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Non-commercial joint-stock company «Almaty University of Energy and
Communications»
Department of Electronics and Robotics named after G. Daukeev
Specialty 5B071600 - «Instrumentation»

ALLOWED TO DEFENCE

Head of Department

Ph.D., Associate Professor

_____ Chigambayev T.O.

«____» _____ 2020 y.

DEGREE PROJECT

On the topic: «Development of a digital security bracelet with tracking and alerts»

Done by:

gr. st. PSa-16-4

Balgabay Sh.Zh.

Research supervisor:

Ph.D, associate professor

Baikenov B.S.

Consultants:

on economic part:

Ph.D., Associate Professor

Tuzelbayev B.I.

«____» _____ 2020 y.

on life and environmental safety part:

senior lecturer

Beginbetova A.S.

«____» _____ 2020y.

Compliance supervisor:

senior lecturer

Fazylova A.R.

«____» _____ 2020y.

Reviewer:

Rakisheva Z.B.

Ph.D., associate professor of the department «Mechanics»

KazNU named after Al-Farabi

«____» _____ 2020y.

Almaty 2020

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ASSIGNMENT

for execution of degree project of student
Balgabay Shapagataiym Zhalgasbekkyzy

Topic of the work: «Development of a digital security bracelet with tracking and alerts »

Approved by the order of the rector №56 from «30 » april 2020 y.

Deadline of the finished work: « 10 » june 2020 y.

Initial data required parameters of the results and initial data:

- Arduino Nano microcontroller
- GPS module
- GSM module

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

- analyze the current state of the problem of loss in Kazakhstan
- review and compare the existing location monitoring systems
- selection of components, description and principle of operation of the system
- development of a digital bracelet

List of graphical material (with precise indication of mandatory drawings):
this degree project contains 29 figures and tables

Recommended basic literature:

1. Global Positioning System Standard Positioning Service Performance Standard, 4th Edition (September 2008)

2. Пресняков В.В., Тюкленкова Е.П., Сеницина Г.Ю. ПРИМЕНЕНИЕ СОВРЕМЕННЫХ СПУТНИКОВЫХ НАВИГАЦИОННЫХ СИСТЕМ GPS И ГЛОНАСС // Международный журнал прикладных и фундаментальных исследований. – 2014. – № 5-2. – 32-35с.

3. Серапинас Б.Б. Глобальные системы позиционирования. — М. ИКФ "Каталог", 2002. — 106 с.

Consultants for work with indication of the relevant section:

Section	Consultant	Date	Sign
Technological part	Baikenov B.S.		
Engineering part	Baikenov B.S.		
Software	Baikenov B.S.		
Life safety	Begimbetova A.S.		
Economic part	Tuzelbayev B.I.		

SCHEDULE
of degree project preparation

Title of section, list of issues to be developed	Deadline for submission to instructor	Note
1 Investigation of existing monitoring systems	01.02	
1.1 State of the problem of missing persons in Kazakhstan		
1.2 GPS tracking system against crime and terrorism		
1.3 GPS tracking system in healthcare		
1.4 GPS tracking system for parents		
1.5 <u>The main market trends</u>		
2 Development of system of a bracelet	15.03	
2.1 The choice of basic sensors and modules		
2.2 Technical characteristics of component parts		
3 Software	01.05	
3.1 Description of the development environment		
3.2 Software development		
4 Life safety	10.05	
5 Feasibility study	20.05	
Conclusion	01.06	

Date of issue of the assignment « 20 » 01 2020 y.

The head of department

Supervisor:

The assignment for execution is accepted by:

Chigambayev T.O.

Baikenov B.S.

Balgabay Sh.Zh.

Аннотация

Данный дипломный проект представляет собой разработку современного цифрового браслета для оповещения и навигации на основе микроконтроллера Arduino Nano. Браслет помогает обеспечить персональную безопасность своего пользователя, посредством мониторинга местонахождения и оповещения доверенного лица при появлении угрозы. При разработке браслета и внедрения программы использовалась специализированная среда разработки для микроконтроллеров Arduino – Arduino IDE, построенная и использующая язык C++. Дальнейшее внедрение цифрового браслета на рынок, будет способствовать безопасному передвижению и дополнительной защите пользователя, необходимые при нахождении за пределами дома, что является главной задачей разработки.

Андатпа

Ұсынылған дипломдық жоба Arduino Nano микроконтроллеріне негізделген ескерту мен навигацияға арналған сандық білезікті әзірлеу болып табылады. Білезік пайдаланушының жеке қауіпсіздігін қамтамасыз етуге көмектеседі, оның орналасқан жерін бақылап, қауіп туындаған кезде сенім білдірген адамына хабарлайды. Білезікті әзірлеу және бағдарламаны жүзеге асыру кезінде біз Arduino микроконтроллерлері үшін құрылған C ++ тілін қолданатын арнайы ортамен - Arduino IDE жұмыс істедік. Бұл құрастырудың басты мақсаты цифрлық білезікті нарыққа енгізу арқылы пайдаланушының үйден тыс кезде қауіпсіз қозғалуына және қосымша қорғалуына ықпал ету.

Annotation

In the submitted final work, a digital bracelet for alerts and navigation is developed based on the Arduino Nano microcontroller. The bracelet helps to ensure personal security for its user by monitoring the location and notifying a proxy in case of a threat. When developing the bracelet and implementing the program, we used a specialized development environment for Arduino microcontrollers - Arduino IDE, built and using the C ++ language. Further introduction of the digital bracelet on the market will contribute to the safe movement and additional protection of the user, necessary when staying outside the home, which is the main task of the development.

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Introduction

In this diploma work, a digital bracelet is developed using the Arduino Nano microcontroller.

This work is very relevant, since according to statistics, several tens of millions of people disappear annually. 20% of all missing people are still not found [1].

Among them there are children who have run away from home, husbands and wives, hiding from each other, healthy and sick people. Many cases, as a rule, have their own explanations. However, the most missing are members of the vulnerable part of the nation.

Independent movement without any threat is one of the most important desires for all people representing the permeable layer of the population. Since the concept of technical assistance to people at risk is of recent origin (after World War II), children, elderly and unhealthy people lived in constant excitement.

One of the most active threats to the lives of such people is the inability to navigate, the risk of an abyss. Therefore, it is necessary to find a solution that will help such people in such cases to notify their near and dear ones.

The current study uses modern technology to improve the efficiency of using traditional navigation aids to create more reliable solutions. In this regard, the digital bracelet is no exception, which is complemented by existing technologies for the development of electronic travel guide, electronic orientation aids and location devices.

Organizations today are facing increasing labor costs and a shortage of workers, and thus are investing in robotics and digital technology. Robots are able to work around the clock, can perform tasks that most people can not perform, for example, work in difficult conditions and perform complex operations, calculations with extreme accuracy. This makes organizations ready for the challenges of the future, not only in technology, but also in human resource management. Especially the influence of robots on the employment and motivation of workers in the law enforcement sector.

The main goal of developing a bracelet is to show an example of how, with the help of devices, you can help people and make their life safer.

To achieve the goals were set the following objectives:

- a) to study the state of development of robotics in law enforcement, also to assess the state of the problems of loss in Kazakhstan;
- b) review and compare the existing location monitoring systems;
- c) selection of components to create a digital bracelet;
- d) development of a digital bracelet.

1 Investigation of existing monitoring systems

We live in an era of daily developments in the field of intelligent technologies, which have become an integral part of our lives. In some cases, these achievements, that is, new technologies have also been found to be valuable to ensure safety, in particular, to reduce the risk to people.

The need of a person to determine the location of himself and various moving objects has been taking place since ancient times. And each time stage corresponded to certain means and methods of solving this problem. With their help, sailors and land travelers made great geographical discoveries, made fairly accurate maps of the surface of the earth. With the development of technology, the results of positioning both on land and in the waters of the oceans became more accurate. But the real revolution in this area took place at the turn of the twentieth and twenty-first centuries, when global navigation systems based on orbital constellations with a large number of artificial earth satellites finally came into operation. And allowed to provide navigation and positioning services throughout the earth's surface. And as navigation receivers became cheaper, they became available to almost everyone.

Global positioning system - appeared in the 50s thanks to the launch of the satellite. When the first Soviet satellite entered orbit, the Americans noticed: when moving away, it alters the signal frequency equally. The signal allows you to accurately determine the coordinates of objects on the ground, as well as the speed of their movement. Satellite navigation is for their purposes, but after a few years it became accessible to civilians. Now in low Earth orbit there are 24 satellites that transmit binding signals and are used for different purposes [2].

There are various GPS trackers available on the market with a range of models, shapes, sizes, functions and cost (figure 1.1). Also, we should notice that cheaper model will have shorter battery life.



Figure 1.1 – Types of devices that use GPS system

Currently, the Global Navigation Satellite Systems (GNSS) GLONASS and GPS are increasingly used in the world. These systems are used in various fields of human activity, from applications for solving important scientific problems to entertainment and consumer services.

Along with global satellite systems, recently began to develop regional satellite systems, covering the navigation field of some local regions of the Earth. An example of such systems is the Japanese quasi-Zenith system QZSS and the Indian IRNSS.

The Global Positioning System (GPS), also known as the Navstar (Navigation System with Time and Ranging), is designed to transmit navigation signals that can be received simultaneously in all regions of the world. The system was developed by order of the US Department of Defense, and spacecraft (SC) manufactured by Rockwell International.

A Russian satellite navigation system (SNA) for a similar purpose, known as Glonass (Global Navigation Satellite System) was developed by order of the Russian Ministry of Defense, but is now used to provide navigation services to various categories of consumers - without any restrictions. The orbital grouping of the Russian navigation system was deployed in the early 90s, and its commercial operation has been carried out since 1995.

GPS and Glonass systems have a similar architecture. They include the space segment, consisting of 24 spacecraft, a network of ground-based stations for monitoring their work and the user segment (navigation receivers). All GPS / Glonass satellites are autonomous.

The coordinates of the mobile subscriber are determined using a standard GPS navigation or GPS / Glonass receiver (figure 1.2), built into the user's terminal. The device, as a rule, uses its own miniature antenna and autonomously calculates geographic coordinates and universal time (UTC) from the navigation signals.

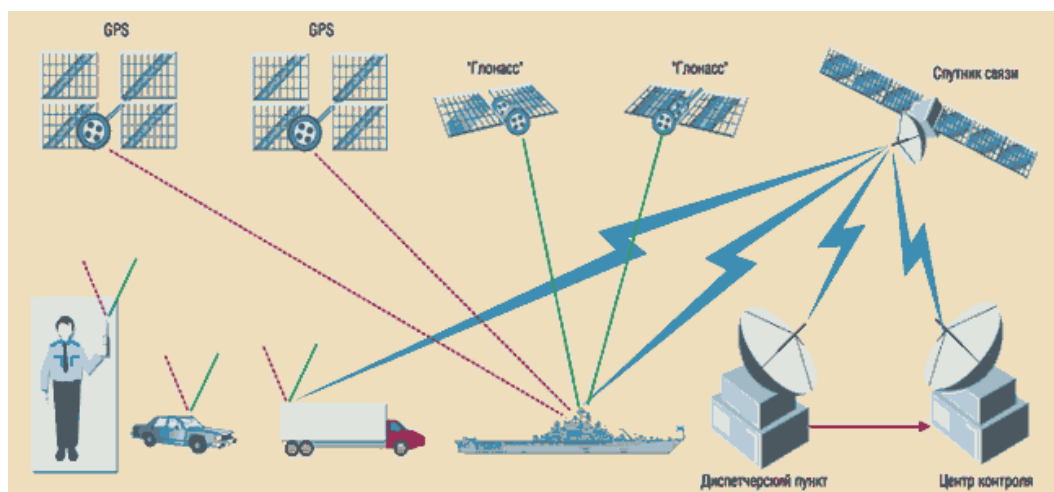


Figure 1.2 - The scheme for determining the coordinates of an object in satellite communication systems using GPS / "Glonnas" receivers

In some cases, the navigation antenna is combined with the communication antenna of the subscriber terminal (for example, in the Inmarsat-C system), and navigation data can be received in both serviced and unattended modes of operation.

GPS / Glonass receivers are most often used if it is necessary to obtain high accuracy of coordinates (error not more than 100 m). Having captured the signal, the navigation receiver automatically calculates the coordinates of the object, the signal speed and world time and generates a report. Information about the location of the facility is transmitted by satellite channels to the control center [3].

1.1 Statement of the problem of missing persons in Kazakhstan

Every year in Kazakhstan, a lot of people disappear without a trace. Some are found alive and unharmed, others, on the contrary, are dead, and some are still sought after to this day.

