environmental protest, affect individual machines. As a Regulator, the purpose of machines is to return objections. Output signal sensor system that is used in the feedback circuit with automatic regulation, and also contains information about other automated devices. This is a separate machine, which negatively affects the operation of the machine of other sensor systems, and is also a regulator of communication between any channels. In this case, the external environment of one machine consists of other machines and in General of the external environment of the robot. The desired network parameters control the high-level robot control system and become stable during the rhythmic movement.

This approach, dedicated to the problems of walking robots, makes it easier to manage the locomotive process and makes it more attractive. It is determined by implementing the recommended approach in the Assembly of walking robots, i.e. walking robots, considering the issues of sensor systems for automation. This problem was solved by using a set of sensors integrated in a sensor system that are able to measure every stroke parameter [2].

1.2 Classification of moving robots

Mobile robots are divided into wheeled, flying, and walking robots.

Walking robots, in turn, are divided into two legs, four legs, six legs, and more legs. Depending on the goals and tasks that you perform, you can be divided into two groups:

a) robots of the production step;

b) robots-developers of the research step.

Designed for performing heavy, monotonous, harmful and dangerous physical work. A characteristic feature of such robots is the presence of automatic control devices (manipulators that simulate the movement of human hands, self-driving cars with different types of chassis, etc.)

In turn, production robots are divided into several types:

- industrial;
- construction;
- agricultural;
- transport;
- household;
- military.

Industrial robots are manipulator robots, i.e. an automatic device consisting of a control device that allows the manipulator and the Executive bodies to show the required movement, perform control actions, reprogram, reprogram. It is used for moving production facilities and performing various technological operations. In other words, these robots are mainly designed to automate all kinds of manual and transport operations in various industries.

The beginning of the nuclear period also contributed to the emergence of manipulators used in industry. In 1947, the first automated Electromechanical manipulator designed for transporting radioactive materials and repeating the movement of a human operator was created in the United States by a group of employees of the argon National laboratory, led by R. Hertz. Due to the fact that no feedback can provide a physical connection, using such manipulators, it was difficult to turn the key nut or place items correctly on the surface of the arrangement. However, in 1948, the company "General Electric", has such feedback with "handy man" (English Handy Man) developed a copy manipulator. He was able to use the manipulator to achieve the strength that operators, manipulators, can hold an object [3].

The first robots began to be created in the literal sense of the word, in the mid - 1950s, in the United States. In 1954, an American engineer named J. p. DeVol using variable punched cards made an approach to managing the loading and unloading manipulator and sent a patent application for a "programmable device for transporting objects", i.e., a robot used in industry (the patent for DeVol was issued in 1961).

In 1956, the year J. Together with Engelberg, the world's first company for the production of industrial robots was established. Its name" Unimation " (English

Unimation), that is," Universal Automation " is an abbreviation of the universal term automation.

In the modern world, no industry, regardless of weight and size, can be without accessories and unloading. The robot can install the product on the machine itself. One robot can interact with several machines.

Now robots allow you to minimize the cost of personnel. It's not just about simple functions like working with printing or using an oven. Robots can lift a higher weight in more difficult conditions, but they do not get tired and spend less time than a living person.

For example, in the foundry and forging industry, the situation for people is quite difficult. This type of production takes the third place in terms of robotization after filming. Now all European foundries are equipped with industrial robots of the automatic system. The cost of implementing the robot at the enterprise is one hundred thousand dollars.

Easy operation for metal, wood or plastic drilling, edge processing and robot milling. Real and robust manipulators can perform these tasks very easily. The working area is not limited, only when installing an extended axis or multiple controlled axes gives greater flexibility and high speed. A person cannot do it this way.

Figure 1.1-Industrial robots

The further growth of industrial robotics was associated with the development of computers, electronics, and the expansion of companies in the automotive market - the main consumers of robots.The 80th anniversary of General Motors invested more than $ 40 billion in automation. The main robot market is the domestic market of Japan, where many companies are located: Fuji, Denso, Epson, Fanuc, Intelligent Actuator, Kawasaki, Nachi, Yaskawa, Nidec, Kawada. In 1995, of the 700,000 robots used in the world, 500,000 were working in Japan.

Construction robots-automate a lot of operations related to organic, auxiliary and basic, manual, typical for the construction business. Robotization of construction is an actual problem of today (Fig. 1. 2). Scientists, engineers and architects were approaching the realization of the dream of millions of people.

They can perform construction work without human intervention, and create remotely controlled machines, i.e. robots. This will allow in the near future, instead of old, abandoned houses, to provide the common population with affordable and convenient, well-maintained multi-storey buildings and structures. It is expected that in the future, robots will assemble the body of a two-story house in one day and reduce the cost of installation by five times [4].

The creation of these wonderful machines and robots is carried out simultaneously by several scientific groups in different countries of the world. These are: researchers from the University of southern California in Los Angeles, experts from the Loughborough University school of Engineering in the UK, participants in the "Minibuilders" project in Russia, led by Petra Novikov and Sasha Jokic, and others.

Figure 1.2-Construction robots

An agricultural robot or agrobot is a robot used for agricultural purposes.

The main application of robots in agriculture is the harvest period.Tractor-spray robots, Autonomous for collecting fruits and berries, and robots designed to replace human labor in General, shearing sheep wool. Unlike other industries, agriculture uses robots, and is a little behind. After all, the types of work related to agriculture, simple and many repetitive tasks are not always the same. In most cases, a number of factors (such as the number and color of fruits to be picked) should be considered before starting a task. Robots can be used for crop management, such as breeding, plowing, watering, Watering, and monitoring

Once again, it is worth noting that robots can be used for milking, washing and closing livestock.

Thus, agricultural robots are designed to automate efficient and monotonous processes in agriculture. Currently, the beginning of intensive development of such robots is marked with the beginning of robotization of agricultural production (Fig1.3).

Advanced countries are working on a transition to unmanned automated agriculture based on the widespread use of mobile and stationary robots. This is expected to result in increased productivity while improving profitability, which reduces the cost of production. Robots are able to perform various operations - tillage, fertilization, seeding, planting, milking livestock, shearing wool, feeding, butchering meat and fish, etc.

The use of software and hardware systems for unmanned control to replace drivers of agricultural vehicles reduces the overspending of materials, as well as increases productivity due to more accurate land cultivation.

Figure 1.3-Agricultural robots

Transport robots are designed to automate the management of a variety of vehicles. These are robots that can automatically control self-propelled carts, walking devices and transport, as well as flight devices (Fig.1.4).

Portable production robots (PP) are divided into ground or floor and inflatable, that is, suspended. TT is defined by the method of cargo transportation as follows: - cargo transportation by manipulator or using a specially equipped mooring device; - cargo transportation using a specially equipped mooring device designed to tow transport devices in the required quantity, which in turn can not move independently or with a manipulator:

- load-bearing cargo (for example, cargo platforms).

In functional terms, the carrier performs certain production operations (determining the maintenance of technological installations, the size and weight of parts, etc.) that ensure the transportation of cargo only. In accordance with the methods of control, the carriers are divided into four subgroups:

- manual control; in this case, the appointment and selection of motion parameters is carried out by the driver. A the carrier provides implementation and maintenance of the specified parameters of the PR management system;
- the carrier is designed for Autonomous control on a production robot that performs the entire complex of operations, has an independent control system, including-the appointment and selection of motion parameters; all motion parameters (speed, path, stop, etc.) are indicated by external movement to the control device, incoming signals from the outside; it is carried out by signaling, communication or contactless method;
- the control device is installed on a PC, encrypts input signals and creates commands and control actions for individual controls;
- the possibility of implementation of various methods of motion parameters that are managed by related management systems. Shares RR, fault and safety, adaptation to changing working conditions, equipped with a developed information system, strictly programmed and adapted, adapted to external conditions.

Figure 1.4-Transport robots

Today, robotics is gaining ground in all major industries and is often being implemented in various areas of human life.

Whereas previously robots could perform the role they play by replacing people in factories where repetitive operations are often required in conveyor production, now robots have come to the time when they appear in every home to help people solve current problems, save their time and energy.

Household robots that come to help people in their daily lives are gaining huge popularity. This is not a surprising situation. Because the variety of robots is growing every year. Already these are vacuum cleaners, lawns, window cleaners, pool cleaners, even robots that remove snow.

By the way, in 2007, bill gates published an article "a robot in every home", paying great attention to the importance of this technological direction. In this article, she demonstrated the prospects that open up to society thanks to the introduction of robots, that is, the future [5].

This is probably why humanity is making great strides in creating household robots-household robots. They are based on automation of operations related to the life and sphere of human activity. This requires more flexible and versatile systems than traditional automatic machines. As mentioned above, these robots should be so that they can perform household chores (Fig. 1. 5), to wash dishes and dirty clothes, wipe floors, cook various dishes, etc.

Figure 1.5-Household robots

The number of household robots can also include robotic toys that can lead to movements, actions of living organisms (sometimes, some emeotii) (figure 1.6).

Figure 1.6-Robotic toys

Military robots (combat robots) – in military conditions, to save a person's life or with disabilities in cases where this is not possible, it is used for military purposes in inaccessible places so that it can be replaced. Currently, there are several types of military robots.

These are unmanned flying or remotely controlled aircraft, underwater devices and surface vessels, robots-mines(robots-minerals), robots-decontaminating mines (robots-sappers), robots-scouts and patrol robots (Fig.1.7).

Combat robots are considered robots that can separate or completely replace a person, atropomorphic actions, not only automated devices, but also robots that can act both in the air and in water.

Currently, many robots are telepresent devices. Most military-style robots, in General, only a small part of all robots, have the ability to automatically perform certain tasks without the help of operators.

In 1910, a young American military engineer from Ohio, Charles Kettering, proposed using aircraft without human assistance. In his opinion, a device controlled by a clockwork mechanism should fall into the enemy like a bomb, lowering its wings when reaching a given place. After receiving funding from the US army, he received various successes and tested several devices called" The Cattering Aerial Torpedo"," Kettering Bug"or " Bug". But they were usually never used in combat [6].

In 1931, Stalin approved a plan for restructuring the troops, which pinned hope on the tanks in jopara. In this regard, during the fighting, radio relay, remote teletanks were built, operated without a crew. These are tanks of the T-26 series, TT (type of teletanks), control tanks (control of a group of tanks"without a crew").

In the early 1940s, the Red Army was armed with 61 radioactive tanks. These machines were first used during the Soviet-Finnish wars. Here, the "intruder" tank, created on the basis of T – 26 tanks, is different in itself.

In 1948, the United States created the AQM – 34 unmanned aerial vehicle. He was the first pilot of the plane in 1951. In the same year, the" unmanned aircraft " was released into mass production.

In 1959, the design Bureau of S. Lavochkin produced an unmanned aircraft "La-17R".

During the Vietnam war, the US air force actively used unmanned aerial vehicles "Firebi" and"Lightning Bag".

In March 1971, the Commission of the Presidium of the Council of Ministers of the USSR decided to develop unmanned aircraft.

In 1979, at the request of the KGB, a complex robot of increased lightness – MRK – 01, designed to neutralize explosives, was created at the Bowman technical University.

After receiving funding from the US army, he received various successes and tested several devices called" The Cattering Aerial Torpedo"," Kettering Bug"or " Bug". But they were usually never used in combat.

In 1979, the design Bureau of S. Lavochkin produced an unmanned aircraft "La-17R".

Figure 1.7-The military robots

Figure 1.8-fully Autonomous military robots

In order to find, collect, process and transmit information about the objects under study, research robots are used (Fig.1.9).

Figure 1.9-Research robots

Objects can include space, the surface of the planet, underwater space, underground cavities (mines, caves, etc.), the Arctic and Antarctic, deserts, polluted places and inaccessible to people.

The emergence of mechanical manipulators, and then programming systems (including digital program control), the creation of industrial robots, i.e. the execution of various operation for controlled manipulators led to the creation of software [7].

Humanity has always tried to facilitate daily life and work as much as possible. And in the course of this evolution, a class of robot machines appeared, and with it a whole direction – robotics. One of the countries where this discipline is most actively developed is Japan. The developers plan to use robots not only for industrial purposes, but also in everyday life. Scientists hope that home robots will become as common as the use of smartphones in the coming decades.

With the increase in the level of development of science and technology, mechanisms with parallel kinematics, such as a tripod, quadropod, hexapod, and others. In in the General classification, such objects are called walkers, or walkers machines — a variety of machines that move with their feet walking. Due to the design complexity of the execution, they are not yet available received a large distribution in real life.

In comparison with wheeled and tracked vehicles, walkers are characterized by increased cross-country traffic. Such mechanisms provide improved short-term repeatability of positioning,reducing the influence of inertia forces. Such mechanisms are based on the structure spider-like insects. The main problem in creating walking paths is price-performance ratio (including marching speed), as well as the lack of sufficiently energy intensive and compact sources energy and high-speed drives for running legs. However, this time in the world is already being developed to create full-fledged walking machines.

The appearance of the "Masha" robot is shown in (figure 1.10).

