MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN
Satbayev Kazakh National Technical University

Institute of industrial automation and digitalization named after A.Burkitbayev

Department of Electronics Telecommunications and Space Technologies

Nurzhan Aidana

Develop an automated control system for cattle feeding based on RFID technology

SENIOR THESIS

5B074600 - Space technique and technology

Almaty 2020

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APPROVED FOR DEFENSE
Head of Department ETaST
Master of technical sciences
___________ Syrgabaev I.
«__»___________2020 year.

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Done by : Nurzhan Aidana

Scientific adviser:
Ph.D.
_______E. Tashtay
“ ” ___________

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Develop an automated control system for cattle feeding based on RFID technology

Technical Task
for Senior Thesis defense

Student: Nurzhan Aidana

Theme: Develop an automated control system for cattle feeding based on RFID technology

Approved *by order of the Rector of the University No. 762 - b of January 27, 2020.*

Deadline for completion of the dissertation is *May 20, 2020.*

Initial data for the thesis: Requirements of international standards: ISO 11784 - Radio-frequency identification of animals. Information structure, ISO 11785 - Radio-frequency identification of animals. Technical concept, ISO / IEC 18000-1 - Radio communication interface (Part 1). General parameters of communication channels for the allowed frequency ranges, Satisfying the requirements of satellite communication systems.

The list of issues to be studied in the thesis:

a) Modern technologies for constructing RFID identification systems

b) Study of potential systems for remote control of feeding processes based on radio signals

c) Development of algorithms for the use of satellite communications for monitoring the quality of pastures

d) Calculate the reading range of RFID codes

Recommended general literature:

1. Kucheryavy AE Internet of Things // Telecommunications. 2013. No 1. S. 21-24.

2. Verzun N. A., Kolbanev M. O., Omelyan A. V. Introduction to infocommunication technologies and networks Future Networks. SPb .: SPbGEU. 2016.51 c.

3. Teltevskaya V.A., Zelenov V.V., Shustov N.I., Kulik V.A., Kirichek R.V., Makolkina M.A. Identification of Internet of Things Using Augmented Reality Technologies // Information Technologies and Telecommunications. 2017.Vol. 5. No 4. P. 64–70.

4. Verzun N. A., Kolbanev M. O., Shamin A. A. Energy efficiency of interaction in wireless sensor networks // Information Technologies and Telecommunications. 2017.Vol. 5. No 1. P. 88–96.

5. Bruce R. Elbert. The Satellite Communication Applications Handbook. — Artech House, Inc., 2004. — ISBN 1-58053-490-2.

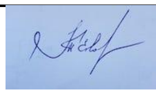
SCHEDULE

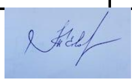
preparation of the master's thesis

Name of sections, list of issues being developed	Submission deadline	Note
1. Study and analysis of modern technology for building RFID identification systems	1.09.2019-01.03.2020	
2. Study of potential systems for remote control of feeding processes based on radio signals	1.01.20-01.04.2020	
3. Development of satellite communications application algorithms for monitoring pasture quality	01.04.2020-09.05.2020	

Signatures

Of the consultants and standard controller for the completed thesis (project) with an indication of the relevant sections of the work (project)

Name of sections	Consultants I. O. F. (academic degree, title)	Date of signing	Signature
Main part	Candidate of Technical Sciences Tashtay E.T.	05.05.2020	
Norm controller	Dr. PhD Senior - lecturer Smaylov N.K..		

Scientific adviser  ________________ E. Tashtay

The task was accepted by ____________________ Nurzhan Aidana

Date “_27_” __05____ 2020 year.

АҢДАТПА

Диссертация 6 негізгі бөлімнен тұрады: бірінші бөлімде RFID технологиясын, жұмыс процесстерін және қосымшалары туралы. Екінші бөлімде халықаралық технологиялық стандарттар сипатталған. Сонымен қатар ,үш негізгі стандарттар қарастырылды: ISO / IEC 18000-2, ISO 11784 және ISO 11785. Үшінші бөлім радио сигналдарға негізделген тамақтандыру процесін қашықтықтан басқарудың ықтимал жүйелерін зерттеуге арналған. Төртінші бөлімде RFID жүйесінің жабдықтарын орнатуды ұйымдастыру және бағдарламалық өнімді орнату бойынша жұмыстың басталуы сипатталған. Бесінші бөлімде жануарларды бақылаудың ГАЖ қарапайым жүйелері, ал соңғы бөлімінде Антенна Гейннің оқу полигонына әсері алгоритмі жасалады.

АННОТАЦИЯ

Диссертация состоит из 6 основных частей: Первая часть посвящена внедрению RFID-технологий, меток, рабочих процессов и приложений. Вторая часть описывает международные стандарты технологии. Кроме того, рассматриваются три стандарта: ИСО / МЭК 18000-2, ИСО 11784 и ИСО 11785. Третья часть посвящена исследованию потенциальных систем дистанционного управления процессом кормления на основе радиосигналов. Четвертая часть описывает организацию установки оборудования системы RFID и начало работы по настройке программного продукта. В пятой части разрабатываются простые системы мониторинга животных ГИС, а в последней - алгоритм влияния усиления антенны на диапазон считывания.