According to statistics, several million people annually disappear without a trace in the world, every second - one person. Among them are children who ran away from home, husbands and wives, hiding from their other halves in search of a new love, a victim of crime and domestic violence. Many cases, as a rule, have their own explanation. Sooner or later, 80 percent of people find them dead or alive. However, the remaining 20 percent disappear forever, as if they had never existed. These cases are inexplicable, mystical and mysterious, the clue of which the relatives of the missing together with the police unsuccessfully searched for decades. According to the legislation of Kazakhstan, the search for the missing is stopped only after ten years from the date of disappearance.

According to the Ministry of Internal Affairs of the Republic of Kazakhstan, every year in Kazakhstan, on average, 500-600 people of different ages and social groups disappear. Many can be found in the first months after disappearance, the rest receive the status of “missing”. Legally, this means that the location of such a person is not reliably known.

The number of missing people in the country from the beginning of 2008 to 2010 has been rapidly declining, but since 2011 it has begun to grow again. So, in 2008, 3365 people were wanted, in 2009 - 2595, in 2010 - 2202 people, in 2011 - 2473 missing people, and already in 2012 the total number of missing people increased to 2838 people. The saddest statistics were recorded in 2015. Then, out of almost three thousand missing, 448 people were not found, and 253 were found dead. In 2019, 2,361 people disappeared, of which 251 were not found, and 176 were killed (table 1.1).

Table 1.1 - Statistics of missing people in 2017-2019

	2017	2018	2019
Found dead	217	166	176
Not found	305	340	251
All gone	2679	2046	2361
Found alive	2157	1540	1934

In general, according to statistics, from 2015 to 2019, 13,085 people were declared wanted, of which 1,066 were found dead, and 1,716 have not yet been found. Now more than two thousand people are wanted as missing. Most often, people disappear in Almaty, Almaty, East Kazakhstan and Karaganda regions.

Law enforcement officials divide all the missing into several groups. Most are people with mental disorders, the elderly and children. In five years, 92 teenagers have gone missing.

Elderly people are often lost due to memory loss or due to senile dementia. That is, the disappearance of such people is not related to crime. Rather, it is an accident, a coincidence. Old people and children are most often found; cases of their irretrievable loss are quite rare.

The search for children begins immediately from the moment the parents contact the police. Experts say - the sooner they begin to search, the more often they find. Often, most of the missing is found in the first 24 hours. However, according to the rules established by the police, searches for a person begin after three days. But under certain circumstances, they can start earlier. So, if a child is lost, then the search work begins from the moment the police report. On average, in Kazakhstan, there are 30 search cases per police officer.

During the first year, up to 80 percent of missing adults and 90 percent of children are wanted. All over the world, special sites and social networks are connected to people search. There are many examples where, using the Internet, it was possible to find missing people.

1.2 Security benefit of a GPS tracking system against crime and terrorism

Over the past couple of decades, progress in automated systems has grown exponentially. However, not enough research has been done on the effects of automation on personal safety. This study, in particular, focuses on the introduction of modern technology in law enforcement.

In particular, trackers are used on parole persons. They are protected against unauthorized access and wear a bracelet or anklet. The ankle device has the shape of a hard plastic ring, followed by a small tracking box that can fit in your pocket. Companies such as iSECUREtrac are developing GPS monitoring systems to track parolees and sex offenders so that they do not commit any crime. They also warn the authorities if they enter certain places (for example, schools, parks), and do not allow them to leave their homes if it is necessary [4]. Some GPS devices may also offer an additional opportunity to find out how much alcohol a person consumes by measuring sweat levels every hour. Parolee and pedophile tracking is widespread in the United States, with an estimated 120,000 monitored parolees being tracked in 28 states [5]. However, there are more than 50,000 convicted sex offenders in the United States that are not tracked at all [6]. Due to the existing overcrowding problem in British prisons, some types of criminals are flagged and released. The use of highly active tags can enable police and probation services to

track the whereabouts of flagged criminals and take appropriate action if necessary.

GPS tracking is used in developed countries to monitor the activities of a suspected terrorist or group. The laws provide for the use of a tracking device attached to any person suspected of “acts prejudicial to security” (for example, Law ASIO1979). During the meeting of the Anti-Terrorism Council at the Australian Government Council (COAG), it was planned to increase this period to 12 months [7].

1.3 Security benefit of a GPS tracking system in healthcare

Old age is often associated with disorientation in time and space. An elderly person feels insecure, as he is afraid of getting lost and being left without help in a critical situation.

Alzheimer's disease affects nerve cells in the brain or neurons, which leads to memory loss, cognitive impairment and dramatic changes in behavior, and as a result, a person may stop communicating. Alzheimer's disease followed by vascular dementia and dementia with Lewy bodies. It currently numbers five percent of people over 65 and twenty percent of people over 80 [8].

According to preliminary estimates, today there are about 170 thousand people with senile dementia in Kazakhstan.

People diagnosed with Alzheimer's and other forms of dementia experience seven progressive changes and, as a result, can be weakened to the point that they become disoriented and can easily get lost.

Since it is difficult to constantly monitor dementia sufferers, the caregiver uses a variety of assistive technologies that automatically notify family members by phone or email in case of problems. The Human Resources Management Research Society emphasizes that these technologies provide dementia sufferers with more independence and freedom.

Active locator technologies used to locate wandering individuals. They are: radio frequency (RF), Active Radio Frequency Identification (RFID), Assisted Global Positioning System (A-GPS), and Wideband Code Division Multiple Access (W-CDMA), Global System for Mobile Communications (GSM) and Global Positioning System (GPS).

The advantages of using GPS trackers is that they achieve horizontal accuracy of 3 meters or higher, and vertical accuracy of 5 meters or better 95 percent of the time [9].

The disadvantages of using GPS are the high need for a battery and the fact that the receiver needs a clear path to the satellites for accurate signal processing. Environmental protection, for example, from buildings and thick foliage, can affect accuracy and even disrupt tracking. Furthermore, when using a GPS tracking device, it is often difficult to detect a wanderer who is in the room.

GPS tracker for the elderly is a solution that brings a balance between the safety of an elderly person and the ability not to deprive him of daily walks. This simple device will always show where a person close to you is located or the

history of his movements for the day. An elderly relative, in turn, to call for help, just press the SOS button - and his loved ones will know about it at the same second.

1.4 GPS tracking system for parents

Ensuring the safety of children is the concern of every parent. Today this issue is more relevant than ever. But due to various circumstances, such as permanent employment and similar reasons, many of us simply do not have the opportunity to constantly be with our child: take him to school and pick him up, take him to mugs and sections. That is why our children often go to and from school alone, without our accompaniment. But there is a way out of this situation - GPS tracking systems for children

Today, parent use GPS tracking devices to monitor their children, pets or car. Thanks to modern technologies, the child's sensor using GPS determines the coordinates of his location and transmits them to the observer's device by SMS (how we get coordinates shown in figure 1.2); parents can set the frequency of these messages on their own. You can track your child online, as well as view the history of movements for any period from your phone or computer, at any time and around the clock.

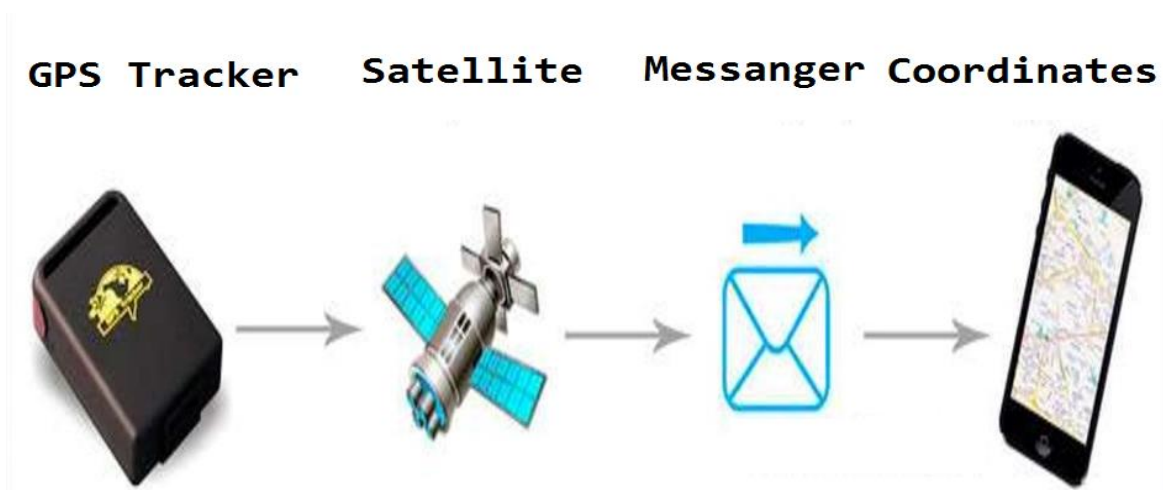


Figure 1.2 – Smart watch market analysis

Tracking children will allow you to see the exact location of the child at any time and from any location. The advantage of some modern systems is that most of them can be used secretly. In other words, the child will not even notice that you are in control of him.

An important aspect of the use of GPS trackers is tracking the movement of the vehicle. It also provides additional security against theft and hijacking. In addition, the use of GPS trackers in cars helps to build optimal routes to optimize transportation costs and make logistics as profitable and efficient as possible. with a tracking system mileage is reduced, which minimizes the cost of fuel and

equipment repair. Devices capable of controlling the speed of movement help reduce the risks of accidents and avoid fines for exceeding the speed limit.

Most modern GPS trackers use two main satellite positioning systems: GPS and GLONASS. Devices are able to receive data on their location from a satellite and transmit them to a connected phone or any mobile device by SMS messages. Many manufacturers also offer very convenient services for online tracking of vehicle movements in real time, as well as special mobile applications.

With the help GPS devices people can track the location of not only a bicycle or smartphone, children or elderly parents, but also their pets.

When you go to the forest, hike, go hunting or just go for a walk with your pet and he is lost sight of, the GPS sensor for the dog, built into the collar, can send information about the pet's location to the owner's smartphone or laptop.

Communication with the owner of the collar is carried out via GPRS or GSM channel, in other words - using the mobile Internet. Collars for tracking animals can also be worn on wild animals, which allow scientists to study its activities and migration.

1.5 The main market trends

In the world, this direction of gadgets is segmented into smart watches and bracelets for adults, the elderly, for sports, for children, for adolescents and for animals.

Smart watches today are almost the most popular device. If initially the watch performed the role of a fitness tracker to a greater extent, today its functions are, if not unlimited, then very extensive. Due to the high demand, the number of manufacturers of smart watches is growing every day. There are top 5 companies which produce smart devices (Apple, Xiaomi, Fitbit, Huawei and Garmin).

The sales leader was Apple's smart watch. In total, nearly 5 million Apple watch have been sold in the world over the past three months.

More precisely, the supply of Apple Watch reached 4.7 million, which is 17% of all global sales. At the same time, growth for the year turned out to be considerable - by 38.4% (table 1.2).

Table 1.2 – Top 5 wearable companies by shipment volume, market share, and year-over-year growth (shipments in million)

Company	2018 shipments	2018 share	2017 shipments	2017 share	Year-over-year growth
1. Apple	4.7	17.0%	3.4	13.0%	38.4%
2. Xiaomi	4.2	15.1%	3.5	13.3%	19.8%
3. Fitbit	2.7	9.5%	3.4	12.8%	-21.7%
4. Huawei	1.8	6.5%	0.8	3.1%	118.1%
5. Garmin	1.5	5.3%	1.4	5.4%	4.1%
Others	13.0	46.6%	13.8	52.4%	-6.2%
Total	27.9	100%	26.4	100%	5.5%

In second place is the Chinese company Xiaomi, which sold 4.2 million wearable devices over the quarter, compared to last year, its supply increased by 19.8%. Fitbit is in third place with 2.7 million, which reduced sales by 21.7% over the year. The fourth and fifth places were taken by Huawei and Garmin from 1.8 and 1.5 million. Interestingly, Huawei's sales grew by 118.1%.

In total, 27.9 million smart watches and fitness bracelets were sold in the world, which is 5.5% more than in the same quarter last year [10].

Next we will consider the characteristics of each company. The main player in the bracelet market is Apple. In 2015, the company presented its first smart watch under the simple name of Apple Watch. Until 2018, the brand released 3 series of smart watches:

- 1) Apple Watch Series 3 - price starting at 299\$;
- 2) Apple Watch Series 4- cost 550\$;
- 3) Apple Watch Nike + Series 4 - price starting at 500\$.