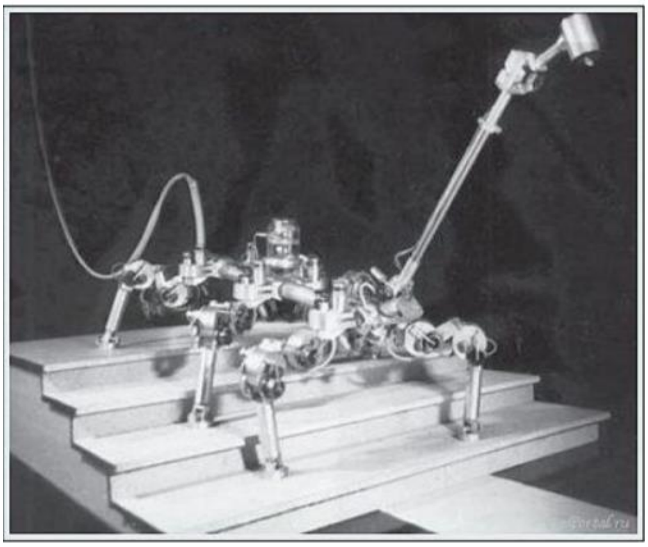

Figure 1.10 - the six-legged Robot "Masha" 1969

Before the theory of manipulators, copying natural objects, as a rule, it did not allow you to create workable structures that it could be used in practice. One of the first created in the world "walking apparatuses", was created at the Institute of mechanics of Moscow state University in the 70s last century, "hexapod". This device received a very attractive the name "Masha", which is short for"machine six-legged".

The prototype of the robot was a red cockroach of the "German cockroach" type. Study the cockroach's gait was recorded on video. The cockroach was placed in a glass tube that was installed at an angle and using a jet they controlled the direction of the cockroach's movement. Experiment recorded on a film video camera. Then a frame-by-frame recording was performed image processing. Thus, it was determined that the main type of the cockroach's gait is a three-three gait. A cockroach always relies on three paws that form a support triangle between them, inside of which the center of gravity of the body is located. This gait makes it much easier the problem of stability, since the robot's support on three legs turns out to be stable [8].

All the limbs of the robot "Masha" have three degrees of freedom and driven by three DC motors via gearboxes. The limbs are equipped with positional sensors that measure the angles of rotation of the leg links in relation to each other. Management system the robot is built on the principle of hierarchy. This system creates a control the impact that ensures the movement of the device with automatic adaptability to small surface irregularities on commands the robot operator (or top-level operator) that sets the main parameters characteristics of the body movement and walking of the device (for example, walking backwards, sideways, forward, u-turn, etc.).

After the appearance of "Masha", the technology race between the United States began and the USSR. In response to "Masha", the US offered its version of the walking a six-legged robot. Less than 10 years later in Europe also began to appear "walking machines", but during this time Masha remained a robot, which determined its time.

In 1985, Japan was able to take the championship from the USSR. Japanese development of Titan III and Titan ij, owned by Tokyo Tokyo Institute of Technology is the first among the walking mechanisms that were equipped with artificial intelligence. This allowed them to overcome simple obstacles. TITAN IV in 1985 in the government pavilion of the scientific exhibition in Tsukuba for six months in total I covered 40 kilometers on a surface divided into 3 levels difficulties. The weight of this robot was 160 kilograms, while the length of one the limbs (there were six of them in total) were about 1.2 m long. the impressive size of the robot developed a speed of up to 40 cm/s. Titan IV became the prototype for many walking robots of that time [9].

Since the introduction of the TITAN IV walking robots have been developed for practical application, for example, for the study of distant reliefs planets, cross-country traffic, etc. In the same years in the Port Harbour robotics laboratory was developed by Research Aquarobot for four years (1985-1989), which was used for deep sea research.

If Walking mechanisms are considered not only from the point of view "platform plus limbs", then you can find many uses for them, for example, in medicine. In 1948, N. A. Berstein-a Russian Professor depicted a person with prosthetics that mimic the skeleton of a leg, equipped with electric drive. This idea was supported By the Institute of prosthetics, but with difficulties after the war, he was not given the opportunity to develop it. Already in the 60s, General Electric company (Japan) presented a full-fledged exoskeleton.

Patent search gives more than ten models of walking robots with more than two legs, with each robot having its own unique features and purpose.

For example, a forest machine of the company "Taberzhek", a robot transport systems laboratories of the USSR Academy of Sciences, walking machine ASV (USA), designed for cross-country travel, mobile Ambler robot (USA), designed by NASA; walking robot MECANT, developed at the Helsinki University of technology; Plustech is a Finnish machine designed for forestry. (figure 1.11)

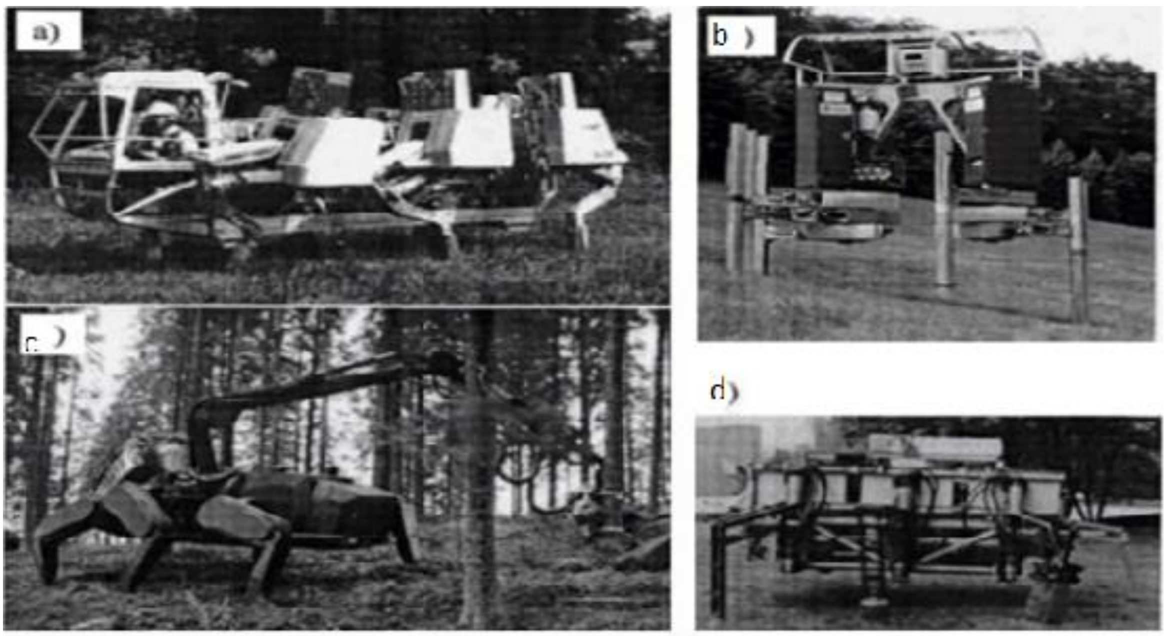

Figure 1.11-Types of robots

a -ASV, b-Ambler, c-plustech, d-Mecant.

In 1995, the four-legged robot Aranho Robot was developed in Japan. Each the paw is a three link mechanism at the ends of which were located disks with many metal hooks. The robot performed upward movements, down, left, right along the vertical wall without negative inclination and having an uneven structure. The appearance is shown in figure 1.12.

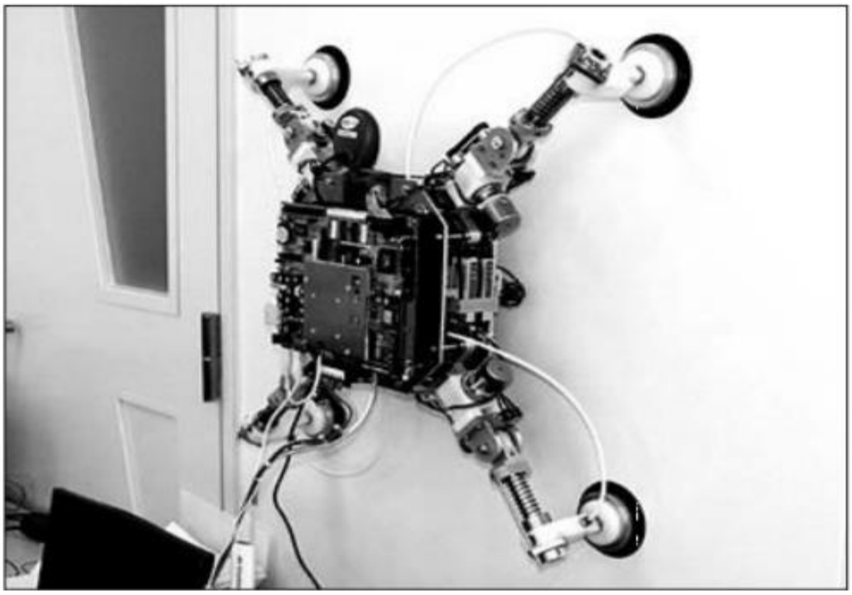

Figure 1.12-Appearance of Aranho Robot

But back to the walking two-legged robots.

Currently for the world science the development of two-legged walking robots (TLWR) is a priority scientific and technical direction in which research is actively conducted, a large number of scientific papers are published, the purpose of which is encouraging the creation of anthropomorphic robots which are capable of replace a person in a disaster or disaster zone and control algorithms them. Anthropomorphic homework-assistants and robot promoters are designed to interact with a person that imposes certain requirements on them, including requirements for security and social behaviors, including visual perception of a robot by a human. However, to perform the above tasks require skills to move inside facilities, ability to use existing infrastructure and manage originally designed for human devices. To ensure the robot must have the necessary versatility and flexibility body structure and mechanics as close to human as possible. In the class of walking robots have a rich history of two-legged walking machine. In 1972, the Institute of mechanics of Moscow state University developed a robot model called "Rishka". The model had 2 "legs" and 2 support wheels. The main task was to create a humanoid robot. But the state of technology did not allow us to implement a fast enough system stabilization for the organization of a "stable" gait. It is (ESR) that most closely meets such requirements and has ability to work and move in normal human conditions: step over obstacles, move across rough terrain, climb stairs, open doors, push handles, levers, buttons etc. Therefore TWLR is almost the only universal type robotic systems that are equally well able to perform multiple tasks. Moving the DSHR while maintaining balance when simultaneous high energy efficiency is their critical a property. The study of a mechanical and mathematical model of a two-legged robot, which represented a flat five-link mechanism consisting of a body and two legs, was conducted. The gait of the apparatus, as well as the gait of a human, was a sequence of alternating phases of one-and two-legged. In the single-support phase, the device it rests on one leg (support), while the other leg is carried. In in the two-legged phase, it rests on both legs. One-legged movement is considered ballistic (passive), i.e. this movement occurs by inertia. The device is affected only by gravity, and, of course, the reaction forces of the support. But the application of any active actions (moments of forces) in the joints ("joints") of the mechanism occurs in the two-support phase. When a person walks, the double support phase takes about 20% of the time of the entire step cycle. in the robot model considered, the two-support phase is considered instantaneous [10].

In the 1990s, two models of two-legged walking were constructed a robot: one with two telescopic legs, the other anthropomorphic, and algorithms for managing them based on the proposed method are developed ballistic walking control. Over the past decades, the theoretical foundations have been explored movement of the DSHR with the preservation of balance. However, the use of these development requires analysis of the applicability of certain control algorithms taking into account the specific kinematic structure and dynamic characteristics work, as well as calculation tools.

As a result, we can state the feasibility of developing a system controlling the gait of an anthropomorphic robot as the most versatile and a multifunctional mobile robot. Development and research of such the system is relevant and is an important scientific and technical task.

The purpose of this work is to improve the efficiency of motion algorithms a two-legged walking robot on a flat surface while maintaining its balance.

In 1964 a model of a two legged machine was developed in Leningrad Chebyshev. As early as 1969. Ishiro Kato (Japan) showed the world an anthropomorphic the two-legged mechanism is based on a model developed in the USSR. In this the same year, the company introduced the development of WAP-1. Interesting in this the development was that the muscles were made of rubber or rubber and the device was driven by Pneumatics due to the impact of on "artificial muscles". This innovative idea, which combined both simplicity, and genius. Ishiro Kato worked with the support of a special the humanoid Research Laboratory at the Waseda University (Tokyo). Interesting is the very fact of its existence at the end 60s, not the best years for Japan. And I must say, the result is obvious, because Ishiro Kato is responsible for most of the history of modern bipeds machine.

Already in 1970 there appeared an improved model of the WAP-2. It contained special controlled drives have been developed, while under the soles of the robot special pressure sensors were built in, which made it possible to automatic position control. Built-in sensors inherited in there are also spider robots. In 1971, there were two premieres, namely, WAP-3 and WL-1. Both they are of equal importance in the history of walking mechanisms. WAP-3 is 20 a continuation of the WAP-2 model, but unlike its predecessor, it had front center of gravity, which allowed you to tilt and move not only on the a flat surface, but also to descend/ascend, for example, on a ladder.

Thus, it was the first robot in the world that could move without only on the horizontal plane. WL-1 is a model controlled by a mini computer. It, like the WAP-

3, had a center of gravity located at in front, but it could change the direction of walking, which became possible by introducing a mini-computer.

In 1973, the WOBOT-1 project was launched in Japan (Ichiro Kato).Which was the creation of a fully functioning anthropomorphic the robot. In addition to control systems, WABOT-1 had built-in video and sound systems that allowed you to estimate the distance to objects and direction to them. Thus, it is one of the first robot machines that had "eyes" and "ears". In addition, WABOT-1 had external receptors and sound-reproducing system (could speak). That is, the first Android was created in 1973.

In 1980 Ishiro Kato developed the WL-9 DR, controlled by 16- a bit mini-computer. However if in previous models the" thinking " mechanism of each step was more than 45 seconds, then in the WL-9DR, it took only ten seconds to take one step.

In 1983, the WL-10 model appeared, which is a" thinking " step it took about four and a half seconds. The WL-10R model used new types of servo mechanisms and materials. Was significantly added the degree of freedom of the robot's members. The WL-10R could turn and walk freely back and forth. More parameters for walking mechanisms became urgent, namely, the degree of freedom.