The Apple Watch Series 3 is equipped with an OLED screen, while the Series 4 and Nike Series 4 models have an OLED Retina screen (figure 1.3). Useful functions that are present in devices of all series are:

- GPS;
- barometer;
- gyroscope;
- accelerometer;
- heart rate monitor;
- for calls;
- inbox alert;
- music player control.



Figure 1.3 – Apple Watch Series 3

The watch Series 3 and Series 4 also has a pedometer, camera control. Series 4 and Nike + Series 4 have a sleep tracking feature. Series 3 has a voice control feature that other devices lack. Series 4 has a calorie burn function, and Nike + Series 4 has a built-in altimeter.

Despite the fact that the range of smart watches from the manufacturer of Huawei is not as wide as that of other brands, the device is in great demand and

popularity among many users. The manufacturer's uniqueness was the special design of the gadget. Watches primarily look like a classic chronometer. All models have a bezel made of ceramic (figure 1.4). With its help, the dial is controlled. All watches run on the Android operating system and are equipped with useful features of a fitness tracker:

- real-time heart rate counter;
- sleep tracking;
- calorie counter;
- physical activity monitoring;
- pedometer;
- the function of reading indicators during swimming lessons.



Figure 1.4 – Huawei bezel watches

The device is water resistant to immersion to a depth of 50 meters. To compensate for the lack of model diversity, you can use the ability to change the dial. The watch screen has additional protection in the form of a sapphire crystal, which prevents scratches. Another great advantage of the watch from the manufacturer of Huawei is the full display of Google maps during GPS navigation.

The well-known manufacturer Garmin, which specializes in the production and production of GPS navigation technology and smart watches, released the first model of smart watches back in 2003. Even then, the clock knew how to measure speed and distance, to fix the heart rate and pulse. The lineup was rapidly expanding, and the technology and functions of new devices were gradually brought to perfection. At the moment, Garmin smart watches provide the user with a functional interface and high autonomy. A total of 7 episodes have been released:

- 1) Garmin Instinct - price starting at 300\$;
- 2) Garmin Forerunner - price starting at 150\$ to 600\$;
- 3) Garmin Fenix 5 Plus - price starting at 750\$;
- 4) Garmin Fenix 5 - price starting at 600\$;
- 5) Garmin Fenix 3 - price starting at 550\$;
- 6) Garmin Vivoactive - price starting at 350\$;
- 7) Garmin Vivomove - price starting at 250\$ to 500\$.

All models are waterproof and have the following functions:

- a) accelerometer;
- b) sleep tracking;
- c) pedometer.

In the models of the Vivoactive, Fenix 3, 5, 5 Plus, Forerunner and Instinct series, GPS functions, a barometer, a gyroscope, an altimeter, an alarm clock, a compass, an incoming alert, sleep tracking, a heart rate monitor, calories burned, music player control, remote phone search have been added . There are also functions for monitoring physical activity in active training mode (figure 1.5).



Figure 1.5 – Garmin Vivoactive watch

Thanks to continuous monitoring of the owner's activity, the device, on the basis of the collected data, has the ability to draw up an individual minimum exercise program [11].

2 Development of system of a bracelet

2.1 The choice of basic sensors and modules

The selection of the main components for the development of the bracelet is a very important task. When choosing, it is necessary to be based on the cost of modules and sensors, as well as their technical characteristics. In this part of the diploma work, a detailed description of the used components will be considered.

Next, we consider the technical characteristics of the selected elements of the bracelet.

2.2 Technical specifications

2.2.1 Microcontroller Arduino Nano

For the bracelet, the Arduino Nano controller is used, in the base of which is the ATmega328. This controller has 14 digital inputs and 6 of them can be used as PWM outputs, the other 8 have analog inputs (figure 2.1).

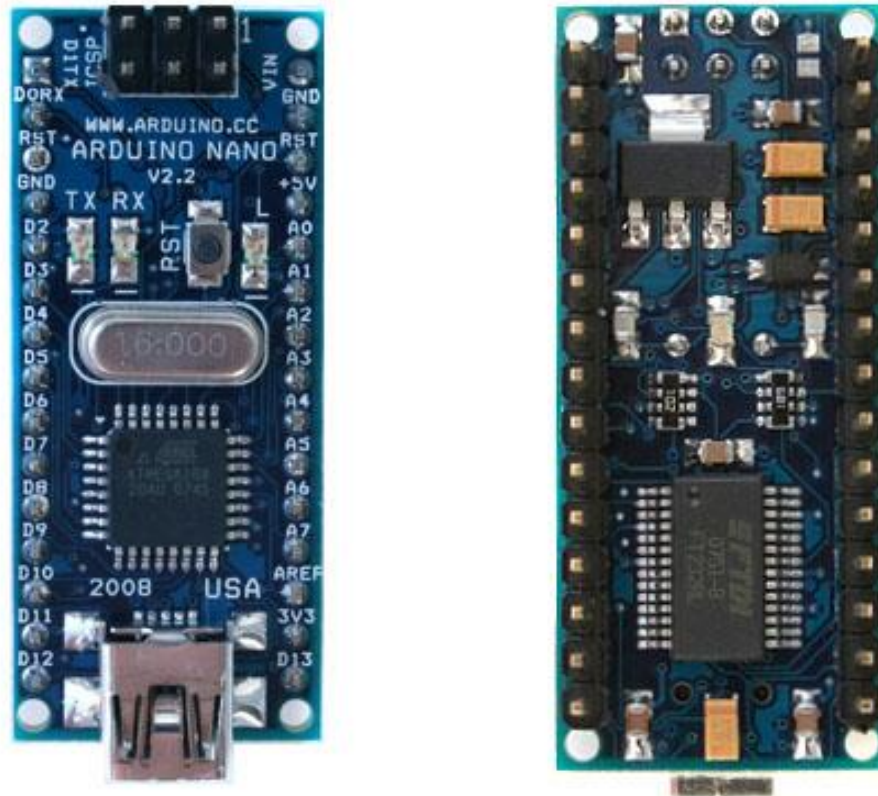


Figure 2.1 - Microcontroller Arduino Nano

Arduino Nano is a smaller analogue of Arduino Uno, it differs in form by the factor of the board, which is 2-2.5 times smaller (19 x 43 mm) than Arduino Uno (53 x 69 mm), in the absence of a DC power connector and operation via a Mini- cable B USB. The Nano platform has pin contacts, so it's easy to install on a breadboard.

The FTDI FT232RL chip receives power only if the platform itself is powered by USB. Thus, when working from an external source (not USB), there will be no 3.3 V voltage generated by the FTDI chip, while the RX and TX LEDs blink only when there is a high level signal at pins 0 and 1 (table 2.1).

Table 2.1 - LED Indication

LED Name	Appointment
RX и TX	Flashing when exchanging data between the Arduino Nano and the PC.
L	Custom LED connected to pin 13 of the microcontroller. At a high level, the LED turns on; at a low level, it turns off.
ON	Availability of power on the Arduino Nano.

The ATmega168 microcontroller has 16 kB flash memory for storing program code, and the ATmega328 microcontroller, in turn, has 32 kB (in both cases, 2 kB is used to store the bootloader). ATmega168 has 1 KB of RAM and 512 bytes of EEPROM (which is read and written using the EEPROM library), and ATmega328 has 2 KB of RAM and 1 KB of EEPROM.

Each of Nano's 14 digital pins, using the `pinMode ()`, `digitalWrite ()`, and `digitalRead ()` functions, can be configured as input or output. The terminals operate at a voltage of 5 V. Each terminal has a load resistor (standardly disabled) of 20-50 k Ω and can pass up to 40 mA.

On the Nano platform, 8 analog inputs are installed, each with a resolution of 10 bits (i.e., it can take 1024 different values). As a standard, pins have a measuring range of up to 5 V relative to the ground, however, it is possible to change the upper limit by means of the `analogReference ()` function [12].

The functional small Arduino Nano board, which is not inferior in function to the large UNO, is cheaper, more convenient for mounting and assembling miniature devices.

Based on these data, the Arduino Nano controller was selected. Figure 2.2 summarizes the main technical specifications of the Arduino boards.

Also, Arduino Nano have following advantages:

- excellent platform for beginners.
- the tiny size makes it ideal for compact projects.
- functionally the same as their larger counterparts.
- mounted on a layout that facilitates the creation of prototypes.

Disadvantage of this microcontroller that limited internal memory can complicate complex programs.

There are practically no differences between Arduino. This is all atmega328 or atmega168 in a different form factor. MINI and NANO are designed to be embedded in one-time DIY projects.

Boards	Microcontroller	Operating Voltage/s (V)	Digital I/O Pins	PWM Enabled Pins	Analog I/O Pins	DC per I/O (mA)	Flash Memory (KB)	SRAM (KB)	EEPROM (KB)	Clock (MHz)	Length (mm)	Width (mm)	Cable	Native Network Support
Uno	ATmega328	5	14	6	6	20	32	2	1	16	68.6	53.4	USB A-B	None
Leonardo	ATmega32u4	5	20	7	12	40	32	2.5	1	16	68.6	53.3	micro-USB	None
Micro	ATmega32u4	5	20	7	12	40	32	2.5	1	16	48	18	micro-USB	None
Nano	ATmega328	5	22	6	8	40	32	1	0.51	16	45	18	mini-B USB	None
Mini	ATmega328	5	14		6	20	32	2	1	16	30	18	USB-Serial	None
Due	Atmel SAM3X8E ARM Cortex-M3 CPU	3.3	54	12	12	800	512	96	X	84	102	53.3	micro-USB	None
Mega	ATmega2560	5	54	15	16	20	256	8	4	16	102	53.3	USB A-B	None
M0	Atmel SAMD21	3.3	20	12	6	7	256	32	X	48	68.6	53.3	micro-USB	None
Yun Mini	ATmega32u4	3.3	20	7	12	40	32	2.5	1	400	71.1	23	micro-USB	Ethernet/Wifi
Uno Ethernet	ATmega328p	5	20	4	6	20	32	2	1	16	68.6	53.4	Ethernet	Ethernet
Tian	Atmel SAMD21	5	20	12	0	7	16000	64000	X	560	68.5	53	micro-USB	Ethernet/Wifi
Mega ADK	ATmega2560	5	54	15	16	40	256	8	4	16	102	53.3	USB A-B	None
M0 Pro	Atmel SAMD21	3.3	20	12	6	7	256	32	X	48	68.6	53.3	micro-USB	None
Industrial 101	ATmega32u4	5	7	2	4	40	16000	64000	1	400	51	42	micro-USB	Ethernet/Wifi
Uno Wifi	ATmega328	5	20	6	6	20	32	2	1	16	68.6	53.4	USB A-B	Wifi
Leonardo Ethernet	ATmega32u4	5	20	7	12	40	32	2.5	1	16	68.6	53.3	USB A-B	Ethernet
MKR1000	Atmel SAMD21	3.3	8	12	7	7	256	32	X	48	64.6	25	micro-USB	Wifi

Figure 2.2 - Comparative specifications of Arduino microcontrollers.

2.2.2 GPS module Ublox NEO-6M (GY-GPS6MV2)

The GPS module on the Ublox Neo 6m V2 board is equipped with the u-blox NEO-6M GPS module with an antenna and built-in EEPROM. Such a module is compatible with various controller boards designed to work with the GPS module (figure 2.3).



Figure 2.3 - GPS module Ublox NEO-6M (GY-GPS6MV2)

The NEO-6 series of modules is a family of standalone GPS receivers with high-performance u-blox 6. These flexible and economical receivers offer many miniature connection options in a 16x12.2x2.4 mm package. Their compact architecture and power and memory capabilities make the NEO-6 modules ideal for battery-powered mobile devices with very strict prices and limited space.

The 50-channel u-blox 6 positioning engine boasts a first fix time (TTFF) of less than one second. A dedicated data collection mechanism with two million correlators can perform massive parallel spatio-temporal searches, which can allow satellites to be found in fractions of a second. The streamlined design and technology dampens interference sources and mitigates the effects of multipath propagation, providing NEO-6 GPS receivers with excellent navigation performance in the most difficult conditions.

Amplification device above «Absolute Maximum Ratings» can cause permanent damage and failure. The product is not protected against overvoltage.

All NEO-6 modules are based on qualified AEC-Q100 GPS chips.

Features of the NEO-6M module:

- GPS modules NEO-6M, having a universal power supply with a voltage of 3V-5V;
- a module with a ceramic antenna, having an excellent signal from GPS satellites;
- when turning off, EEPROM saves configuration parameter data;
- LED indicator that helps determine the operation of the module;
- default baud rate: 9600 bps;
- having compatibility with Raspberry Pi and Arduino.