In 1984, a team of scientists at the University of Tokyo creates a biped working with eight degrees of freedom. However, this robot has already had independent power supply from a DC source.

In 1985 And wide that creates the WL-10RD. Now the robot spends from 2 up to 5 seconds for each step. When working with Hitachi Ltd. model: WL-10R it is continued in another version - WHL-11 (Waseda Hitachi Leg 11). A computer and hydraulic drive were added to the WHL-11.

At the moment, there are a lot of anthropomorphic robots released for exploitation in various tasks, but I would like to highlight the best among them,so to speak, my list of top 3.

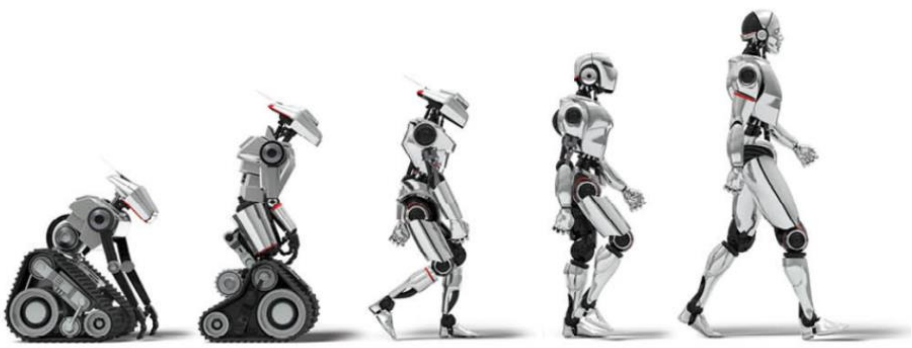

Figure 1.13-Evolution

And the first of them is the development of the company Boston Dynamics anthropomorphic robot – Atlas. One of the most ambitious projects of the company was the creation of a "dynamic" humanoid robot-the famous robot named Atlas.

Our friend has gone through a number of redesign stages in recent years. The world's most dynamic humanoid robot, Atlas is a research platform designed to push the limits of whole-body mobility. Atlas's advanced control system and state-of-the-art hardware give the robot the power and balance to demonstrate human-level agility. Atlas has one of the world's most compact mobile hydraulic systems. Custom motors, valves, and a compact hydraulic power unit enable Atlas to deliver high power to any of its 28 hydraulic joints for impressive feats of mobility. Boston Dynamics is a company from Massachusetts (USA) that not only engineers know about. The company is famous for its YouTube videos in which two-legged and animal-like robots jump, run, balance and even do somersaults [11].

Figure 1.14- Atlas dynamic humanoid robot

The advanced Atlas control system provides highly diverse and flexible locomotion, while algorithms reason through complex dynamic interactions involving the entire body and environment to plan movements. thanks to the advanced Atlas control system, it can reach speeds of up to 1.5 m /s.

Figure 1.15 – Lightweight

Atlas uses 3D printed parts to give it the strength-to-weight ratio needed for jumps and somersaults. Height 1.5 m, weight 80 kg. A research venture in creating the world's most dynamic humanoid. The Atlas robot is constantly learning new things. At first he learned to walk on two legs, like any other man. Later, his skills were added to balancing on one leg, the ability to carry loads, pass through doors and even do a back flip. Now he has learned parkour. Robots are gradually conquering the world. Some of them are already running for election, some are hiring people. And it is time for humanity to think about philosophical things. legal and ethical issues are related to the latest technologies. For example, what is the death or murder of a robot. Boston Dynamics is a very small company-it has only 100 engineers. Over the past 15 years, the team has focused on the basic principles of motion mechanics of robotics. They seek to change people's perception of what they can do. And they do it.

Figure 1.16- The robots of Boston Dynamics

Let's go to the main thing. The goal of creating the Atlas robot is to encourage innovation to push people to understand how to operate complex machines. The robot will help people understand what robots are capable of in General, and the time is not far off when Boston Dynamics products will begin to go into mass production. The company is engaged in training robots to jump, because this will give it ideas how to solve many pragmatic problems. In robot tasks such as jumping, you need to have coordination in both your upper body and legs. Images showing the Atlas robot show that the robot's arms move to better stabilize its body, and its legs bend when it lands on soft ground. This is not the same as in the laboratory. Boston Dynamics does a unique thing – the company brings robots to the real world. Before that robots were almost always tested only in laboratory conditions. In real conditions, robots must navigate the terrain independently. The only help this robot gets from the operator is simple joystick commands, such as moving forward, left, or right. Everything else happens independently of the operator's control system. Boston Dynamics began developing Atlas in 2009, literally spraying one of its four-legged robots in half to make a two-legged robot. This work began as part of a government project that used Pneumatics.

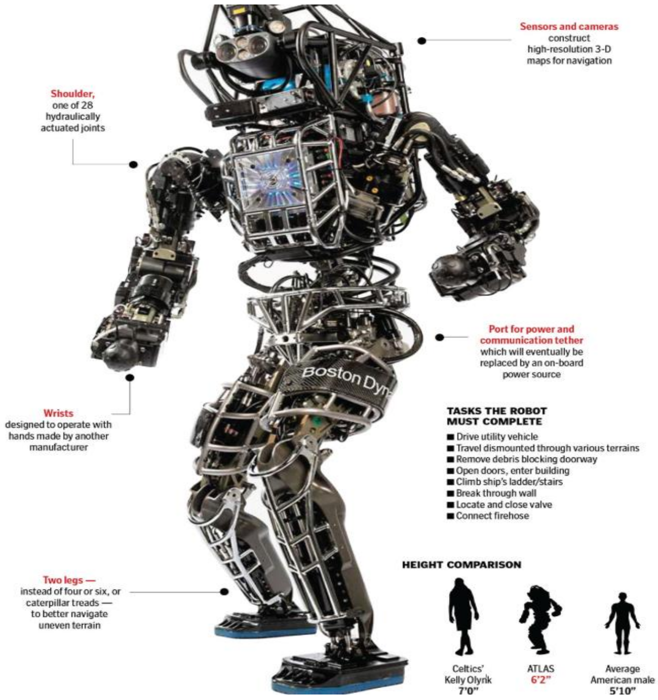

Figure 1.17 -The first concept of the Atlas from Boston Dynamics

In 2012, a large wave of popularity began in the United States regarding the use of mobile robots in disaster and emergency response scenarios. The government has asked the company to create 10 robots to give universities the opportunity to study how these latest technologies can be used in practice. Boston Dynamics first used many ready-made components to make up a hydraulic robot that was two meters tall and weighed almost 200 kg.

In 2013, the company was acquired by Google and it was able to really focus on the details of improving the robot. Boston Dynamics took the opportunity to reconstruct this humanoid robot from scratch. This new model of Robot Atlas has a height of about 1.5 m and weighs 80 kg. It has an increased power close to human. Atlas is fully Autonomous (it can run for 30 to 60 minutes depending on what it does) and has 28 degrees of freedom [12].

Instead of many ready-made parts that were the basis of the first robot model from Boston Dynamics, they began to develop their own. 3D printing technology has become the key for this version of the Robot Atlas. 3D printing is a key technology in the production of a modern robot. The company was able to significantly reduce the inertia of the limbs, which is very important for walking a robot – most of the force in the system is used to swing the legs through the air and accelerate and stop them. When you are a biped and you are walking – you are actually very effective. We rarely think about it. But we need a lot of strength to swing our legs, especially when they are heavy, so this [reduction] was an important thing in the process of improving the robot.

But this is not yet the peak of the Atlas robot's capabilities, and we are looking forward to new news from its parents, Boston Dynamics. In the meantime, we can only fantasize about the near robotic future – as is done in the new series ” Love, death and robots ” from Netflix.

I think it would be wise to move on to the next robot. This robot is physically different from its predecessor.The body of this robot is very peculiar.

The name of this robot is AnyWalker. What does it mean by its name, and what can it do? AnyWalker-a chassis that can move freely over difficult terrain on two legs.

If you describe the platform: 2 legs, 3 orthogonal flywheels, resistance to the overturning effects of power up to 100 W, Overcoming obstacles from 1.5 to 4.5 m in height, the estimated speed of movement in step mode is 5 km/h, the estimated speed of movement in rolling mode is 10 km/h, Autonomous operation time — 5 hours, remote operator management, video and photography.

Figure 1.19-AnyWalker

If I tell you about the capabilities of this robot, you may be pleasantly surprised. Although the design looks ridiculous, not every robot can perform the actions of this robot. The possibilities of this robot are not unlimited of course but it is worth evaluating. To move in difficult terrain. Open doors, turn valves, latches, and push buttons. To work in narrow spaces of the vestibule and sewers. With the help of the original stabilization system, you can achieve stability of a wide class of structures — robots, shooting platforms, multi-rotor unmanned aerial vehicles.Climb obstacles three times the size of the chassis. What will using AnyWalker in tasks give us?

First of all all-passable kinematic scheme of the robot. If you describe it in more detail AnyWalker with a body diameter from 40 cm to 1.5 m can move in any environment, even if it is not adapted for humans, over rough terrain. Secondly a completely new stabilization system adapts to your needs, in a nutshell it is integrated into service robots, emergency systems for stabilizing transport, construction objects in case of an earthquake, devices for reducing pitching for small vessels, systems for positioning objects in space, devices for supporting people with disabilities (power exoskeleton, 3D mobile wheelchair). Thirdly open architecture of the software and hardware robotic platform. Revealing the meaning of these words allows you to build your own solutions for robotic systems based on the anywalker chassis. And all this is a solution to using AnyWalker in different tasks [13].

If you talk about the origin of this robot AnyWalker — Russian startup, finalist of the track Robotics of the Federal accelerator GenerationS. Developed by Professor of optoelectronics physico-technical faculty of the Kuban state University, head of laboratory of robotics and mechatronics, candidate of physical and mathematical Sciences Igor Ryadchikov.

And next on my list HRP-5P with artificial intelligence. The Japanese National Institute of advanced industrial science and technology (AIST) has developed a prototype humanoid robot HRP-5P with artificial intelligence under the leadership of Fumio Kanehiro. It can capture and move heavy loads, open doors, climb and descend stairs, avoid obstacles, and use a hand tool.

Intel announced two neuroprocessors at CES 2019 in Las Vegas. Both chips are special-purpose integrated circuits (ASICS) developed within the Nervana platform. The eponymous startup Nervana Systems was bought by Intel at the end of 2016, but since then the company has been tight-lipped about the progress of its own neurochips.The first one will be called NNP-I. Its name stands for" neural network processor for Inference". It speeds up half-precision floating-point operations (FP16) and processing data requests in DNN networks. This is important for AI analysis of images and text, and is a typical load for social network servers.it is not for nothing that Facebook has become one of Intel's partners in its development.

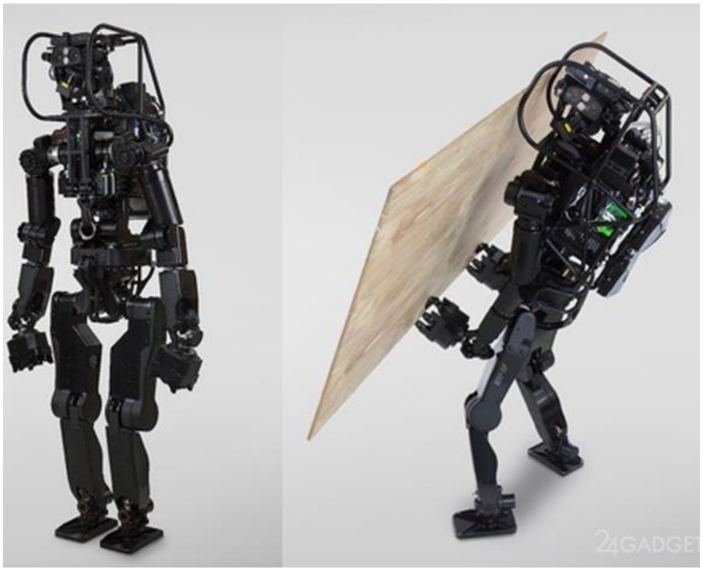

Figure 1.20 - HRP-5P with artificial intelligence

Intel called a series NNP and platform Nervana's first chipset for the AI. This is a fairly controversial statement, as specialized accelerators for neural network algorithms are used in it industry not the first year. Intel called a series NNP and platform Nervana's first chipset for the AI. This is a fairly controversial statement, as specialized accelerators for neural network algorithms are used in it industry not the first year.

The robot is designed to automate heavy physical labor and replace people when working in dangerous conditions. It has incorporated developments from the entire HRP series, which AIST collaborated with Kawada Robotics and other private companies to create. Also it uses a patented technology of Honda Motor.

At the time, HRP-2 was the first bipedal AIST robot that could stand up on its own, walk along narrow paths, capture large objects, and perform other simple actions. The HRP-3 was already able to move on slippery surfaces and tighten bolts. For a real practical application he still does not have enough degrees of freedom and autonomy – it is controlled with the remote control.

In parallel, AIST experimented with neural networks and developed a version of HRP-4C. The model was named Miim. She looked like a Japanese girl, had a fairly realistic facial expression and good vocal data (thanks to the Vocaloid synthesizer from Crypton Future Media). HRP-4C became the first AIST model with artificial intelligence, but so far has found application only in the entertainment industry.

Unlike its predecessors, the HRR-5P (P – prototype) is a purely utilitarian robot, devoid of a human face and entertainment functions. It is based on HRP-2 and HRP-3, but due to AI, it has more autonomy and does not need constant operator control. For example, when the robot is assigned the task of rearranging a sheet of drywall, it automatically recognizes it among other objects, calculates the optimal trajectory, and selects capture points so as to maintain balance.