Module Dimensions:

- mounting hole: 3 mm;
- module size: 23mm x 30mm;
- antenna size: 25mm x 25mm;
- cable length: 50 mm [13].

Table 2.2 shows the characteristics of different models.

Table 2.2 - Technical specifications of GPS modules

Model	NEO-6G	NEO-6Q	NEO-6M	NEO-6P	NEO-6V	NEO-6T
Cold start, sec	26	26	27	32	27	26
Hot start, sec	1	1	1	1	1	1
Sensitivity to search and navigation, dBm	-162	-162	-161	-160	-161	-162
Maximum speed, Hz	5	5	5	1	1	5

Continuation of table 2.2

GPS accuracy, m	1,5	1,5	1,5	1,5	1,5	1,5
Frequency configuration	0,25Hz-1kHz	0,25Hz-1kHz	0,25Hz-1kHz	0,25Hz-1kHz	0,25Hz-1kHz	0,25Hz-10MHz
Voltage, V	2,7-3,6	1,75-2,0	2,7-3,6	2,7-3,6	2,7-3,6	2,7-3,6

2.2.3 Liquid Crystal Display (LCD) 1602

The liquid crystal display (LCD) is abbreviated as LCD based on liquid crystal technology. When designing electronic devices, we need an inexpensive device for displaying information, and a second equally important factor is the availability of ready-made libraries for Arduino. Of all the available LCD displays on the market, the most commonly used is the LCD 1602A, which can display ASCII characters in 2 lines (16 characters in 1 line) each character in the form of a 5x7 pixel matrix (figure 2.4). The power is supplied using a voltage of 5 V. There is also a LED backlight on the display, which allows it to be used in the dark.



Figure 2.4 - Liquid Crystal Display (LCD) 1602

To facilitate communication between the Arduino and LCD display, uses a built-in library in the IDE Arduino «LiquidCrystal.h» - which is written for LCD

displays using the HD44780 (Hitachi) chipset (or compatible chip). This library can handle both 4 - bit mode and 8 - bit LCD connection mode.

For ease of connection, it is customary to use the I2C interface. Thanks to this bus, the number of pins used to connect the display is reduced to four.

Most often, such displays are already sold with this bus soldered on the back, but you can also connect this interface to the screen yourself if you originally purchased a display without an I2C adapter.

I2C adapter has the following outputs:

- 1) SCL - serial clock line (Serial CLock);
- 2) SDA - serial data line (Serial DAta);
- 3) VCC - "+" power;
- 4) GND - "-" power.

The main advantages of the LCD display:

- low price;
- high performance at all operating temperatures;
- small dimensions and weight;
- clear character mapping;
- ability to program any characters;
- wide viewing angle;
- high and adjustable contrast;
- hardware implementation of the cursor;
- convenient openings in the case for reliable fastening [14].

2.2.4 GSM module SIM800L

The module is based on the SIM800L chip from SimCom. The operating voltage of the chip is from 3.4 V to 4.4 V, which makes it ideal for direct power supply from a lithium battery, but the contacts of the SIM800L chip are displayed on the sides of the module. Including the contacts necessary for communication with the microcontroller UART interface, the supported speed is from 1200 bps to 115200 bps with automatic speed detection. To connect to a cellular network, you need an external antenna that comes with the module. Also, the board has a U.FL connector, if you need to connect a remote antenna (figure 2.5).

In the upper right corner of the SIM800L module there is an LED that shows the status of the cellular network.

Blinks once every 1s. - the module works, but has not yet connected to the cellular network.

Blinks every 2s. - The connection you requested for GPRS data transfer is active.

Blinking every 3s. - The module has established a connection with the cellular network and can send / receive voice and SMS messages [15].

The module can be controlled both from a computer (USB-UART TTL converter) and through STM, Arduino, Raspberry Pi microcontrollers.

On the rear panel there is a slot for installing a SIM card (any SIM card is suitable, the main thing is that it is activated). Install the SIM card with the necessary contacts to the SIM800L chip, and the key should be located on top.

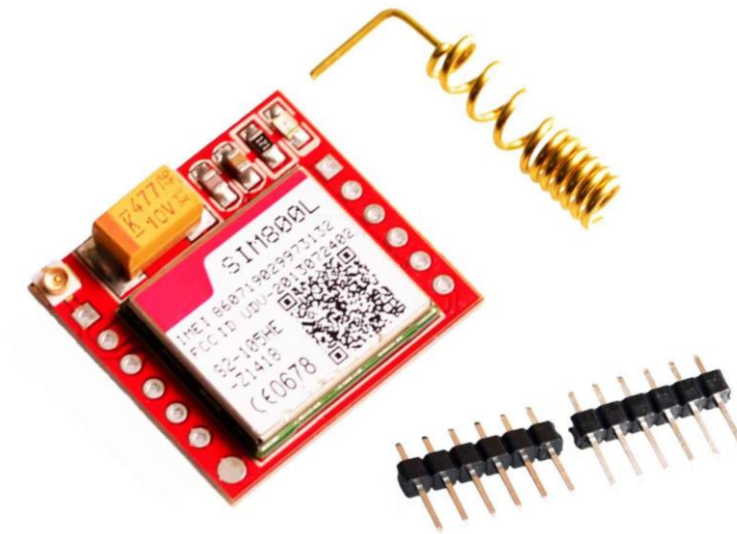


Figure 2.5 - GSM module SIM800L

2.2.5 MP1584EN DC-DC Step Down Module

For stable operation of the SIM800L module, a power supply with an output voltage of 3.4 to 4.4 V (ideally 4.1 V) with a maximum operating current of 2A is required. To connect the SIM800L module to Arduino, you need a DC-DC step-down converter (figure 2.6)

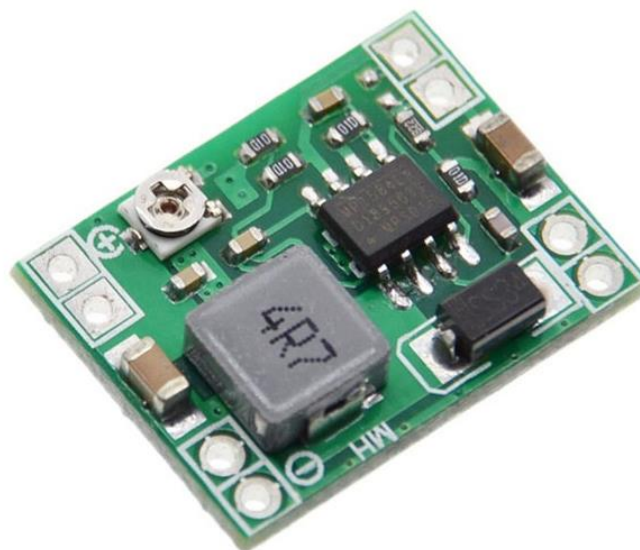


Figure 2.6 - DC-DC step-down converter

MP1584EN is a compact dc-dc buck converter. Due to its low weight, the MP1584EN is often used in aircraft models.

DC-DC step-down converters have the following characteristics:

- input voltage: 4.5V ~ 28V;
- output voltage: 0.8V ~ 20V;
- maximum output current: 3A;
- efficiency: 96%;
- ripple: <30mV;
- switching frequency: 1.5MHz (max), usually 1MHz;
- operating temperature (city. Celsius): -45 ~ +85;
- dimensions: 2.3 cm x 1.7 cm x 0.4 cm [16].

2.3 Assembling the bracelet

All selected components for the assembly of smart canes were purchased at the RadioMart store.

In order to upload the program to the microcontroller, the Arduino IDE software is used, in 3 parts a detailed description of this software.

First you need to understand the work of individual parts: GPS and GSM modules.

A GPS receiver module is a device that receives information from GPS satellites and receives the geographical location of the device. When connecting the GPS module for the first time, a cold start took 2 minutes, a hot start took already a second, as the manufacturer promised. For this receiver, a voltage of 3.3 V should be applied, but 5 V is also allowed, since a 3.3 V converter is installed on the board. When connected to an Arduino, we connect the RX module from the TX controller and the TX module from the RX controller, GND to GND and VCC with 5 V. To test the functionality, the developers of the Ublox Neo 6m module created the U-center program. This program is supported on all types of Ublox modules (figure 2.7-2.8).

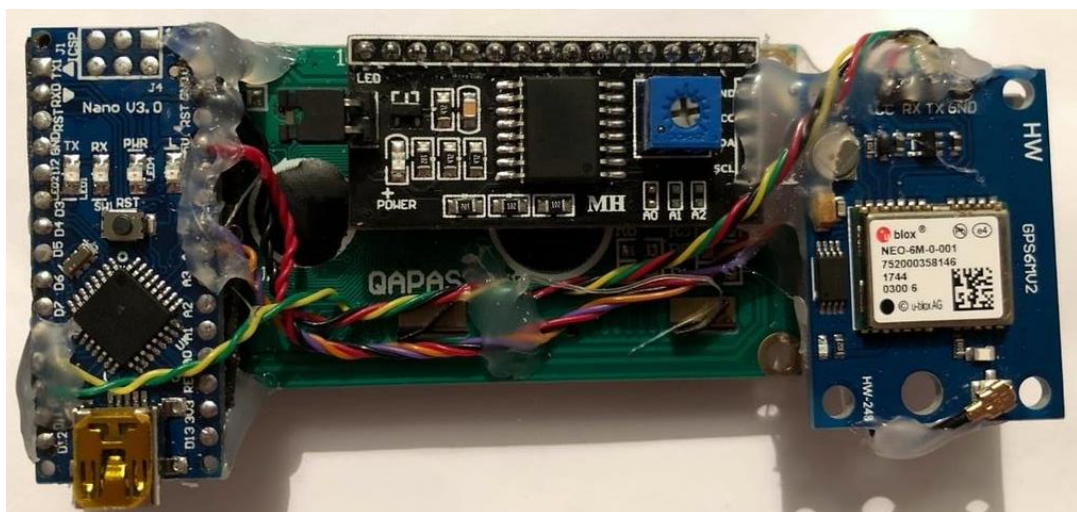


Figure 2.7 - Scheme of connecting of GPS module (back view)



Figure 2.8 - Scheme of connecting of GPS module (front view)

The GSM module is a device used to establish communication over a mobile network. The GSM module requires a SIM card to work and to register a connection with a network operator. The SIM card should be of a standard size and it is better to use it with a prepaid or unlimited SMS, as in case of errors many messages will come and you will often have to replenish the balance. We use a SIM card from the mobile phone operator TELE2 with a tariff for unlimited messages and calls. To turn on the module, use a 5 V power supply, which can provide 2 A. For this, we use a 3.7 V battery and a voltage converter. In order to supply power to the microcontroller 12 V and GSM 5 V, we put two converters with a parallel connection from the battery and a toggle switch, as shown in figure 2.9.



Figure 2.9 - Scheme of connecting of GSM module

GSM modules work with AT commands, which we will use when writing the code. The GSM connection to the Arduino is shown in Figure 2.10.

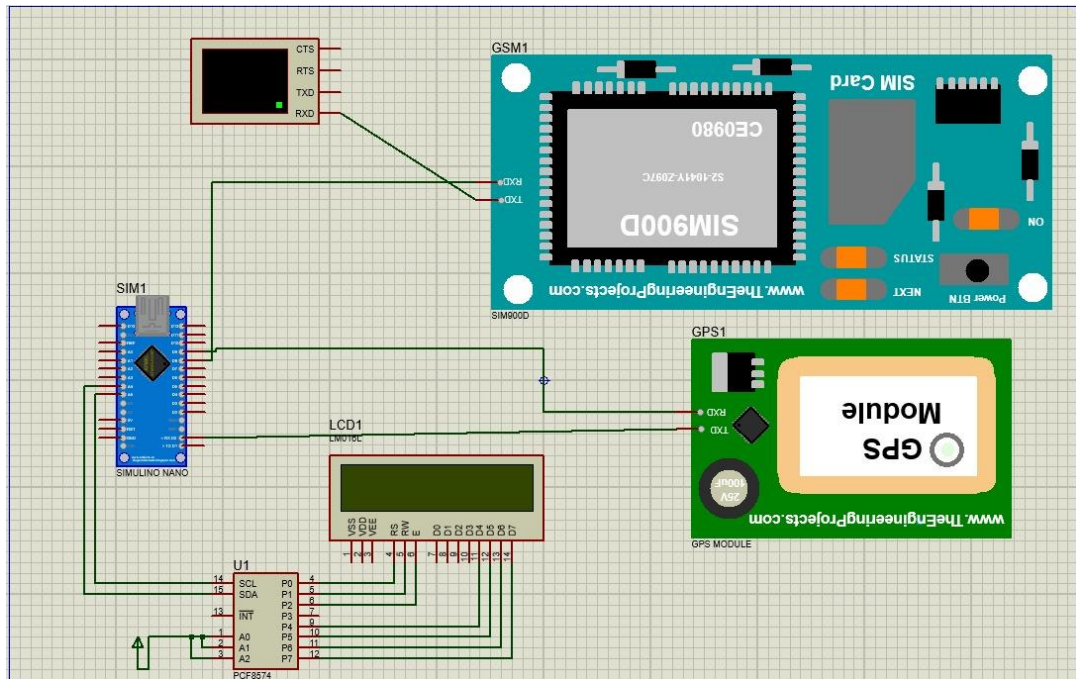


Figure 2.10 - Scheme of GPS tracker in Proteus software

If everything is connected properly that's the way the device will look like finally in figure 2.11.