Using head-mounted cameras and ultrasonic sensors, the robot constantly receives a 3D image of the surrounding area, updating the map every three seconds. If the field of view is partially closed, it will use the last saved frames and build a movement plan according to them.

The convolutional neural network (CNN) provides training functions. It uses an updated database of images of working objects. The robot can use it to recognize ten types of objects with more than 90% accuracy, even in images with low contrast or in low light.

With a height of 182 cm and a weight of 101 kg, HRP-5P has 37 degrees of freedom: two in the neck, three in the waist, six on the legs, eight on the hands and two additional on the grips of the manipulators. The large number of degrees of freedom allowed the HRP-5P to move more smoothly and more human-like.

Compared to the HRP-2, the HRP-5P's torque and movement speed are more than doubled, thanks to the use of powerful electric motors and the addition of a cooling system. As a result, each HRP-5P arm extended horizontally can lift up to 2.9 kg (HRP-2-1.3 kg).

In partially bent arms, the robot is able to lift up to 7 kg with each manipulator. Using both hands, the HRP-5P can move large objects such as sheets of drywall (1820 × 910 × 10 mm, about 11 kg) or plywood (1800 × 900 × 12 mm, about 13 kg).

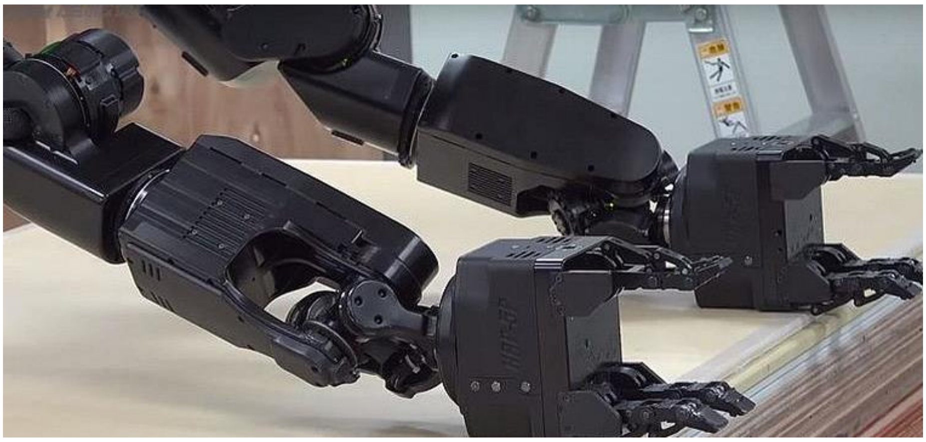

Figure 1.21 - The hands of HRP-5P

HRP-5P was first presented in Madrid at the October international conference on intelligent robots and systems (IROS 2018). Then it was shown at the World Robot Expo 2018 in Tokyo, and in 2019 it will be taken to other specialized exhibitions.

The developers expect that the experience of creating HRP-5P will accelerate the development of such robots that will be able to replace people on construction sites, factories and shipyards. AIST offers the sharing of HRP-5P as a research platform for the needs of industry and the scientific community.

2 Design department

2.1 Creating a 3D model of the manipulator in Solidworks

SolidWorks is a product of the SolidWorks Corporation. Solid Works ® is an automated design system that uses the familiar Microsoft Windows graphical user interface. In other words, it allows design engineers to quickly demonstrate their ideas on a sketch, experiment with elements and dimensions, and create models and detailed drawings.

New features and improvements in the Solidworks solution portfolio help you maximize the productivity of your design and manufacturing resources, as well as accelerate the release of innovative products [14].

Speed up the design of large assemblies and check their relevance with improvements in drawings, builds, and simulations. Instantly open large drawings in Layout mode, while still being able to add and edit notes to drawings. Improve your design speed with the new envelope Publisher tool, which lets you add components from top-level assemblies to Assembly nodes as envelopes. Run simulations faster thanks to a hybrid grid that uses both rough and high-quality elements at the same time.

Improvements for design, simulation, and manufacturing can simplify work-flows, reduce time to market, improve product quality, and reduce production costs. Speed up your design and get accurate specifications with the Make part flexible tool. Quickly select multiple edges of a silhouette in a sketch using the new "Silhouette objects" tool. Use the Simulation Evaluator tool to determine the optimal configuration in a simulation study.

Connect your Solidworks solution to the cloud using the 3Dexperience platform with a growing Suite of applications for all aspects of product development. Manage data, projects, and product lifecycle directly from the Solidworks desktop application using the 3D Component Designer and Project Planner modules. Easily create models with bionic shapes using the 3D Sculptor app. This is a new surface separation modeling solution that includes the xShape app. Quickly configure custom dashboards, reproduce 3D models, and securely exchange data. You can do all this in the cloud using the Business Innovation module.

The most successful engineering developments are created using Solidworks products. Find out why industry leaders are using Solidworks solutions not only to get optimal and efficient projects, but also to achieve competitive success [15].

In this part I developed a 3D platform model. In the figure shown below the picture below shows the back of the platform. In this rear part is ocmpleted fee and other details.

As you can see, the scheme does not require detailed analysis. The movement is completely madly flawed, but in the future we have the opportunity to develop.

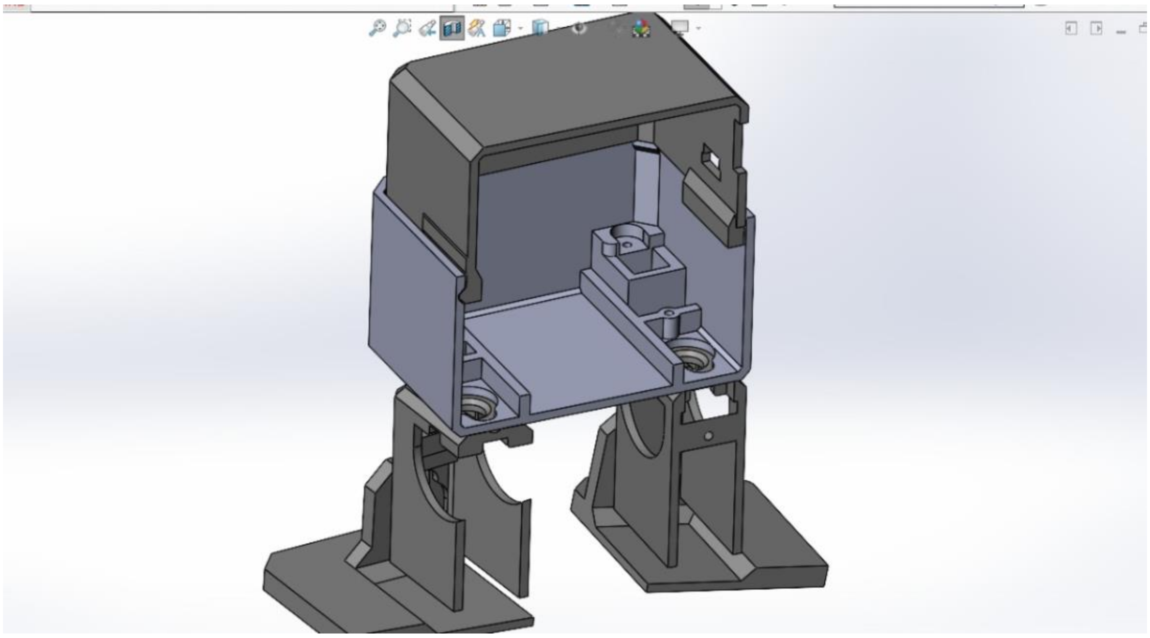

Figure 2.1- The back of the platform

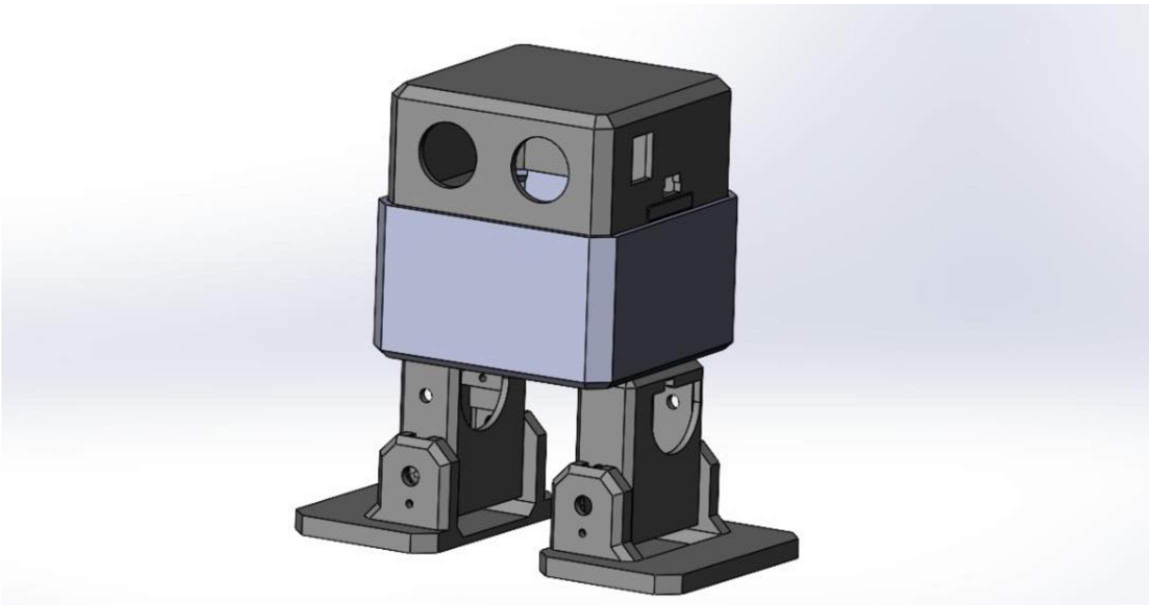

Figure 2.2-Front of the platform

In this part I developed a 3D platform model. In the figure shown below the picture below shows the back of the platform. In this rear part is ocmpleted fee and other details.

The most successful engineering developments are created using Solidworks products. Find out why industry leaders are using Solidworks solutions not only to get optimal and efficient projects, but also to achieve competitive success .

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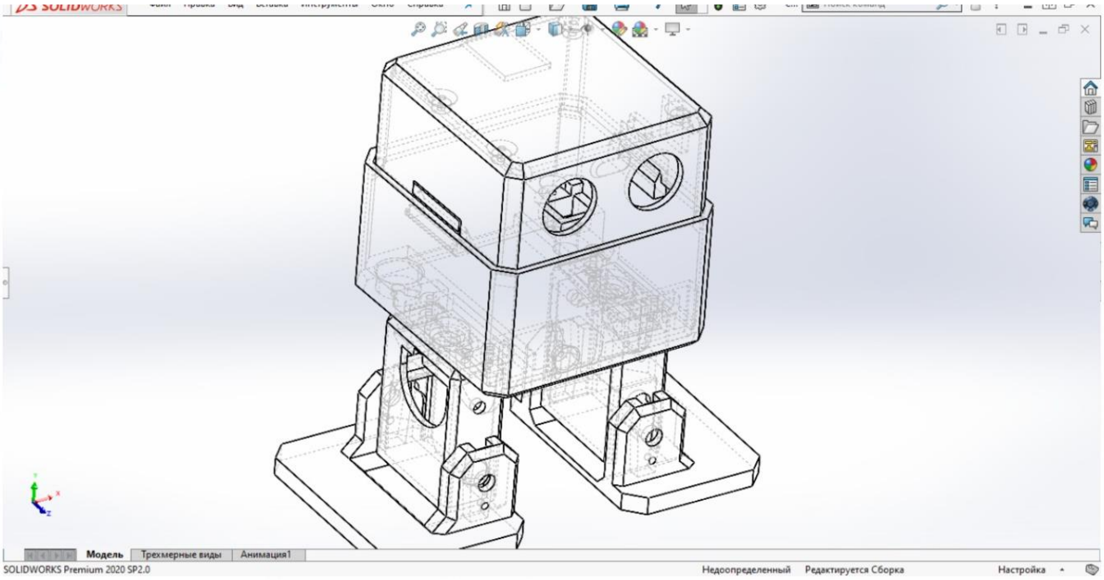

Figure 2.3-This drawing shows the completed platform design

This drawing shows the complete design of the platform i.e. the full 3D model.

2.2 Preparing the necessary equipment

2.2.1 Selecting microcontrollers

Arduino Mega ATmega2560 microcontrollers. The Board has 54 numeric inputs / outputs (as a PWM output from 14), 16 fiber-optic inputs, 4 UART, 16 MHz lathe generator, USB connector, power connector, ICSP, and keyboard restart. To connect to a computer using a USB cable or AC / DC adapter, or rechargeable batteries. In connection with the expansion of all Arduino Mega 2560 boards, the UNO or Duemilanove platform was developed (Fig. 2.4).

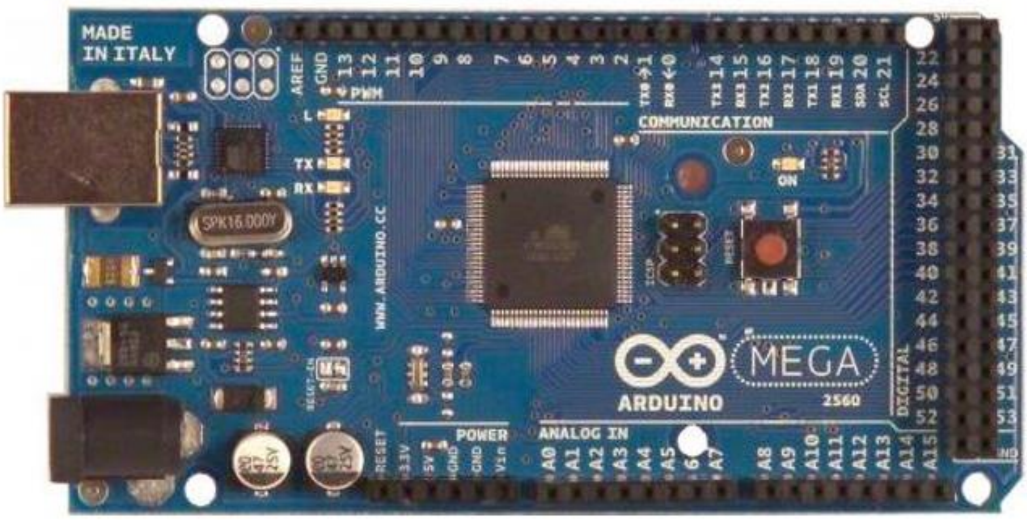

Figure 2.4-Arduino Mega ATmega2560

Table 2.1-technical characteristics of the Arduino Mega panel

Name of the characteristic	Value
Microcontroller	ATmega2560 в
Operating voltage	5 В
Input voltage (recommended)	7-12 В
Input voltage (limited)	6-20 В
Digital input / output	54 (14 can be used as a PWM output)
Analog input	16
Flash memory	256KB
RAM	8KB
Direct current through input / output	40мА
EEPROM	4KB
clock frequency	16MHz
Size	6.9 см x 5.3 см

Arduino Uno is an advanced platform based on the ATmega328 microcontroller. Arduino Uno offers you everything you need for convenient operation with the microcontroller: 14 digital input / output (including 6 PWM can be used as output), 6 analog inputs, 16 MHz crystal oscillator, USB connector, power switch, (ICSP) and reset button.

Figure 2.5-Arduino Uno

Table 2.2-technical characteristics of the Arduino UNO panel

Name of the characteristic	Value
Microcontroller	ATmega328
Operating voltage	5 В
Input voltage (recommended)	7-12 В
Input voltage (limited)	6-20 В
Digital input / output	14 (6 can be used as a PWM output)
Analog input	8

Continuation of table 2.2

Flash memory	32 KB
RAM	2KB
Direct current through input / output	40mA
EEPROM	1KB
clock frequency	16MHz
Size	6.9 cm x 5.3 cm

The platform installed on ATmega328 microcontrollers can be used in Nano lab work. Arduino has functionality similar to Duemilanove, but there is a difference in its construction.

Unlike the fact that there is no direct current and works with a USB Mini-B cable, Nano is developed and sold by Gravitech (Fig. 2.6).

Table 2.3-technical characteristics of the Arduino Nano panel

Name of the characteristic	Value
Microcontroller	ATmega328
Operating voltage	5 B
Input voltage (recommended)	7-12 B
Input voltage (limited)	6-20 B
Digital input / output	14 (6 can be used as a PWM output)
Analog input	8
Flash memory	32 KB
RAM	2KB
Direct current through input / output	40mA
EEPROM	1KB
clock frequency	16MHz
Size	1.85 cm x 4.2 cm

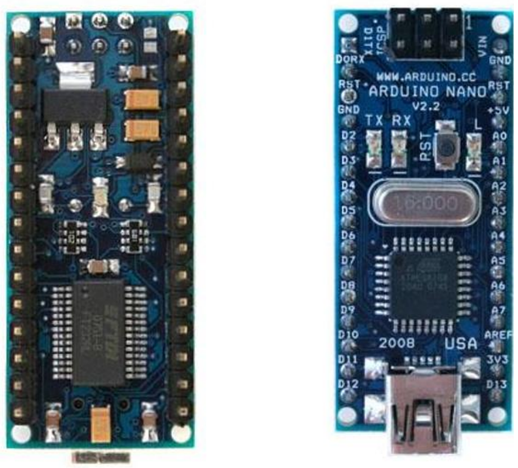

Figure 2.6-Arduino Nano

The Arduino Nano mini b USB power cable receives power from an external power supply, either from an unregulated 620 V, or a regulated 5 V. the Maximum voltage selects the eye automatically (Figure 2.7).

In Nano, using the PinMode (), digitalWrite (), and digitalRead () functions, you can configure each of the 14 digital input-outputs as input or output.

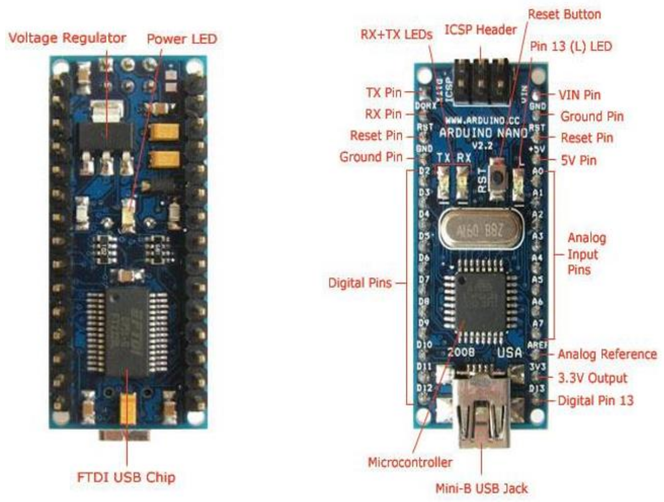

Figure 2.7-Arduino Nano

Input-expenses work under a voltage of 5 V. Each input-flow has a 2050 resistor and can carry up to 40 mA. Some have special functions:

Serial bus: 0 (RX) and 1 (TX). Releases are used for receiving and transmitting TTL (RX) (TX) data.

Outer break: 2 and 3. these tails can cause a break down or when the leading or trailing edge or value changes. For more information, see In the description of the attachInterrupt () function.

Shim: 3, 5, 6, 9, 10 and 11. any output gives an 8-bit PWM with the analogWrite () function.

SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). The output data will link to the SPI.

2.2.2 Selecting a servomotor

The MG995 server has 30 cm of wire length and 3 type" S " contacts. The shaft coming out of the servomotor turns about 120 degrees. You can use any controller with 5 V logic, including an Arduino, to control the MG995 server (figure 2.8).

The servomotor is available in plastic packaging. In the East, there is a metal gearbox. The kit has a plastic terlesky various forms.

The General appearance and overall dimensions of the MG995 servomotor are shown in the figure below.

Table 2.4-technical characteristics of the MG995 servomotor

Name of the characteristic	Value
Weight	55 grams
Volume	40.7 x 19.7 x 42.9
Torque	8.5 kg x cm (4.8 V), 10 kg x cm (6 V);
Speed	0.2 c/60º (4.8 B), 0.16 c/60º (6 B);
Operating voltage	4.8 - 7.2 B
Dead zone width	5mks
Operating temperature range	0 ºC – 55 ºC

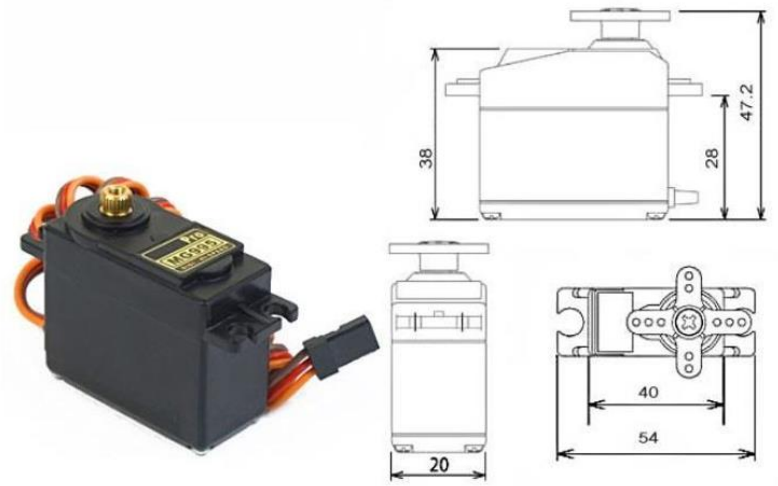

Figure 2.8-MG995 servomotors

Tower Pro MG90S micro servo 14g is a lightweight and high-quality servomotor. The Tower Pro differs from the SG90 in its metal gearbox. Figure 2.9 - control diagram for Arduino, AVR, PIC, ARM and other microcontrollers (figure 2.9).

Tower Pro SG90 servos are mainly used to control small light vehicles, the rotation angle is from 0 to 180 degrees (Fig. 2.9).

Figure 2.9– Tower Pro MG90S micro servo

Table 2.5-technical characteristics of the MG90S servomotor

Name of the characteristic	Value
Weight	13.4 gr
Volume	22.8 mm x 12.2 mm x 28.5 mm
Torque	8 1.8-2.2 kg / cm(4.8 In);
Speed	60 degrees/0.1 seconds.(4.8 V)
Operating voltage	4.8 - 6 B

Figure 2.10-Tower Pro SG90 micro servo

Table 2.6-technical characteristics of the SG90 server

Name of the characteristic	Value
Weight	9 gr
Volume	22.8 mm x 12.2 mm x 28.5 mm
Torque	1.2 kg / cm(4.8 V);
Speed	60 degrees/0.12 seconds.(4.8 V)
Operating voltage	3 - 7 B

3 Program part

3.1 Arduino

The Arduino development environment includes program code, a message area, a text output window, a toolbar with frequently used command buttons, and a built-in text editor for multiple menus. Connect to the Arduino hardware Department to connect to the program download and development environment.

A program written in the middle of an Arduino is called a sketch. The sketch is written in a text editor with tools for displaying/placing text search / replacement tools. When you save and export a project, comments are displayed in the message area, and errors may also be indicated. The text extraction window displays Arduino messages, including incomplete error reports and other information (Figure 3.1).

Figure 3.1-Arduino IDE

3.2 Algorithm and flowchart

Nerdherd the variable declarations and the algorithm starts libraries. The Arduino input is set as the input output, and will also be the source location of all servers. Then the current is converted to a specific frequency. Next according to the signal received from the serial port, the manipulator moves along the specified routes. The flowchart is presented in program A.

3.3 Checking the program's performance in the Proteus environment

Using the Proteus Design Suite, a software package for computer-aided design (CAD) of electronic circuits developed by Labcenter Electronics, we will assemble.

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.

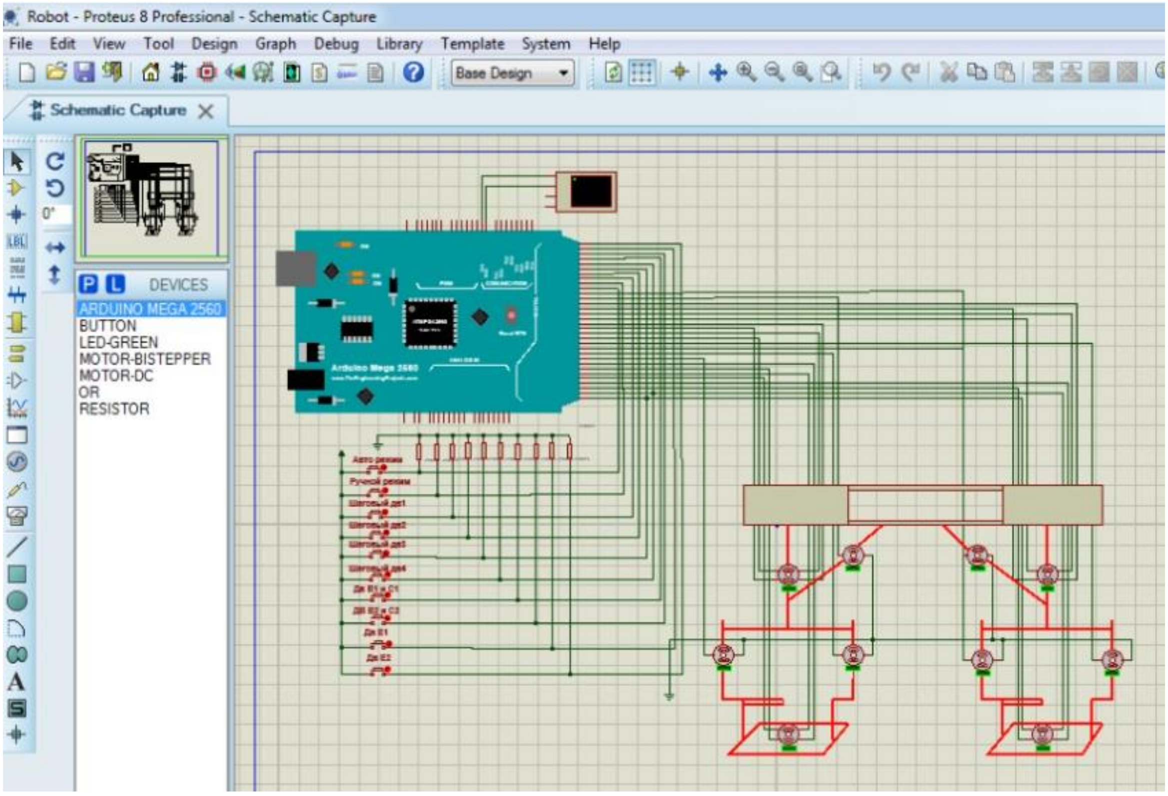

Figure 3.2-Schematic diagram of the entire system in the Proteus environment

4 Life safety

This diploma project provides for the creation and development of an antramorphic robot, in which it is necessary to calculate the ventilation in the operator's room, protection from electromagnetic waves.