Figure 2.11 - Power connection diagram for the controller

3 Software

3.1 Description of the development environment

To write the program code for this diploma work, the Arduino IDE development environment is used.

This Arduino IDE software is open source and easily accessible software that can be downloaded from the developers website. It is supported on Windows, Mac OS and Linux, very affordable and comfortable use. This environment is written in Java and is based on processing and other open source software. All Arduino microcontrollers can be flashed using this development environment.

This is the official Arduino software, which makes compiling the code too simple, and even an ordinary person who does not have prior technical knowledge can enjoy the learning process.

The main code, also known as a sketch created on the IDE platform, will ultimately generate a hex file, which is then transferred and downloaded to the controller on the board.

The IDE mainly consists of two main parts: the editor and the compiler, where the first is used to write the necessary code, and then to compile and load the code into this Arduino module (figure 3.1).



Figure 3.1 - Arduino IDE initial view

An amazing feature of this software is that its installation does not require any preliminary agreements or any difficulties, 2 minutes after installing the IDE you can already write the program.

3.2 Software Development

In this part of the work, individual parts of the program and connecting libraries are considered when connecting all modules and sensors for developing the bracelet code.

To program the LCD screen, you need to connect the LiquidCrystal_I2C library, which is designed to work with character displays on the I2C interface, which is shown in Figure 3.2.

The very first thing we do is create a variable by passing it the arguments 16 (number of characters) and 2 (number of lines), thereby indicating the size of this screen. Next, the screen itself is launched in the setup method, where the test text is printed using the print method of the lcd variable of type LiquidCrystal_I2C. Thus, the text is displayed on the screen. The setCursor method determines the line and the vertical position (1 unit = 1 offset to the right) from which printing will begin.

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
|
//LiquidCrystal_I2C lcd(0x27, 20, 4); // Для экрана 20x4 (четырёхстрочный)
LiquidCrystal_I2C lcd(0x27, 16, 2); // Для экрана 16x2 (двухстрочный)

void setup()
{
  lcd.begin();
  lcd.setCursor(0, 0); // 1 строка
  lcd.print("LCDI2C Test-20x4");
  lcd.setCursor(0, 1); // 2 строка
  lcd.print("01234567899876543210");
  lcd.setCursor(0, 2); // 3 строка
  lcd.print("01234567899876543210");
  lcd.setCursor(0, 3); // 4 строка
  lcd.print("  gekelectronics.org");
}

void loop()
{
}
```

Figure 3.2 - The program for checking the LCD

As mentioned earlier, GSM Shield requires a separate enable, which can be done both hardware and software. In order to implement this programmatically, you should enter the part of the program shown in Figure 3.3.

```
void SIM900power()
{
  pinMode(9, OUTPUT);
  digitalWrite(9, LOW);
  delay(1000);
  digitalWrite(9, HIGH);
  delay(2000);
  digitalWrite(9, LOW);
  delay(3000);
}
```

Figure 3.3 - The moment of the program to enable GSM software

To send AT commands and communicate with GSM, a serial port monitor is used, in this case it is COM8 port. Figure 3.4 shows a sketch for checking the response of a module to AT commands.

```
#include <SoftwareSerial.h>
SoftwareSerial mySerial(16, 17);
void setup()
{
    Serial.begin(115200);
    mySerial.begin(115200);
    Serial.println("Initializing...");
    delay(1000);
    mySerial.println("AT");
    updateSerial();
    mySerial.println("AT+CSQ");
    updateSerial();
    mySerial.println("AT+CCID");
    updateSerial();
    mySerial.println("AT+CREG?");
    updateSerial();
}
void loop() {
    updateSerial();
}
void updateSerial() {
    delay(500);
    while (!Serial.available()){}
    mySerial.write(Serial.read());
}
while(mySerial.available()) {
    Serial.write(mySerial.read());
}
}
```

Figure 3.4 – Testing of AT - commands

Figure 3.5 shows the port monitor, which shows responses to commands.

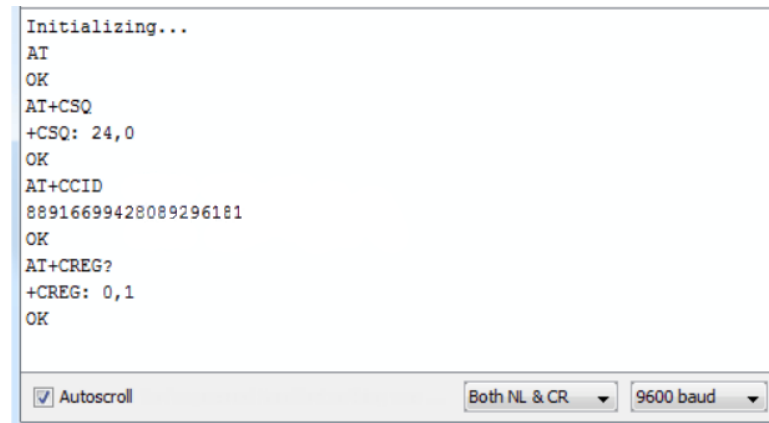
Communication with the module is established, then you can already send SMS and calls.

For programming the GPS module, the SoftwareSerial.h library and TinyGPS are also used.

At the very top, all the necessary libraries are connected. The following is the declaration and initialization of the variables.

Initially, the setup function is registered, on which the LCD, GPS and GSM modules are configured, as well as launched (figure 3.6).

At the figure 3.7 we can see that loop function was started. Device will repeat the code that is placed inside that function. Firstly, we check is the signal on our Serial Port for availability. Using encode() method of TinyGPS we convert GPS signal to the machine signal. If encoding was successful we assign “true” value for newData variable, which means that data is coming.

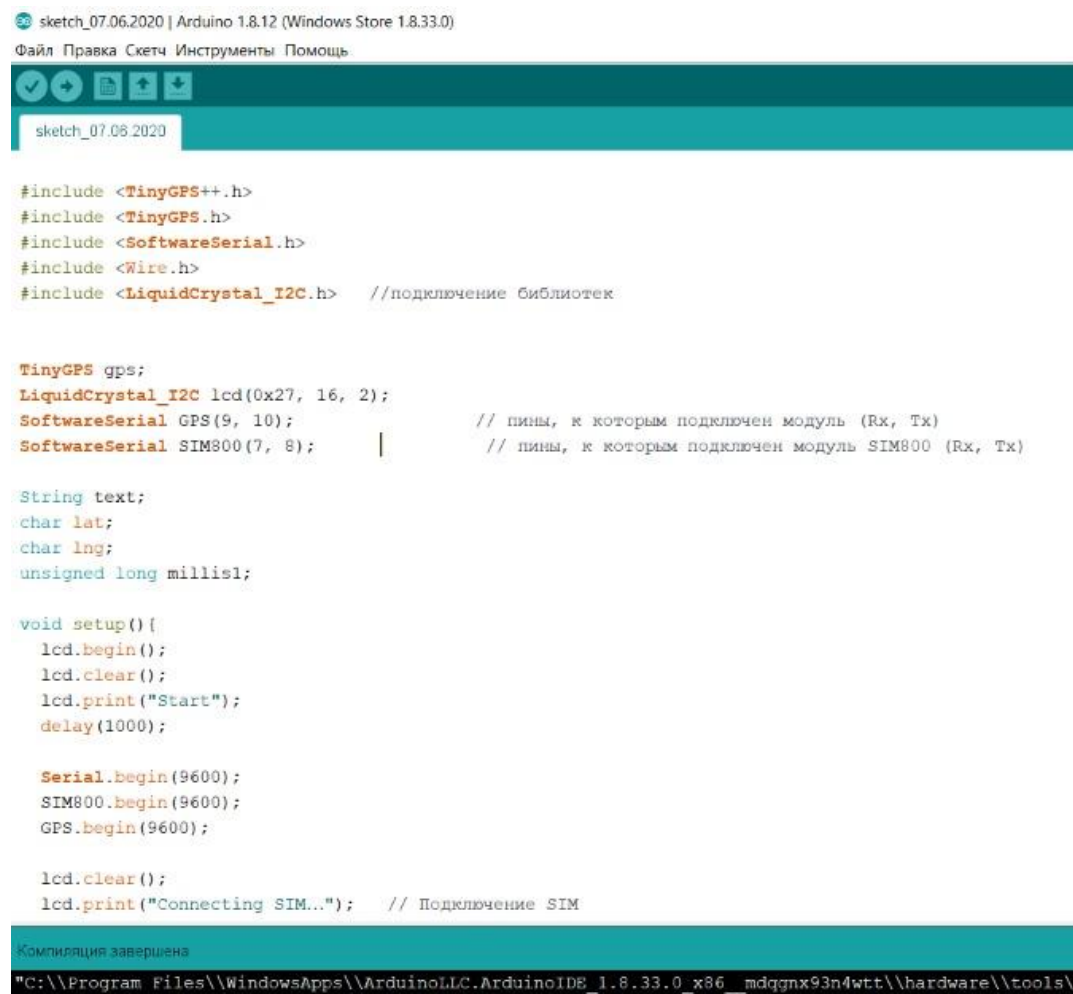


```

Initializing...
AT
OK
AT+CSQ
+CSQ: 24,0
OK
AT+CCID
88916699428089296181
OK
AT+CREG?
+CREG: 0,1
OK
  
```

Autoscroll Both NL & CR 9600 baud

Figure 3.5 – Responses of GSM module on AT-commands



```

sketch_07.06.2020 | Arduino 1.8.12 (Windows Store 1.8.33.0)
Файл Правка Скетч Инструменты Помощь

sketch_07.06.2020

#include <TinyGPS++.h>
#include <TinyGPS.h>
#include <SoftwareSerial.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h> //подключение библиотек

TinyGPS gps;
LiquidCrystal_I2C lcd(0x27, 16, 2);
SoftwareSerial GPS(9, 10); // пины, к которым подключен модуль (Rx, Tx)
SoftwareSerial SIM800(7, 8); // пины, к которым подключен модуль SIM800 (Rx, Tx)

String text;
char lat;
char lng;
unsigned long millis1;

void setup() {
  lcd.begin();
  lcd.clear();
  lcd.print("Start");
  delay(1000);

  Serial.begin(9600);
  SIM800.begin(9600);
  GPS.begin(9600);

  lcd.clear();
  lcd.print("Connecting SIM..."); // Подключение SIM
}

Компиляция завершена
"C:\Program Files\WindowsApps\ArduinoLLC.ArduinoIDE_1.8.33.0_x86__mdqgnx93n4wt\hardware\tools\
  
```

Figure 3.6 - Program code

```

sketch_07.06.2020
lcd.print("Connecting SIM..."); // Подключение SIM
delay(1000);
if (SIM800.println("AT") == "OK"){
    lcd.clear();
    lcd.print("SIM Connected");
}

lcd.clear();
lcd.print("Waiting for gps");
lcd.setCursor(0, 1); // Выбор второй строки
lcd.print("connection...");
}

void loop(){
    bool pressed = true;
    bool newData = false;
    unsigned long chars;
    unsigned short sentences, failed;

    while (Serial.available())
    {
        char c = Serial.read();
        //Serial.print(c);
        if (gps.encode(c))
            newData = true;
    }

    if (newData) //If newData is true
    {
        float flat, flon;

```

Figure 3.7 - Program code

Then figure 3.8 demonstrate that we check using “if” condition is device is turned on for more than 5 seconds. If it is not we just show the coordinates of the user on our display. Else if time is more than 5 seconds device sends SMS to the defined number. Using this condition our device will send SMS with location of the user every 5 seconds. That kind of duration was setted to check the device for correctness. Actually, it will be changed by 30 minutes.