4.1 Analysis of working conditions of employees

Working conditions in the workplace GOST 12.2.032-78 " SSBT. The workplace when working with the seat. General ergonomic requirements". When creating its elements, the nature of the work and psychological characteristics are taken into account:

- the height of the desktop is set in the range of 680-760 mm, if this is not possible, - 720 mm;
- optimal dimensions of the desktop plane 1200x700 mm;
- under the work table there is a legroom 600 mm high, 500 mm wide, 650 mm deep;
- chair height 400-500 mm;
- chair width 400 mm, depth 360 mm;
- the height of the supporting plane of the seat is 300 mm, the width is 380 mm. Its radius of curvature in the horizontal plane is 400 mm.

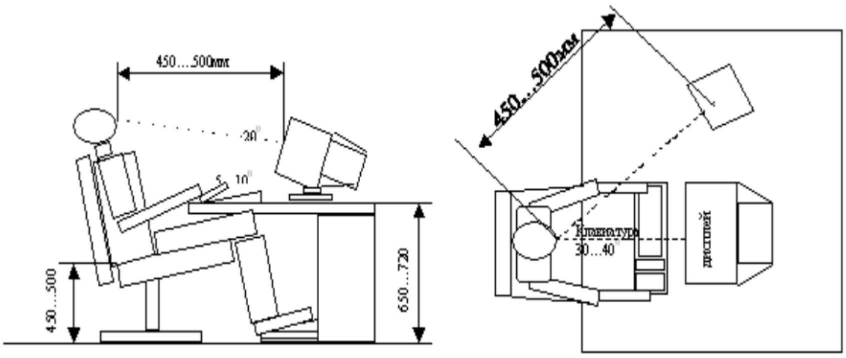

Figure 4.1-Employee's workplace

4.2 Calculation of mechanical air exchange ventilation

Air temperature has a significant impact on the mood and results of work. Low temperatures can make the body lose weight and lead to the onset of flu. At high temperatures, the body heats up and sweats, and performance decreases [13].

The following issues were considered in this diploma project: 1. the Main concepts used in this thesis; 2. the Main concepts used in the thesis; 3. the Main concepts used in the thesis; 4.the Main concepts used in the thesis.

When changing the parameters of the microclimate and performing various heavy work, the ability of the body to maintain a stable temperature (36.6°) is called a heat regulator.

To ensure long-term operation of the equipment, it is necessary to create optimal climatic conditions: temperature from 0 ° C to 36 ° C, relative humidity from 10% to 75%.

In accordance with the requirements of SNIP RK 4.02 -2006 "Ventilation, heating and air condensation" is performed in accordance with the section of SNIP RK 4.02 -2006 "Ventilation, heating and air condensation".

Table 4.1-optimal norms of microclimate parameters

Operating time	T,^{0}C	Air exchange rate, m / s, no more
Cold	21-24	0.1
Warm	23-25	0.1

The microclimate parameters are as follows: the air temperature in the cold season, its speed and relative humidity, respectively: 22-24 °C, 0.1 m/s, 60%; the air temperature can deviate from 21-25°C.

In the warm season, the air temperature, its mobility and relative humidity correspond to: 23-25 °C; 0.1 - 0.2 m/s; 60-70 %; the air temperature can range from 22-26 ° C.

Fresh air is supplied to the production premises in the following volume:

a) in a room with an area of 20 m2 per employee - at least 30 m3 per person;

b) 20 - 40 m2 per employee, in a volume room - 20 m3 per person.

Air exchange of apparent heat:

$$G_я \frac{Q_я}{CX(t_{yx} - t_я)} \tag{4.1}$$

where, C - the heat capacity of dry air removed by General exchange ventilation;

C=1.05 kJ/kg* ºC;

tyx =20 ° C; Ty =15 ° C.

Clearly generated heat:

$$Q_я = Q_1 + Q_2 + Q_3 + Q_4, \tag{4.2}$$

where, Q1-heat generation of installations;

Q2-the heat dissipation of the light sources;

Q3-heat generation of people;

Q4-heat release of solar radiation through the window.

Installation heat dissipation:

$$Q_1 = 860 \times P_{об} \times \eta_1, \tag{4.3}$$

where, 860 is the thermal equivalent of 1 kW / hour, followed by the thermal equivalent of 1 kW / hour of electrical energy;
Power consumption of Rob-equipment, kW/h;
the coefficient of heat capacity of the room is determined by the formula: N1 = 0.75 (for the control room).

$$Q_1 = 860 \times 0{,}63 \times 0{,}75=406{,}35 \text{ [W]}$$

The heat dissipation of the light sources:

$$Q_2=И\times N_{осв}, \quad (4.4)$$

where, and is the energy coefficient that takes into account the value of the heat exchanger, And = 0.8;
Nzhar-a room made of light. power of the device (4 lamps 65 W each).

$$Q_2 = 0{,}8 \times 4 \times 65=512 \text{ [W]}$$

Heat release from people depends on the intensity of work and the parameters of the surrounding air, and the calculation of the heat accounting of the workforce must take into account the layer of personnel.

The distribution of the total heat of people is calculated using the following formula:

$$Q_3=n\times q, \quad (4.5)$$

where, n is the number of employees;
q-heat consumption per person, at 26 ° C about 61-102 W.
Except:

$$Q_3 = 3 \times 102=306 \text{ [W]}$$

Heat release of solar radiation through the window:

$$Q_4=(q_{вп}+q_{вр})\times F_{окн}\times m\times k, \quad (4.6)$$

where, Ft-window area, m2;
m-number of Windows;
k-correction factor, for metal cover k=1.25;
q-heat output of the window per 1 m2, q=42 W/m2.

$$Q_4 = 6{,}6 \times (42+70) \times 1 \times 1{,}25=924 \text{ [W]}$$

Determine the total amount of expressed heat generated:

$$Q_я = 406,35+512+306+924=3072,85 \text{ [W]}$$

Determine the air exchange of apparent heat:

$$G_я = 3072,85 \div 1,05 \times (20\text{-}15)=585,3 \text{ [m}^3\text{ /h]}$$

Find the product of the necessary air conditioner:

$$W_к=k_з \times G_я, \quad (4.7)$$

where, $k_з$ is the remainder coefficient, $k_з$ =2.

$$W_к =2 \times 585,3 =1170,6 \text{ [m}^3\text{ /h]}$$

According to the calculations, one air conditioner with a capacity of at least 1171 m3/h must be installed in the operator's room to maintain the necessary microclimate parameters.

Table 4.2 - technical characteristics of HITACHI RAS-5142CH

Parameter	Data
Electric power	220-240 В; 50 Гц
Cooling power, kW	3,60
Heat output, kW	4,65
Energy consumption for cooling, kW	1,29
Energy consumption for heating, kW	1,46
Max. applied current, A	7,0
COMT. pipe max length./ Height, m	15/5
Indoor unit air consumption, m3 / h	372/450/540
Outdoor unit air consumption, m3 / h	1600
Humid air, l / h	2,5
Noise level of the indoor unit, dB	35/39/44
Noise level of the external unit, dB	51
Weight of the indoor unit without box, kg	8
Weight of outdoor unit without box, kg	38

4.3 Protection from electromagnetic fields

Protection of the human body from the effects of EMF involves reducing their intensity to levels that do not exceed the maximum permissible. Protection is provided by the choice of specific methods and tools, taking into account their economic indicators, simplicity and reliability of operation. The organization of this work implies:

- assessment of field intensity levels and their comparison in accordance with current regulations;

- selection of necessary measures and means of protection;
- organization of a control system for functioning protection.

Protecting a person from electromagnetic fields is currently a necessary area to protect their health. After all, this phenomenon accompanies the citizen everywhere due to the rapid development of radio and television, cellular mobile communications, as well as the Internet. All these achievements of scientific thought are increasingly penetrating into our lives and "polluting" the environment.

Protection from electromagnetic fields and radiation is also required when using household electrical appliances, computers, and urban electric vehicles. Unfortunately, few people realize the extent of this danger. First of all, the radiation intensity is subject to assessment. And the electromagnetic fields generated by irons, telephones, refrigerators, and other devices we need are extremely small. However, a person should also protect their health in this case. After all, the situation is much more complicated than we think, and the consequences can be extremely dangerous. This circumstance convinces us that each of us should have an idea of the electromagnetic fields harmful to his health, correctly assess the existing degree of danger, and use all necessary means and methods of protection.

Today we are surrounded by an electromagnetic world. It is full of all the benefits of civilization, which we simply can not refuse. However, the natural mechanism by which protection against EMF would be carried out is absent in humans. Being essentially open systems, all living organisms interact informatively with external radiation. For the past five decades, we have been literally surrounded by artificial electromagnetic fields that have largely replaced the subtle, elusive energies of the natural world.

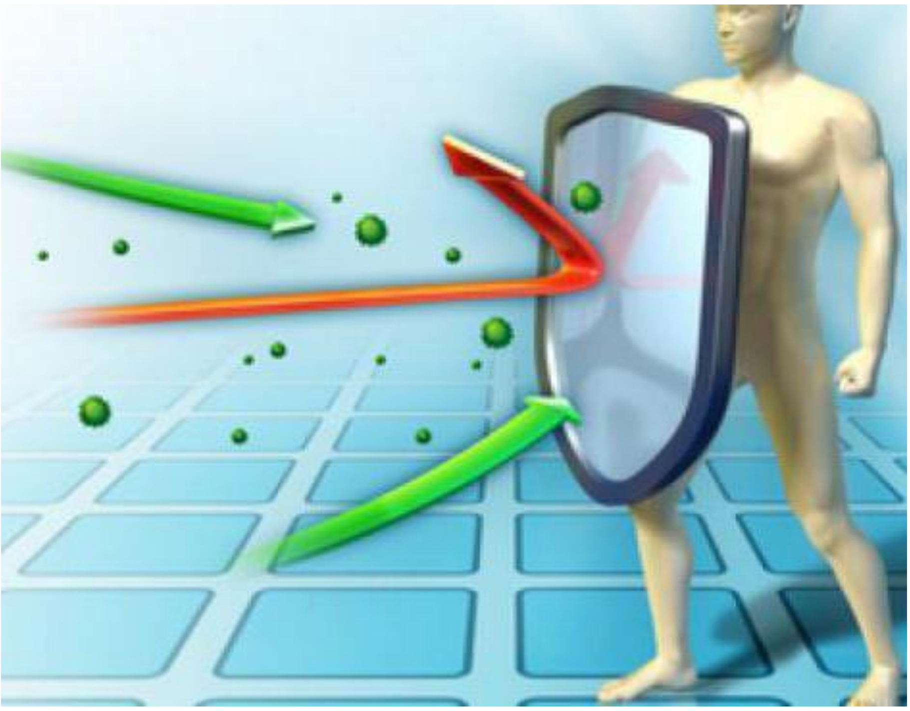

Figure 4.2- Health effects

The resulting chaotic energy of particles is a kind of electromagnetic mud. It has a huge destructive force that affects the bioelectric field of the human body, and in fact it should normally maintain a balance between millions of elusive electrical impulses. This balance regulates the activity of each cell. The stronger the impact of artificial electromagnetic sources, the greater the disturbance is caused in the human biofield. This negatively affects the work of the body.

According to scientists, the current electromagnetic radiation is 100 million times higher than that experienced by our grandparents. With prolonged exposure to charged particle flows, it can seriously impair our health. Thus, according to research by epidemiologists, cancer most often affects those people who live near powerful sources of electromagnetic fields. They are, for example, high-voltage power lines. The negative effect of charged particles on the production of a hormone such as melatonin has also been proven. It is produced by the pineal gland and plays a significant role in strengthening the immune system. Sometimes this element is called the "hormone of youth". When exposed to external sources of electromagnetic radiation, a person may face such problems as: depression and insomnia, memory loss and headaches, dizziness and muscle weakness; failures in the heart and blood vessels, expressed in heart rate instability, neurocirculatory dystonia, hypertension and violations in the blood composition; immune suppression; endocrine system dysfunction; disorders of the sexual system, expressed by deterioration of spermatogenesis, slowing of fetal development, various complications of pregnancy, etc.; imbalance of the energy system and its pathogenic changes.

In contrast to mechanical vibrations, electromagnetic waves can also propagate in a vacuum, i.e. in a space that does not contain atoms, but they behave like mechanical waves, in particular, they have a finite speed and transfer energy. The highest speed of electromagnetic waves is characteristic of vacuum (the speed of light is 300 thousand km/s). The energy of the electromagnetic field (EMF) is proportional to the fourth.

Sources and characteristics of electromagnetic waves

In the process of operation, the PC creates fields with a wide frequency range around it spectrum and spatial distribution, such as:

- electrostatic field;
- variable low-frequency electric fields;
- variable low-frequency magnetic fields.

Potentially harmful factors can also be:

- x-ray and ultraviolet radiation of the cathode ray tube (CRT) display;
- radio frequency electromagnetic radiation;
- electromagnetic field (the electromagnetic fields created by third-party sources).

It should be noted that the screens of modern displays are made of glass that is opaque to the x-ray radiation that occurs in the tube, and ultraviolet radiation is not detected during tests even in the oldest models of displays. Radiofrequency radiation from electronic components of computer equipment is also significantly lower than the maximum permissible levels regulated by sanitary standards. Accordingly, these factors are potentially dangerous, but do not take place in practical work.