```

sketch_07.06.2020
float flat, flon;
if (!(millis()-millis1 > 5000)) {
    lcd.clear();
    unsigned long age;
    gps.f_get_position(&flat, &flon, &age);
    lcd.print("Lat= ");
    lcd.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
    lcd.setCursor(0,1);
    lcd.print("Lon= ");
    lcd.print(flton == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
    delay(1000);
} else if (millis()-millis1 > 5000) {
    lcd.clear();
    gps.f_get_position(&flat, &flon);
    lcd.print("SOS!");
    lcd.setCursor(0,1);
    lcd.print("Sending location");
    SIM800.print("AT+CMGF=1\r");
    delay(400);
    SIM800.println("AT + CMGS = \"+77072529066\""); // recipient's mobile number with
    delay(300);
    SIM800.print("Latitude :");
    SIM800.println(flat, 6);
    SIM800.print("Longitude:");
    SIM800.println(flton, 6);
    SIM800.println((char)26); // End AT command with a ^Z, ASCII code 26
    millis1 = millis();
}
}

```

Figure 3.8 - Program code

4 Life safety

4.1 Analysis of working conditions in the production room (office)

The employees of the production and technical department are at their workplaces equipped with electronic computing machines, during the entire working day. In the process of operation, the user and the computer form a system of interaction between man, machine and the environment. Based on this interaction system, it is possible to identify dangerous and harmful factors affecting the computer user. The following physical factors can negatively affect an office employee: air temperature, dustiness and gas contamination, air humidity, insufficient illumination of the workplace, noise levels that exceed permissible standards, and increased levels of electromagnetic fields and radiation. Chemically dangerous factors include the occurrence, as a result of air ionization during computer operation, of active particles, as well as the appearance of harmful chemical products of combustion in the air when a fire occurs in the office. Psychophysical factors, which include neuro-emotional overload, mental stress, overstrain of the visual apparatus, can also influence an employee.

Irrational designs and the location of the elements of the workplace necessitate the maintenance of a forced working posture. Long-term discomfort in conditions of hypokinesia causes increased positonic muscle tension and causes the development of general fatigue and decreased performance.

When organizing a workplace, anthropometric data of operators are taken into account, and appropriate placement of equipment elements is provided, depending on the nature of the work performed, based on modern ergonomic requirements. The design of working furniture (tables, chairs) allows individual adjustment according to the height of the worker, and create a comfortable pose. Frequently used work items and controls should be located in the optimal working area.

When periodically monitoring the screen, it is recommended to arrange the hardware elements so that the screen is on the right, the keyboard is opposite the right shoulder, and documents are in the center of the viewing angle. When working constantly, the screen should be located in the center of the field of view, documents on the left of the table or a special stand [17].

The optimal height of the screen location corresponds to the direction of the operator's view in the sector of 30-40 degrees relative to the horizontal. The distance from the eyes to the screen is 60-80 cm.

The display panel is placed on a stand; the height of the keyboard in relation to the floor was 65-72 cm. The angle of the keyboard is 15°.

The desktop has a rigid structure. The plane of the table corresponds to the size of the documents; it is 160x90 cm.

The table plane, as well as the operator's seat, is adjustable in height.

The height of the table plane must be adjusted in the range of 65-85 cm. In this case, the height from the horizontal line of sight to the working surface of the table with a straightened working position of 40-45 cm.

The surface of the table should be matte (gray, green) and easy to clean. The corners and the front upper edge of the board are rounded.

The height of the seat from the floor can be adjusted within 42-55 cm. At the request of the operator, a footrest with a size of 40-30-15 cm and a tilt angle of 0-20 degrees with a non-slip coating and movable on the floor is installed (figure 4.1).

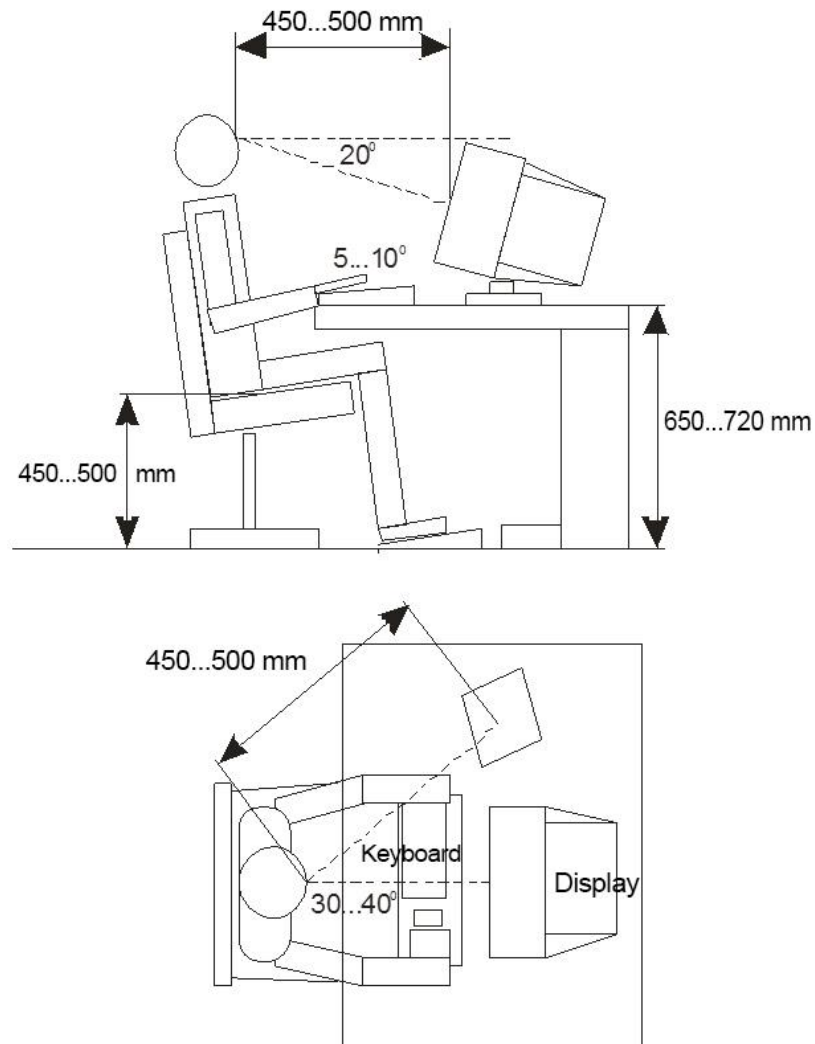


Figure 4.1 - Sketch of the placement of operator equipment

Insufficient illumination of the workplace leads to eye strain, weakens attention, and leads to premature fatigue. At the same time, excessively bright lighting causes blinding, irritation and pain in the eyes. These reasons may lead to occupational diseases of employees.

Properly designed and high-quality production lighting has a positive impact on office employees. According to building codes and premises, a room with a personal computer must have natural and artificial lighting.

The intensity of the work process can cause deviations in the state of health of various organs and systems of the employee. Therefore, it is important to

monitor the state of the indicator of labor intensity in the workplace, to prevent deviations in the state of health and the development of occupational diseases.

In addition, to ensure comfortable conditions, organizational methods are used (rational organization of work depending on the time of the year and day, alternation of work and rest), and technical equipment (ventilation, air conditioning, heating system).

The rational mode of work and rest of workers provides for strict adherence to regulated breaks. The main break is a lunch break. Additionally, two or three regulated breaks of 10 minutes each can be introduced: two breaks - with an 8-hour working day. For an 8-hour shift with a lunch break after 4 hours of work, additional regulated breaks must be entered 3 hours after the start of work and 2 hours before it ends. The number of working hours per week should not exceed 40 [18].

Air conditioning provides the best indoor climate and working conditions for accurate and sensitive equipment.

In conclusion, this chapter outlined the requirements for the workplace of an engineer. Created conditions should ensure comfortable work. Based on the literature on this task, the system was selected and the optimal lighting of the production room was calculated, and ventilation and noise were calculated.

To increase the operability of the engineer, it is necessary to try to fulfill all the conditions for the organization of the workplace.

4.2 Plan of office

Working conditions are a set of factors of the working environment that affect human health and performance in the labor process.

Favorable working conditions contribute, on the one hand, to preserving the health of workers, improving their labor skills, and on the other, increasing working capacity and labor productivity.

Working conditions should be comfortable and exclude the preconditions for the occurrence of injuries and occupational diseases.

The office is located on the 2nd floor of a five-story building, with windows facing the North and the West. The dimension of the room is 6x5 m; the total area of the room is 30m² (figure 4.2). The size of the windows is 4*1.80*1.50 = 10.8m; all windows start a meter from the floor.

In the office there are 5 workplaces of software engineers with all the adjacent equipment. Room area $S = 6 \times 5 = 30\text{m}^2$, Volume - $V_{\text{contr}} = 30 \times 3 = 90\text{m}^3$. Therefore, per person has an area of $30/5 = 6\text{m}^2$ and a volume of $90/5 = 18\text{m}^3$.

This is more than the minimum area and volume per employee set by the norms (volume - at least 15 m³, area - at least 4.5 m²).

Indoors are:

- 7 workstations;
- 3 laser printers;
- 2 scanners.

It is assumed that 5 employees will work in the room during the daytime: a system administrator, 3 programmers and a department head.

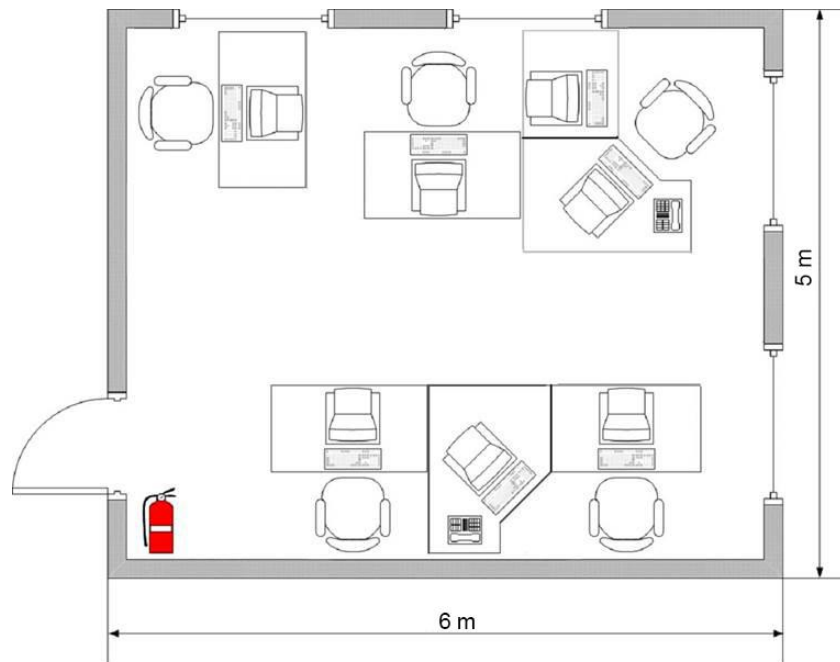


Figure 4.2 – Working room plan

4.3 Calculation of artificial lighting using the spot method

For artificial lighting of the room should be used mainly fluorescent lamps. The most acceptable are white and warm – white fluorescent lamps.

Because, they have high light output, long service life, ability to have a different spectral composition of light, slight heating of the tube surface, relatively low brightness.

According to spot method, for round-symmetric point emitters (incandescent lamps and mercury arc lamp), it is assumed that the luminous flux of the lamp (or the total luminous flux of the lamp) in each lamp is equal to 1000 lm. The illumination created by such a lamp is called conditional. The value of conditional illumination depends on the light distribution of the lamp and the geometric dimensions: the distance from the point to the projection of the illuminating lamp (α) and the height of the lamp above the level of the illuminated surface (h) [19].

Required:

Calculate the total lighting of the working room 6 m long, 5 m wide, 3.2 m high with a whitewashed ceiling, light walls with unfinished windows. The working room is in the city of Almaty, i.e. in the IV time zone. Normalized illumination is 400 Lux. The factor of safety. The height of the lamp suspension above the working surface $h = 3.2 - 0.75 - 0.25 = 2.2$ m. the illumination scheme is shown in figure 4.3.

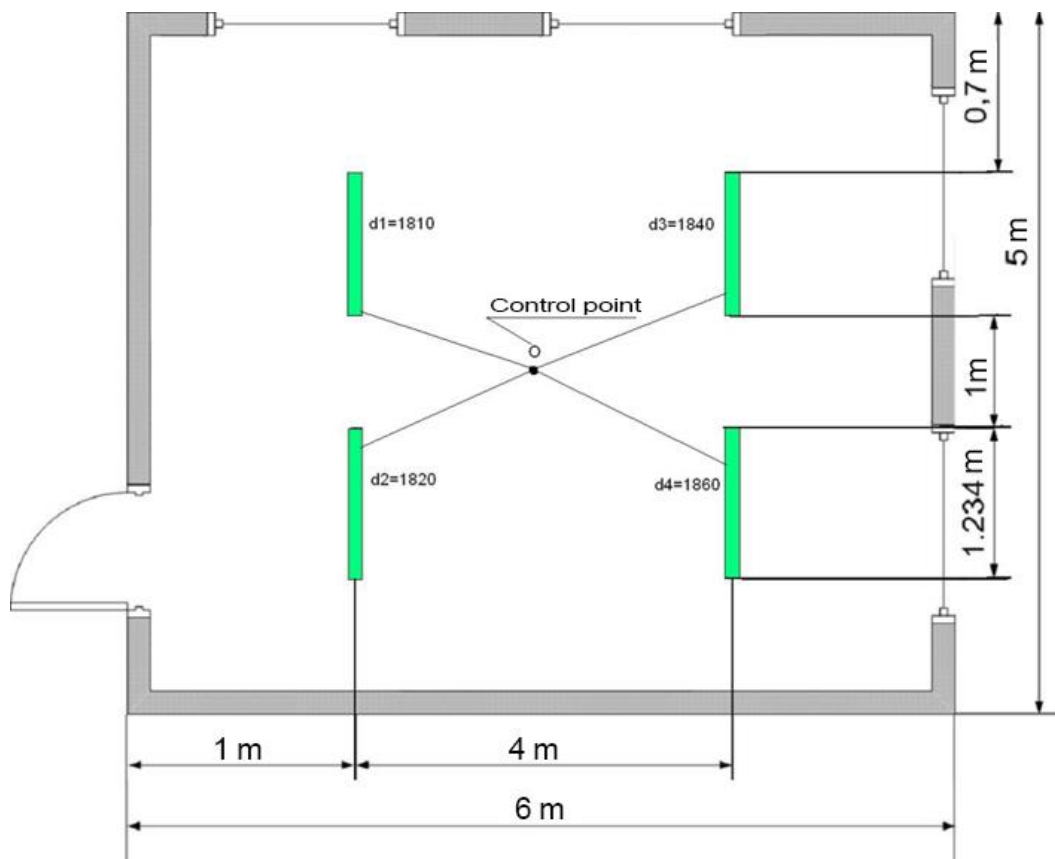


Figure 4.3 – Illumination calculation scheme

We outline the control point O. Find the distance from this point to each lamp and then, from the spatial isolux chart, we find the illumination of each lamp.

The first lamp:

$d_1=1810$ m;

$E_1=10$ lx;

The second lamp:

$d_2=1.820$ m;

$E_2=20$ lx;

The third lamp:

$d_3=1.1840$ m;

$E_3=20$ lx;

The forth lamp:

$d_4=1860$ m;

$E_4=15$ lx;

The total illumination from all the lamps at the control point O:

$$\sum E_0 = E_1 + E_2 + E_3 + E_4, \quad (4.1)$$

$$\sum E_0 = 10 + 20 + 20 + 15 = 65 \text{ lx}$$

The luminous flux is calculated by the formula:

$$\phi = \frac{1000 \cdot E \cdot k_z}{\mu \cdot \sum E_0} \quad (4.2)$$

where μ is the coefficient that takes into account the action of "remote"/ enameled direct light lamps (1.1-1.2 is accepted);

E - normalized illumination of the room.

$$\phi = \frac{1000 \cdot 400 \cdot 1.5}{1.2 \cdot 65} = \frac{600000}{78} = 7692 \text{ lm};$$

Consequently, for illumination of the workplace, general lighting is sufficient, in which the workplace is illuminated by two lamps, each lamp has two lamps with a luminous flux of radiation of 1923 lm each.

4.4 Calculation of the time of evacuation during an emergency.

The estimated time of evacuation of people from rooms and buildings is established by calculating the time of movement of one or more human flows through evacuation exits from the most remote places of people.