An electrostatic field occurs due to the presence of an electrostatic field potential (accelerating voltage) on the cathode-ray tube screen. In this case, there is a potential difference between the display screen and the user's personal electronic computer. The electrostatic field around the user depends not only on the fields, generated by the display, but also from the potential difference between the user and surrounding objects. This potential difference occurs when charged particles accumulate on the body as a result of walking on a carpeted floor, when clothing materials RUB against each other, etc.

The electrostatic field around the user depends not only on the fields, generated by the display, but also from the potential difference between the user and surrounding objects. This potential difference occurs when charged particles accumulate on the body as a result of walking on a carpeted floor, when clothing materials RUB against each other, etc. The electrostatic field around the user depends not only on the fields, generated by the display, but also from the potential difference between the user and surrounding objects. This potential difference occurs when charged particles accumulate on the body as a result of walking on a carpeted floor, when clothing materials RUB against each other, etc.

In modern display models, drastic measures have been taken to reduce the electrostatic potential of the screen, but this is achieved only in the steady-state display mode. within 20 /30 seconds after switching on and up to a few minutes after switching off the electrostatic potential level the screen is ten times higher than normal. The electromagnetic field (EMF) is a special form of matter by which charged particles interact. Sources of variable electric and magnetic fields in a PC are nodes that have high alternating voltage, and nodes that work with high currents.

According to the frequency spectrum, these electromagnetic fields are divided into two groups:

- fields created by the power supply unit and the frame scan unit display (the main energy spectrum of these fields is concentrated in the frequency range up to 1 kHz);

- fields created by the lowercase block (the spectrum is concentrated in the frequency range from 15 to 100 kHz).

Electromagnetic fields generated by extraneous sources are called background fields. The nature of these fields and their spatial distribution and the levels are determined by the physical characteristics of the sources, their position in relation to the workplace. The main source of background fields is the network power supplies. Typical spatial distributions of the alternating magnetic field and the alternating electric field around the PC display is shown in Fig. 1.1 and 1.2

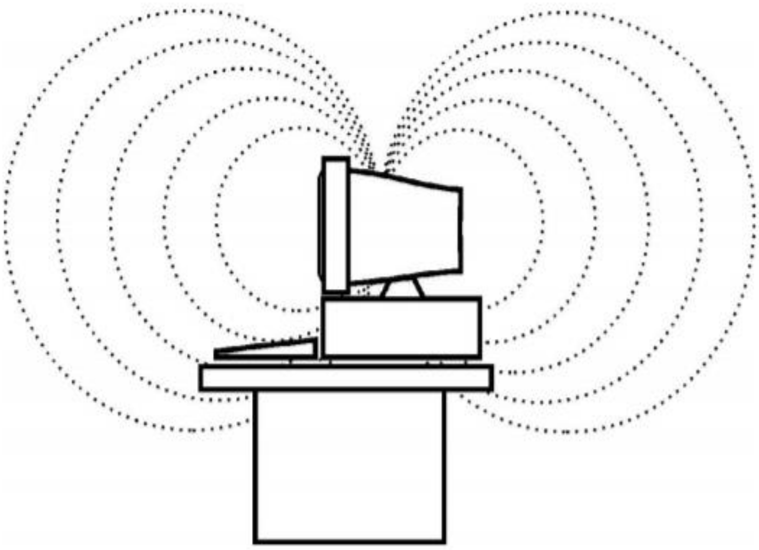

Figure 4.3-Magnetic field lines around the display

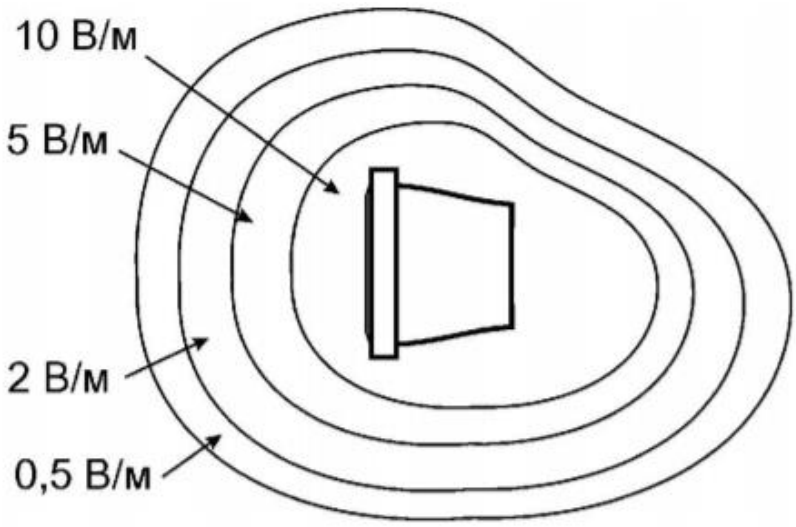

Figure 4.4-Spatial diagram of intensity distribution electric field around the display

Maximum permissible levels of electromagnetic fields in the workplace.

Normalization of EMF parameters is carried out taking into account the possibility of simultaneous impact on the PC user of all the physical factors listed above.

Temporary permissible levels of EMF generated by PC in the workplace.

To reduce the influence of radio frequency EMF (from 30 kHz to 300 GHZ), the following measures are taken:

1) reducing the intensity and density of the EMF energy flow by matching loads and powerful absorbers;

2) shielding workplaces;

3) eliminating the workplace from the EMF source (remote control);

4)rational placement of irradiating equipment in the workplace electromagnetic energy;

5) use of equipment and maintenance personnel.;

6) use of warning signs (light, sound);

7) use of personal protective equipment.

The maximum efficiency of EMF protection can be achieved by isolating the electromagnetic field of a radio engineering device using a housing, as well as using a screen. In more detail, the voltage of electric and magnetic components of EMF in the frequency range from 30 kHz to 300 MHz, as well as the energy load on a person is normalized:

$$Э_{Н} = Н^{2} * Т, \qquad (4.8)$$

where, $Э_{Н}$- energy load with a magnetic field, (A / m)^2 hours;

T-time of exposure per person per hour.

In the frequency range of 30 kHz and 300 MHZ (table 4.3), e and H are acceptable. The permissible energy load at the workplace of personnel should be determined taking into account the time of exposure according to the formulas.

$$Н_{Пд} = \sqrt{\frac{Э_{Нпд}}{Т}}, \qquad (4.8)$$

Table 4.3 - In the frequency range

Parameters	Limit values in the frequency range, MHz			
	От 0,03 до 3	От 3 до 30	От 30 до 50	От 50 до 300
$Е_{пд}$, В/м	500	296	80	80
$Н_{пд}$, А/м	50	3	Not developed	Not developed
$Э_{Нпд}$, $(В/м)^{2}$*ч	20000	7000	800	80
$Э_{Епд}$, $(А/м)^{2}$*ч	200	Not developed	0,72	Not developed

$$Т = \frac{Э_{Нпд}}{Н^{2}}, \qquad (4.9)$$

$$Т = \frac{Э_{Нпд}}{Н^{2}} = \frac{20000}{50^{2}} = 8\ [h]$$

With this formula, we can see that a worker can work 8 hours in the workplace.

Yonglun of electromagnetic radiation is called radiation environment causing. Electromagnetic radiation in the workplace of the operator of the computer to show calls and the periphery. Therefore, this factor should ensure that the working environment is protected from roads. The monitor includes a wide range of frequency spectrum. Low-frequency electromagnetic fields of the skin in the human body can undergo biological changes. High intensity of electromagnetic fields has a long-term effect on human fatigue. For example: drowsiness, headache, hypertension, heart disease, sleep disorders, and so on. Very high frequency fields cause changes in blood composition, in eye diseases, and in some people causes neurological and trophic diseases.

Influence of static electricity field on the human body:

It is written that a weak long current or short time passing through the human body. This discharge causes the movement of reflexes that affect the human body. The following issues were considered in this diploma project: 1. the Main concepts used in this thesis; 2. the Main concepts used in the thesis; 3. the Main concepts used in the thesis; 4.the main concepts used in the thesis. The voltage of electric locomotives at the workplace should Not affect the value of 60 kV/m for a long time for 1 hour, from 1 to 9 hours is calculated by the formula:

$$E_д = \frac{60}{\sqrt{t}}, \tag{4.8}$$

where, t is the exposure time, unit is hour.

The specified standard values are used provided that the electric field exceeds 20 kV/m, the Ed value for the remaining working time does not exceed 20 kV / m.the electric field Voltage at a distance of 50 cm must be: 25 V / m (for frequencies in the range of 5 Hz - 2 kHz); 2.5 V / m (frequencies in the range of 2 kHz to 400 kHz); the magnetic flux density must be: 250 NT (frequencies from 5 Hz to 2 kHz); 25 NT (frequencies in the range of 2 kHz to 400 kHz). The surface electrostatic potential should not exceed 500 V.

5 Economic part

5.1 Rationale and purpose of the work

Business plan

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 document that sets out the economic goals of an enterprise or entrepreneur and the ways to implement it, its tasks and methods. To create a business, the market environment is thoroughly studied. The current state of the market environment, possible changes and barriers, the amount of revenue from the project, and so on. A business plan is primarily designed to obtain a loan from a Bank and ensure its repayment. With the participation of the owner, the direction of strategic development of the enterprise is determined, thereby determining the effectiveness and necessity of the project.

In the business plan I created, I plan to make a summary, description, product marketing, financial plan, calculation of investment costs, cost and economic efficiency.

5.2 Summary

The calculation of the economic efficiency of absolutely any project is an integral part of the development of the project, because it makes no sense to implement unprofitable development in advance. The costs of implementing any software tool depend on material costs for resources, developer wages, including social security contributions, depreciation expenses, and others. The technical equipment obtained as a result of the development of the graduation project is two-legged robot.

Currently, there are a significant number of branches of science, technology and medicine where the capabilities of traditional robot manipulators are insufficient. For example, the use of non-traditional robot manipulators designed for internal control of main pipelines of nuclear power plants is promising. Another example is the machining of complex products when it is necessary to move the tool in five or six coordinates (for example, dies, pads, turbine knives, etc.).

The two-legged robot is the subject of many scientific studies. Today, on the basis of parallel construction mechanisms, there are examples of successful projects of machines for various purposes, stands and other equipment.

Basically, in my graduation project, I briefly talked about modern developers and other mobile robots. In particular, this applies to the project that I developed and studied the main device, that is, it is a two-legged robot.

In fact, we know that there is nothing more meaningful in this life than the life of a person. But in some cases, we see that in some areas people tragic events and die.

In particular, as you know, work is carried out in unfavourable working conditions and in places that are difficult for people to reach, and in other conditions that make it difficult for humanity to work. one of the types of mobile robots two-legged robots that are created in robotanists, with the aim of preserving human life, replacing it in the developed time.

the functions of a robot with two legs are as follows:

- transportation of substances;
- penetration into places inaccessible to humans;
- intelligence;
- carrying out military engineering services, etc.

Device description

The two-legged Arduino robot is designed by software embedded through the Mega 2560 microcontroller. Three different MG996R, SG909G, and MG90S servers are installed at each end, providing three degrees of freedom and all-round movement. One of them helps to move in the common leg – under the feet, one – in the front-back, the other-in the ankle part of the leg and helps to bend and bend the shins. It needs an energy source to get movement. That is, it must have a DC power that will help it in its movement. We can accept it from lithium-polymer batteries (3.7 V 2500 mAh).

In an Arduino microcontroller, we are all aware of the significant limitations of the current strength of the force applied to it. For the Board it is 800, and for each individual output it is less than 40. We can't connect directly to an Arduino Uno, Mega, or Nano even to a minimal DC motor. Any of these motors exceeds the maximum current limit when triggered or stopped. Therefore, a two-channel l298n motor driver is used to control the DC current entering the microcontroller.

For remote control of the robot, i.e. in my case, for controlling a smartphone with a phone connector using Android, I connected the Bluetooth module HC – 05 to the device from the adapter panel. In order to control the robot in this way, you need to install a special Bluetooth control program on a smartphone developed by Android. The hexapod can then be controlled remotely. In order for all the mentioned equipment to be connected to the microcontroller separately, we need a set of wires with parent disconnectors. In addition, work will be carried out by the welding station.

In General, it should be noted that the platform, body and legs of my Assembly are made of polyvinyl chloride(PVC) material intended for making a robot layout, its parts made of polyvinyl chloride material are connected to each other through thermosolation and simply with glue. And in order for all of the above equipment to be attached to this layout, you will need the type M3, M4.

A lenovo laptop is used to input the robot software into the Arduino Mega 2560 microcontroller.

Marketing plan

The world is already full of discoveries and devices for the auxiliary life of humanity, but what kind of help and what additional work can be done by the robot that I designed ...

Why would a robot look like a human? Humanoid robot as a way to answer existential questions. Anthropomorphic (human-like) robots are the hope of followers of the theory of transcendence, who believe that human consciousness can be transferred to some other carrier, and then a person can become virtually immortal.

Initially, when there were first attempts to make a robot that looks like a human, there was a fundamental interest – will it work or will it not?

Then developers, and after them philosophers and artists, began to ask deeper questions: what does our own body mean to us? The movies "Avatar", "Surrogates" and many others like them are just about this – how much do we need the body in which we were born to exist normally? We may be getting ahead of ourselves but the issue remains relevant.

The humanoid robot is comfortable in an environment created for humans. The humanoid robot is comfortable in an environment created for humans. After all, the habitat for many creatures, including humans, reveals what they need. We, modern developers, are more interested in the question "how" — how to make a robot so that it can perform the same functions as a human?

We have created a world around us that is comfortable for people. We have doors that open when you pull the handle, steps that are easy to walk on, and so on. If we want to have robot helpers who live in the same environment as us, they must be like us.