When calculating the entire path of movement of the human flow is divided into sections (passage, corridor, doorway, flight of stairs, vestibule) of length and width. The initial sections are passageways between workstations, equipment, rows of chairs, etc.

The estimated time of evacuation of people (t_p) should be defined as the sum of the time of movement of the human flow over individual sections of the path t_i (according to the formula 4.3)

$$t_p = t_1 + t_2 + t_3 + \dots + t_i \quad (4.3)$$

where t_1 - the time of movement of the human flow in the first (initial) section, min;

t_2, t_3, \dots, t_i - time of movement of the human flow on each of the following after the first section of the path min.

The movement time of the human flow along the first section of the path (t_1), min, is calculated by the formula

$$t_1 = \frac{l_1}{v_1} \quad (4.4)$$

where l_1 is the length of the first section of the path, m;

v_1 , - the value of the speed of human flow along a horizontal path in the first section, is determined by the table 1 depending on the density D, m/ min.

The density of human flow (D_1) in the first section of the path, m^2 / m^2 , calculated by the formula 4.5

$$D_1 = \frac{N_1}{l_1 b_1} \quad (4.5)$$

where N_1 - the number of people in the first section, people .;
 f is the average area of the horizontal projection of a person, taken equal to, m^2 8,

adult in home clothes - 0,1

adult in winter clothes - 0,125

teenager - 0.07

b_1 , is the width of the first section of the path, m.

The speed v_1 of the movement of the human flow in the sections of the path following the first is taken according to table 1, depending on the value of the intensity of human flow along each of these sections of the track, which is calculated for all sections of the track, including for doorways, according to the formula:

$$q_i = \frac{q_{i-1} b_{i-1}}{b_i} \quad (4.6)$$

where b_i , b_{i-1} - the width of the considered i and the preceding section of the path, m;

q_i , q_{i-1} are the values of the intensity of the movement of the human flow along the considered i and previous sections of the path, m / min, the value of the intensity of the movement of the human stream on the first section of the path ($q = q_{i-1}$), determined by the table 5.1 according to the value of D_1 established by the formula 5.6 [20].

Table 4.1 - Traffic intensity value

Density of a stream D , m^2/m^2	Horizontal way		Doorway Intensity, q , m/min	Stairs down		Stairs up	
	Speed v , m/min	Intensity q , m/min		Speed v , m/min	Intensity q , m/min	Speed v , m/min	Intensity q , m/min
0,01	100	1	1	100	1	60	0,6
0,05	100	5	5	100	5	60	3
0,1	80	8	8,7	95	9,5	53	5,3
0,2	60	12	13,4	68	13,6	40	8
0,3	47	14,1	16,5	52	15,6	32	9,6
0,4	40	16	18,4	40	16	26	10,4
0,5	33	16,5	19,6	31	15,6	22	11
0,6	27	16,2	19	24	14,4	18	10,6
0,7	23	16,1	18,5	18	12,6	15	10,5
0,8	19	15,2	17,3	13	10,4	13	10,4
0,9 and more	15	13,5	8,5	8	7,2	11	9,9

Input parameters:
 $t_0 := 20$ - initial room temperature, °C;
 $Q := 16.7$ - net calorific value, MJ·kg⁻¹
 $C_p := 0.001068$ - specific isobaric heat capacity of gas MJ / kgK;
 $\phi := 0.6$ - heat loss coefficient;
 $\eta := 0.95$ - combustion factor;
 $V := 90$ - free space, m³;
 $\alpha := 0.3$ - coefficient of reflection of objects on escape routes;
 $E := 65$ - initial illumination, lx;
 $l_{ext} := 20$ - extreme range of visibility in smoke, m;
 $D_m := 60.6$ - smoke generating ability of burning material, Np·m²·kg⁻¹;
 $L_{CO_2} := 0.879$ - specific yield of toxic gases during the combustion of 1 kg of material, kg·kg⁻¹;
 $L_{CO} := 0.0626$;
 $L_{HCl} := 0.0037$;
 $X_{HCl} := 23 \cdot 10^{-6}$ - maximum allowable toxic gas content in the room, kg·m⁻³;
 $(X_{CO_2} = 0,11 \text{ кг·м}^{-3}; X_{CO} = 1,16 \cdot 10^{-3} \text{ кг·м}^{-3}; X_{HCL} = 23 \cdot 10^{-6} \text{ кг·м}^{-3})$;
 $L_{O_2} := 2.56$ - specific oxygen consumption, kg·kg⁻¹;
 $h := 2.2$ - working area height, m;
 $H := 3.2$ - room height, m;
 $\Psi_f := 0.0244$ specific mass burn up rate, kg·m⁻²·с⁻¹ ;
 $v := 0.0071$ - linear flame velocity, m·с⁻¹ ;
 $n := 3$.

$$Z := \frac{h \cdot \exp(1.4 \cdot \frac{h}{H})}{H} \quad (4.7)$$

$$Z = 0.818$$

$$B := \frac{353 \cdot C_p \cdot V}{(1 - \phi) \cdot \eta \cdot Q} \quad (4.8)$$

$$B = 5.347 \cdot 10^3$$

$$A := 1.05 \cdot \Psi_f \cdot v^2 \quad (4.9)$$

$$A = 1.292 \cdot 10^{-6}$$

We calculate the necessary evacuation time:

$$t_{krt} := \left[\frac{B}{A} \cdot \ln \left[1 + \frac{(70 - t_0)}{(273 + t_0) \cdot Z} \right] \right]^{\frac{1}{n}} \quad (4.10)$$

$$t_{krt} := 0.868 \times 10^3 \quad t_{tnb} := t_{krt} \frac{0.8}{60} \quad t_{tnb} := 11.57 \quad (\text{minutes})$$

$$Ht_{kpv} := \left[\frac{B}{A} * \ln \left[\frac{1}{1 - \frac{V * \ln(1.05 * \alpha * E)}{l_{ext} * B * D_m * Z}} \right] \right]^{\frac{1}{n}} \quad (4.11)$$

$$t_{kpv} := 0.602 \times 10^3 \quad t_{tnb} := t_{kpv} \frac{0.8}{60} \quad t_{tnb} := 8.02 \quad (\text{minutes})$$

$$t_{kp0_2} := \left[\frac{B}{A} * \ln \left[\frac{1}{1 - \frac{0.044}{\left(B * \frac{LO_2}{V} + 0.27 \right) * Z}} \right] \right]^{\frac{1}{n}} \quad (4.12)$$

$$t_{kp0_2} := 0.826 \times 10^3 \quad t_{tnb} := t_{kp0_2} \frac{0.8}{60} \quad t_{tnb} := 11.01 \quad (\text{minutes})$$

$$t_{kpc0_2} := \left[\frac{B}{A} * \ln \left[\frac{1}{\left(1 - \frac{V * X_{CO_2}}{B * L_{CO_2} * Z} \right)} \right] \right]^{\frac{1}{n}} \quad (4.13)$$

$$t_{kpc0_2} := 1.593 \times 10^3 \text{ i under the sign of the logarithm is a negative number}$$

$$t_{kpc0} := \left[\frac{B}{A} * \ln \left[\frac{1}{\left(1 - \frac{V * X_{CO}}{B * L_{CO} * Z} \right)} \right] \right]^{\frac{1}{n}} \quad (4.14)$$

$$t_{kpc0} := 2.465 \times 10^3 \text{ i under the sign of the logarithm is a negative number}$$

$$t_{kphcl} := \left[\frac{B}{A} * \ln \left[\frac{1}{\left(1 - \frac{V * X_{hcl}}{B * L_{hcl} * Z} \right)} \right] \right]^{\frac{1}{n}} \quad (4.15)$$

$$t_{kpc0} := 2.961 \times 10^3 \text{ i under the sign of the logarithm is a negative number}$$

As a result, the required evacuation time is 8.02 minutes.

Summary. The fifth chapter outlined the requirements for the workplace. These conditions should ensure the comfortable work of the engineer. Based on the materials studied, we have calculated of the optimal lighting of the production

room and evacuation time. The spot method makes it possible to determine the illumination at any point in the room. It allows you to calculate the luminous flux of a light source. You can also estimate the actual light distribution. The calculation of the evacuation time is carried out in order to determine the time values of the onset of fire hazards. This takes into account the size and layout of buildings. The timing is necessary so that people can freely leave the danger zone in the event of a fire.

To increase the working capacity and labor productivity, compliance with the conditions have great importance on the organization of the workplace. All these activities play an important role in maintaining health.

5 Feasibility study

The most important requirement for the content of the economic section of the thesis is to assess the economic, scientific, technical, environmental, social effectiveness of the developed information system and the implementation of the proposed IP or its individual subsystems for the subject area.

5.1 Information on the development

This project is a simple and effective way to track. This is protection for children, elderly relatives or the disabled when the family cannot contact this person. The target audience of the project is not only children, but also elderly people, people with disabilities, animals.

5.1.1 The need for development

According to statistics, several tens of millions of people disappear annually. 20% of all missing people are still not found.

Keeping your child safe is a top priority for any parent. Thanks to modern technologies, a child's sensor using GPS determines the coordinates of its location and transmits them to the observer's device by SMS.

5.1.2 Goals and objectives

Diploma work affects two aspects of life social and economic. Main task to study the state of development of robotics in law enforcement, also to assess the state of the problems of loss in Kazakhstan. Based on this problem develop a digital bracelet which help for navigation.

From an economic point of view, the project contributes to job creation, which will allow workers to receive a stable income. Also we justify the profitability and return on investment of the project. And obtain profits to further improve and expand services. The most important thing is the introduction of a domestic product on the market.

5.2 Financial plan

The purpose of this section is to predict the economic efficiency of the project based on an analysis of cash inflows and outflows. The financial plan is valid for a period of three years.

In table 5.2, you can see the quarterly investment plan for the production of the bracelet, which begins in the first quarter of 2021 and ends in the third quarter of 2023. In total, this financial plan covers 13 time periods (quarters).

5.2.1 Calculation of investment costs

Investment costs are the costs of fixed assets (equipment, buildings), as well as working capital, which must be produced to launch an investment project.

Investment costs are closely related to costs, costs, since any investment is the cost of funds for profit on a certain date. Investments in business are associated

with the acquisition of capital (financial or physical), which in the future will bring money. In practice, in this regard, they often talk about capital investments.

The payback period of an investment project is one of the key indicators of investment efficiency, by which it is possible to determine their feasibility. The payback period of an investment project can be calculated by net or discounted cash flow. The moment of project payback will be the transition from a negative value of cash flow to a positive one [21].

To calculate the discounted payback period, in other words, the calculation of the payback period of the investment project, it is necessary to prepare the initial data:

1) In the event that one person makes 3 copies a day, in a month he will produce 66 pcs, where the five-day work schedule is taken as the basis. For one quarter, this amount, at best, will be 198pcs. The market price of the goods is 10,000 tenge.

2) Initially, the headquarters will consist of two employees whose salary is estimated at 100,250 tenge.

3) Office space of 20 sq.m will cost 50,000 tenge, taking into account utilities.

4) 300,000 tenge will be spent on the purchase of equipment. Where it includes: buying a 3D printer to print the bracelet frame; purchase of working tools and initial material costs. For one quarterly period, 30,000 tenge will be spent on equipment maintenance and further replenishment of the material base.