And it turned out that for the younger generation, an anthropomorphic robot that makes its own decisions is no longer associated with something terrible from science fiction movies. For young people, this is just a robot device that benefits, and the human task is to make the robot as useful as possible. How else can we explain to you that humanoid robots are helpers in the daily life of mankind. And such an helper , before whom you are not ashamed. I faced the following problem: my mother, due to her advanced age, cannot cope with household duties on her own. It is even difficult for her to move around the house. But she doesn't want me or my sister to help her – she's ashamed of us. And it is more comfortable for her to be "followed" by an inanimate mechanism. I can't judge the subtleties of emotional relationships between robots and humans – whether it's good for a person to get attached to a robot or not. This is a job for other professionals. But I do know that we, as technicians, and humanitarians, need to work together to make sure that our work finds its place in our society.

And as a result we understand that humanoid robots have already become an integral part of human life.

5.3 The complexity of developing a software project

The main tasks of work planning are:

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

Planning work is reduced to compiling a list of works, determining their complexity, calculating the duration of the work cycle, substantiating the cost estimates for the work.

Table 5.1 - Planning work

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

5.4 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;
- other expenses;

5.5 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 table 5.2 - 5.3.

Table 5.2 - the cost of hardware and software

№	Name	Description	Price per unit, tg	The amount, tg
1	A laptop	HP Pavilion g6 Notebook PC	200 000	200 000
2	operating system	Microsoft Windows 10	free	free
3	Arduino Mega 2560		8600	8600
4	996 R servo with metal gear	2	1200	2400

Continuation of table 5.2

5	SG90 9G servotec	1	900	900
6	Bluetooth module HC-06 from the adapter panel	1	1500	1500
7	Polyvinyl chloride (PVC) materials black 60*60	1	6000	6000
8	Welding station	1	5000	5000
9	Power Supply 12V-1A		4200	4200
10	Additional expenditure			9500
TOTAL hardware and software costs				238100

Table 5.3 - the Cost of material resources

№	Name	Description	Price per unit, tenge	The amount, tenge
1	Paper	A4	1 100	1 100
TOTAL hardware and software costs				1 100

5.6 Electricity Costs

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

$$З_э = \sum_{i=1}^{n} М_i * Т_i * К_i * Ц, \quad (5.1)$$

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

5.7 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):

$$З_{ТР} = \sum_{i=1}^{n} ЧС_i * Т_i, \quad (5.2)$$

The hourly rate of the employee, calculated by the formula, is -600 tg/h.

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

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

5.8 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 [tenge]

From here, the amount of social tax will be:

СН=(90000-9000)*9,5%=7 695 [tenge]

5.9 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):

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

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):

$$Н_{ai}=100/Т_{Hi} \qquad (5.4)$$

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.

$$Н_{А1}=100/8=12,5 \text{ [\%]}$$

$$Н_{А3}=100/4=25$$

$$З_{ам}=(200000*0,125*25)/(1*12*24)=2170 \text{ [tenge]}$$

$$З_{ам}=(8600*0,125*25)/(1*12*24)=93,31 \text{ [tenge]}$$

$$З_{ам}=(2400*0,125*25)/(1*12*24)=26,04 \text{ [tenge]}$$

$$З_{ам}=(900*0,125*25)/(1*12*24)=9,76 \text{ [tenge]}$$

$$З_{ам}=(1500*0,125*25)/(1*12*24)=16,276 \text{ [tenge]}$$

$$З_{ам}=(6000*0,125*25)/(1*12*24)=65,104 \text{ [tenge]}$$

$$З_{ам}=(5000*0,125*25)/(1*12*24)=54,253 \text{ [tenge]}$$

$$З_{ам}=(4200*0,125*25)/(1*12*24)=45,57 \text{ [tenge]}$$

$$З_{ам}=(9500*0,125*25)/(1*12*24)=103,08 \text{ [tenge]}.$$

Table 5.6- Depreciation of fixed assets

Name of hardware and software	The cost of hardware and software, tg	Annual depreciation rate, %	Development time of equipment and software for development ПП, д	The amount, tg
A laptop	200 000	12,5	25	2170
Arduino uno	8600	12,5	25	93.31
Professional mg 996 R servo with metal gear	2400	12,5	25	26.04
SG90 9G servotec	900	12,5	25	9.76
Bluetooth module HC-06	1500	12,5	25	16.276

Continuation of table 5.6

Power Supply 12V-1A	4200	12,5	25	45.57
Welding station	5000	12,5	25	54.253
Polyvinyl chloride (PVC) materials black 60*60	6000	12,5	25	65.104
Additional expenditure	9500	12,5	25	103.08
TOTAL depreciation of fixed assets				2583.753

Table 5.7 - the cost of other expenses

Name	quantity	time	price, tenge	The amount, tenge
the Internet	-	2 month	4000	8000
advertising	-	1 month	12000	12000
Total expenses for other expenses				20000

When developing the equipment, Internet resources were used, the costs of which amounted to 8,000 tenge per month. Also, the payment for advertising amounted to 12,000 tenge. Total for other expenses, the amount is 20,000 tenge.

5.10 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, tenge
Salary	90000
Social tax	7 695
Electric power	447.387
Depreciation of fixed assets	2583.753
Other expenses	20000
Total estimate	120726.14

5.11 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).

$$Ц_д = З_{нир}(1+\frac{P}{100}), \quad (5.5)$$

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

$$Ц_д=120726.14*(1+0,2)=144871.368(тенге).$$

Then the sales price is determined, including value added tax (VAT), and the rate (VAT) is set by law. The tax Code of the Republic of Kazakhstan for 2020 sets the VAT rate at 8% starting from March.

The selling price including НДС is calculated according to the formula (5.6):

$$Ц_р=Ц_д+ Ц_д* \quad (5.6)$$

$$Ц_{р=}144871.368+144871.368*0.08=156\ 461.07\ [tenge]$$

The calculated possible price of SP is 156 461.07 tenge.

5.12 Payback period calculation

$$С_{ок}=\frac{S_В}{П_Г} \quad (5.7)$$

where, Sв - amount of invested funds;

Пг - net profit per year.

We have already calculated the amount of funds spent earlier. It made up - 156 461.07 tenge.

Conclusion

In developing this project I have done the results of this diploma project, can give a brief information about the work performed in each section during its implementation and research. In particular, since the topic of my thesis project is the Creation and research of a mobile two legged robot, in the first part of my thesis project I wrote and conducted research written by mobile and walking robots developed to date in General. And in the second part of the project, it was written about the structure of the two legged robot 's two steps and the principle of movement of its legs. In General, the movement of the hexapod's legs was shown by kinematic diagrams. In the third part of the project, I developed a 3D scene model of two legged robot structures, equipment, and the robot as a whole in the SolidWorks program. In the fourth part of the diploma project, we showed ways to connect two legged robot devices, hardware to software, with the preparation of schematic diagrams for them. Two legged robot hexagon software is developed based on the Arduino Mega 2560 microcontroller. In the section "life Safety and environmental protection" in section "Safety and environmental protection" in section "Safety and environmental protection" in section "Safety and environmental protection" in section "Safety and environmental protection" in section "Safety and environmental protection" in section "Safety and environmental protection" in section "Safety and environmental protection" in order to determine the area of each window, the electrostatic field around the user depends not only on the fields, generated by the display, but also from the potential difference between the user and surrounding objects. This potential difference occurs when charged particles accumulate on the body as a result of walking on a carpeted floor, when clothing materials RUB against each other, etc. The electrostatic field around the user depends not only on the fields, generated by the display, but also from the potential difference between the user and surrounding objects. This potential difference occurs when charged particles accumulate on the body as a result of walking on a carpeted floor, when clothing materials RUB against each other, etc.

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Приложение А

```
#include <Servo.h>
Servo rightfoot;
Servo rightthigh;
Servo leftfoot;
Servo leftthigh;
Int pos;
Void setup()
{
Rightfoot. Attach(9)
Rightthigh. Attach(5)
Leftfoot attach(3)
Leftthigh.attach
leftfoot.write(10);
leftthigh.write(90);
rightthigh.write(100);
rightfoot.write(180);
}
void loop()
{
  delay(700);
  leftfoot.write(20);
  delay(300);
  leftfoot.write(30);
   delay(300);
     leftfoot.write(40);
   delay(300);
     leftfoot.write(50);
   delay(300);
  leftfoot.write(60);
  delay(700);
  rightfoot.write(160);
  delay(700);
  rightfoot.write(150);
  delay(700);
    rightfoot.write(140);
  delay(700);
rightfoot.write(130);
  delay(1000);
    leftfoot.write(35);
  delay(500);
     leftfoot.write(10);
  delay(700);
```

```
  rightthigh.write(90);
  delay(700);
   rightthigh.write(80);
  delay(700);
   leftthigh.write(65);
  delay(700);
   rightthigh.write(70);
  delay(700);
  rightfoot.write(140);
  delay(500);
    rightfoot.write(150);
  delay(500);
    rightfoot.write(160);
  delay(500);
  rightfoot.write(170);
  delay(500);
  rightfoot.write(180);
  delay(700);
     rightthigh.write(100);
   delay(700);
     rightfoot.write(150);
  delay(300);
  rightfoot.write(140);
  delay(300);
    rightfoot.write(130);
  delay(300);
   rightfoot.write(120);
  delay(700);
  leftfoot.write(20);
  delay(300);
   leftfoot.write(30);
  delay(300);
   leftfoot.write(40);
  delay(300);
   leftfoot.write(50);
delay(1200);
  leftthigh.write(80);
  delay(700);
  leftthigh.write(90);
delay(700);
```

Приложение Б

```
#include "Op3MotionPlayer.hpp"
#include <RobotisOp2MotionManager.hpp>
#include <webots/Camera.hpp>
#include <webots/Keyboard.hpp>
#include <webots/LED.hpp>
#include <webots/PositionSensor.hpp>
#include <webots/Speaker.hpp>

#include <stdlib.h>

using namespace webots;
using namespace managers;
using namespace std;

static const char *motorNames[NMOTORS] = {
  "ShoulderR" /*ID1 */, "ShoulderL" /*ID2 */, "ArmUpperR" /*ID3 */,
"ArmUpperL" /*ID4 */, "ArmLowerR" /*ID5 */,
  "ArmLowerL" /ID6 */, "PelvYR" /*ID7 */,    "PelvYL" /*ID8 */,    "PelvR" /*ID9
*/,    "PelvL" /*ID10/,
  "LegUpperR" /ID11/, "LegUpperL" /ID12/, "LegLowerR" /ID13/, "LegLowerL"
/ID14/, "AnkleR" /ID15/,
  "AnkleL" /ID16/,      "FootR" /ID17/,       "FootL" /ID18/,       "Neck" /ID19/,
"Head" /ID20/
};

Op3MotionPlayer::Op3MotionPlayer() : Robot() {
  cout << "--- Demo of ROBOTIS OP3 ---" << endl;
  cout << "This demo shows how to play the RobotisOp3 motions." << endl;

  mTimeStep = getBasicTimeStep();

  mHeadLED = getLED("HeadLed");
  mBodyLED = getLED("BodyLed");
  mCamera = getCamera("Camera");
  mSpeaker = getSpeaker("Speaker");

  mCamera->enable(mTimeStep);
  for (int i = 0; i < NMOTORS; i++) {
    string sensorName = motorNames[i];
    sensorName.push_back('S');
    getPositionSensor(sensorName)->enable(mTimeStep);
```

```
  }

  mMotionManager = new RobotisOp2MotionManager(this, "motion_4095.bin");
}

Op3MotionPlayer::~Op3MotionPlayer() {
}

void Op3MotionPlayer::myStep() {
  if (step(mTimeStep) == -1)
    exit(EXIT_SUCCESS);
}

void Op3MotionPlayer::wait(int ms) {
  double startTime = getTime();
  double s = (double)ms / 1000.0;
  while (s + startTime >= getTime())
    myStep();
}

void Op3MotionPlayer::run() {
  mHeadLED->set(true);
  mBodyLED->set(0xFF00FF);
  myStep();

  mMotionManager->playPage(1);  // Standing position.

  while (true) {
    mSpeaker->speak("Hi, my name is AUPET Robot.", 1.0);
    mMotionManager->playPage(38);  // Hi.
    wait(1000);
    mSpeaker->speak("First", 1.0);
    mMotionManager->playPage(16);
    wait(1000);
    mSpeaker->speak("Second", 1.0);
    mMotionManager->playPage(17);
    wait(1000);
    mSpeaker->speak("Third", 1.0);
    mMotionManager->playPage(4); // kol
    wait(1000);
    mSpeaker->speak("Four", 1.0);
    mMotionManager->playPage(18);
    wait(1000);
    mSpeaker->speak("Five", 1.0);
```

```
    mMotionManager->playPage(19);
    wait(1000);
    mSpeaker->speak("Six", 1.0);
    mMotionManager->playPage(20);
    wait(1000);
    mSpeaker->speak("Seven", 1.0);
    mMotionManager->playPage(21);
    wait(1000);
    mSpeaker->speak("Eight", 1.0);
    mMotionManager->playPage(9);  // tize bugu
    wait(1000);

   /* mSpeaker->speak("I have 20 degrees of freedom, and a lot of sensors.", 1.0);
    mMotionManager->playPage(46);  // Talk.
    wait(1000);

    mSpeaker->speak("I love to play football.", 1.0);
    mMotionManager->playPage(83);  // kick right.
    mMotionManager->playPage(84);  // kick left.
    wait(1000);

    mSpeaker->speak("I'm at your disposal.", 1.0);
    mMotionManager->playPage(55);  // Small bow.*/
    wait(3000);
  }
}
```