5) "Costs of labor remuneration" includes expenses on remuneration of labor of all workers involved in the development of software (table 1). Individual income tax-42500 tenge.

Table 5.1 - The calculation of the basic salary of production personnel

Name	Decryption	Value (tenge)
Compulsory pension contributions	10% of (120000)	12000
Individual income tax	10% of (120000-12000-42500)	6550
Social tax	9.5% of (120000-12000-1200-3780)	6366
Social contributions	3.5% of (120000-12000)	3780
Compulsory Social Health Insurance	2% of (120000)	2400
Contributions to the compulsory social health insurance	1% of (120000)	1200
Salary		120000
Salary at the hands of the employee		100250

Continuation of table 5.1

Employer costs		132546
Employee taxes		19750
Employer taxes		12546

In table, you can see that employee's taxes are 19750 tenge and employee's taxes are 12546 tenge, overall equal to 32296 tenge per person.

For month: $32296 \times 2(\text{number of workers}) = 64,592$

For one quarter: $64,592 \times 3 = 193,776$

6) Net cash flow (NCF or fair value) is a key indicator of investment analysis that reflects the difference in cash flow over a given period of time. To calculate net cash flow we use the following formula:

$$CF_{\text{net}} = CF_0 + CF_i + CF_f \quad (5.1)$$

where, CF_0 - Cash flow from operating activities;

CF_i - Cash flow from investing activities;

CF_f - Cash flow from financing activities.

7) The discount rate is an estimated value that allows you to evaluate the profitability of future investments.

Cash flow discounting coefficient is a digital indicator, using which you can understand how much money you can get after a certain time, taking into account the time factor and possible risk.

8) Discounted cash flow (DCF) allows you to determine the real value of cash by calculating its value depending on expected income in future periods reduced to the current period. And have following formula:

$$DCF = \frac{CF_{\text{net}}}{r} \quad (5.2)$$

where r - discounting coefficient.

9) Discounted payback period (DPP) is the time period during which the investor will receive the same income reduced to the current period as in the case of investing financial capital in an alternative asset. The discounted payback period is determined by the formula:

$$DPP = \sum_{t=1}^n \frac{CF_t}{(1+r)^t} \geq I_0 \quad (5.3)$$

where, n is the number of periods;

CF_t - cash flow in period t ;

r - (discount coefficient);

I_0 - the value of the initial investment in the zero period.

Table 5.2 - Money movement budget of investment project

Name of article	I qtr 2021	II qtr 2021	III qtr 2021	IV qtr 2021	I qtr 2022	II qtr 2022	III qtr 2022	IV qtr 2022	I qtr 2023	II qtr 2023	III qtr 2023	IV qtr 2023	I qtr 2017
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Revenue	700 000	3 000 000	3 300 000	3 630 000	4 174 500	4 800 675	5 520 776	6 348 893	7 618 671	9 142 405	10 970 887	13 165 064	16 456 330
Operating expenses, including:	1 660 276	2 280 276	2 400 276	2 532 276	2 797 954	3 349 174	3 637 214	3 968 461	4 555 370	5 164 864	5 896 256	7 074 677	8 482 031
Purchase of raw materials for production	280 000	1 200 000	1 320 000	1 452 000	1 669 800	1 920 270	2 208 311	2 539 557	3 047 468	3 656 962	4 388 355	5 266 026	6 582 532
Staff costs	601 500	601 500	601 500	601 500	601 500	902 250	902 250	902 250	902 250	902 250	902 250	1 203 000	1 203 000
Maintenance and operation of buildings and premises	150 000	150 000	150 000	150 000	165 000	165 000	165 000	165 000	189 750	189 750	189 750	189 750	218 213
Equipment maintenance	330 000	30 000	30 000	30 000	33 000	33 000	33 000	33 000	37 950	37 950	37 950	37 950	43 643
Vehicle maintenance	75 000	75 000	75 000	75 000	82 500	82 500	82 500	82 500	94 875	94 875	94 875	94 875	109 106
Company maintenance	30 000	30 000	30 000	30 000	33 000	33 000	33 000	33 000	37 950	37 950	37 950	37 950	43 643
Taxes and fees	193 776	193 776	193 776	193 776	213 154	213 154	213 154	213 154	245 127	245 127	245 127	245 127	281 896
Cash flow from operating activities	-960 276	719 724	899 724	1 097 724	1 376 546	1 451 501	1 883 562	2 380 432	3 063 301	3 977 542	5 074 630	6 090 387	7 974 299

Continuation of table 5.2

Incomes from investment activities	0	0	0	0	0	0	0	0	0	0	0	0	0
Disposals from investment activities	2 000 000			0	0	0	0	0	0	0	0	0	0
Cash flow from investing activities	-2 000 000	0	0	0	0	0	0	0	0	0	0	0	0
Incomes from financial activities	2 000 000	0	0	0	0	0	0	0	0	0	0	0	0
Disposals from financial activities	97 778	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	110 000	2 000 000	0
Cash flow from financing activities	1 902 222	-110 000	-110 000	-110 000	-110 000	-110 000	-110 000	-110 000	-110 000	-110 000	-110 000	-2 000 000	0
Net cash flow, CF _{net}	-1 058 054	609 724	789 724	987 724	1 266 546	1 341 501	1 773 562	2 270 432	2 953 301	3 867 542	4 964 630	4 090 387	7 974 299
Discount rate	4,88%	4,88 %	4,88 %	4,88 %	4,88 %	4,88 %	4,88%	4,88 %	4,88 %	4,88 %	4,88%	4,88%	4,88%
Discount coefficient, r	1	1,049	1,100	1,154	1,210	1,269	1,331	1,396	1,464	1,536	1,611	1,689	1,772
Discounted Net Cash Flow	-1 058 054	581 349	717 931	856 144	1 046 733	1 057 084	1 332 503	1 626 425	2 017 144	2 518 651	3 082 645	2 421 612	4 501 284
Accumulated discounted net cash flow	-1 058 054	-476 705	241 226	1 097 370	2 144 102	3 201 186	4 533 690	6 160 115	8 177 259	10 695 910	13 778 555	16 200 167	20 701 450
Discount payback period, DPP			2,66										

5.2.2 Cost calculation

The cost of production (works, services) is the cost estimation of natural resources, raw materials, fuel, energy, fixed assets, labor resources, and other costs for its production and sale used in the production process of products (works, services).

The financial performance of enterprises, the rate of expanded reproduction, and the financial condition of business entities depend on the cost level.

Analysis of the cost of products, works and services is extremely important. Cost analysis allows you to identify trends in this indicator, the implementation of the plan by its level, to determine the influence of factors on its growth and on this basis to assess the work of the enterprise on the use of opportunities and establish reserves for reducing production costs. Reducing the cost of production for the enterprise is of great importance, because is one of the decisive sources of increasing savings for the purpose of expanding production and improving staff welfare.

The cost of production is expressed in cash the current costs of enterprises for the production and sale of products (works, services).

The cost of production is not only the most important economic category, but also a qualitative indicator, since it characterizes the level of use of all resources (variable and constant capital) at the disposal of the enterprise.

According to the degree of uniformity of costs, expenses are divided into elemental and complex.

Elemental (homogeneous) include expenses that cannot be divided into component parts (costs of raw materials, basic materials, depreciation of fixed assets).

Complex are called cost items that consist of several homogeneous costs (expenses for the maintenance and operation of equipment, general production, general economic, non-production expenses), which can be decomposed into primary elements [22].

To calculate the cost of goods, as an example, was taken II quarter of 2021.

According to the tabular data, it can be seen that 1,200,000 tenge was spent on raw materials and basic materials. This number is formed from the fact that if for the production of 300 pieces of goods per unit of goods, our expense will be 4000tenge. Also, the table shows the total operating expenses for a given period of time, which, according to my calculations, will be 2,280,276 tenge.

The total cost of 300 products is $2,280,276 / 300 = 7601$ tenge.

Manufacturer price for one product:

$$P = C + N \quad (5.4)$$

where C is the cost of the product;

N - net income.

$$P = 7601 + 7601 * 31\% * 100\% = 9958 \text{ tenge}$$

Including profit from the sale of one product = $7,601 * 31\% / 100\% = 2,357$ tenge.

5.2.3 Calculation of income from sales

Revenue is an economic category that reflects the monetary relations of suppliers and consumers.

The revenue indicator is the most important source that participates in the formation of own financial resources of any enterprises.

Revenue and profit are not equivalent concepts, since profit is revenue minus costs (expenses). Also, revenue and income are not equivalent, since income is revenue (turnover) minus cost.

Proceeds from the sale of goods (services) consist of cash or other property in money terms that are received or are to be received when selling goods (products, services, works) at prices and tariffs in accordance with the concluded agreement.

In table 1, revenue for the II quarter of 2021 amounted to 3,000,000 tenge. For the implementation of this volume, 2,280,276 will be spent. As a result, the cash flow is 719,724 tenge, of which 609,724 tenge is net cash flow.

Summary. In table 5.2 you can see that the investment project will pay off at the beginning of the III period of 2021 year. The amount of cash flow in the II quarter of 2021 is negative and equal to 476,705 tenge, and in the III quarter of 2021 positive – 241,226 tenge.

From the third quarter, the company will receive a steady profit. From this we can conclude that the company has every chance of success.

Conclusion

In the presented diploma work, a digital bracelet is developed with the ability to monitor location and alerts.

When analyzing existing prototypes, it was shown that a digital bracelet is more convenient and comfortable than its competitors. But also the available analogues are not in demand in the market, because some of them are expensive, and those with affordable prices have a huge number of errors and fail at a very fast pace.

Development is implemented using the Arduino Nano microcontroller. The main tasks of the bracelet: determining and transmitting the user's location via SMS using the GPS module NEO-6M and GSM / GPRS SIM800L.

For microcontroller firmware, Arduino IDE software was used. C++ was used as a programming language.

In the economic part of the work, a financial plan for the implementation of this bracelet was calculated. According to the calculations made, the production of a bracelet will require 2,000,000 tenge one-time costs. According to the results of calculating the economic part, the presented work is profitable and effective in all aspects of investment assessment and can be considered for implementation.

In the section of life safety, fire safety at the workplace, ergonomics of the workplace are studied, as well as the calculation of artificial lighting and ventilation systems.

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