ANNOTATION

The thesis consists of 6 main parts: the first part deals with the introduction of RFID-technology, tags, working process, and applications. The second part describes the international standards of the technology. In addition, three standards are considered: ISO/IEC 18000-2, ISO 11784 and ISO 11785.The third part describes the research on potential systems for remote control of feeding process based on radio signals. The fourth part describes the Organization of the installation of RFID system equipment and the beginning of work on setting up a software product. The fifth part develop the simple GIS animal monitoring systems and last part develop an algorithm of the effect of Antenna Gain on Read Range.

CONTENT

1. RFID

The beginning of radio frequency identification technology could be seen retrospectively in the 1940s, when laboratory research focuses on reflective power communication. It started to be used for business reasons in the 1980s, primarily in the truck and rail factories. These utility programs manage and track fixed assets using, for example, battery-powered radio frequency identification of active tags and patenting devices.

The price of radio frequency identification technology has been reduced by using passive tags, which is non battery powered and can substitute barcodes as a way of collecting data. Due to this, radio frequency identification technology has been extended to various commercial applications.

Nowadays, barcodes are being widespread used, from the vessel level to the person level, but the main limitations for this technology is that all the items has the unique inventory unit (SKU), which has same bar codes. In addition, items can be hard to pursue when need to be recalled for quantity or safety reasons. By comparison, radio frequency identification can be used to classify items level objects, work in harsh environments, where humidity and dust can affect other types of items, read radio frequency identification without a reader or scanner's direct line of sight. You can even read several tags at the same time, so you can program the tags with ease. Unlike the 19-bit barcoding technology, tags can carry information more than 60 bits, allowing RFID stock additional information like history of movement, expiry data, location and ambient conditions such as humidity and temperature.

1.1. Radio frequency identification literature review

Because of the radio frequency identification technology is still in its infant stages, the RFID studies is distributed and limited. I recently checked the literature accessible on the radio frequency identification technology.

1999	Brewer and Sloan	Find RFID as such an advanced production monitoring system to help logistics design and implementation.
1999	Jansen and Krabs	Think that RFID will monitor reusable products.
2000	Smaros and Holmstrotrom	Find RFID as a form of data analysis in model refrigerators to establish a modern kind of digital food service.
2002	Ka Rkka Inin and Holmstro	Assume that RFID is a wireless commodity recognition system that will increase the performance of goods processing, configuration and knowledge exchange in the production process.
2003	McFarlane and Sheffi	Used ship / receiver products (S / R) to analyze the layout of four specific logistics processes (storage,

	Ka kka¨inen	storage, receipt and in-facility operational activities) and explore ways to develop each mechanism using cheaper RFID. British supermarkets Sainsbury's RFID research addressed the application of RFID to increase the future performance of supply chain limited shelf life goods.
2004	Jones et al. Lapide Hosaka Janz et al. Srivastava	Described the benefits and drawbacks of RFID adoption for UK stores. Implemented advantages of RFID prediction, like the increased forecasting accuracy, more effective point-of - sale information gathered by sellers, and better tracking of products on the market or not. Modelled clinic living room and nursing room environments to automatically test the alignment of patients and their medical equipment and. medical errors; Technical and interpersonal problems posed in the introduction of the RFID medical management program at the Elvis Presley Memorial trauma center in Memphis . Describes the benefits, current applications and barriers to the implementation of RFID in supply chain management. Discuss the advantages, emerging implementations and challenges to the introduction of RFID in the management of inventory.
2005	Visich, etc. Angeles	RFID system has been applied into the closed-loop supply chain, and the use of RFID has been analyzed in different price recovery schemes and how to use it. Gives recommendations on RFID deployment in the supply chain and analyzes integration issues.
2006	Li and Visich	Read the related literature and addressed the benefits of RFID in the production process, the effects of the production process, the difficulties of deployment and the subsequent RFID techniques.

Figure 1.1-Brief overview of accessible RFID research

1.2 Radio frequency identification tags

Radio frequency identification tags can indeed be passive, semi-passive or active. The active tag can convey signals to the reader up to 10 meters because of the tag includes a charge, which can be powered. In contrast, passive tags do not generate batteries, therefore they are much less expensive than other tags, also its read out from the electric field of the user. The last type of the tag is semi-passive, controlled by electromagnetic radiation generated by a reader and an inner charger. Also this type of tags could be used for measuring environmental different factors, including fresh produce temperature and vessel moisture.

Tags could be with chips or not. Tags with chip consist of a computer chip that stores information, and combining element including a cylinder transmitter, which connects mostly through radio frequency communication, even though chip-free tags do not involve advanced sensor chips. The chip-free tags can be used for protection systems.

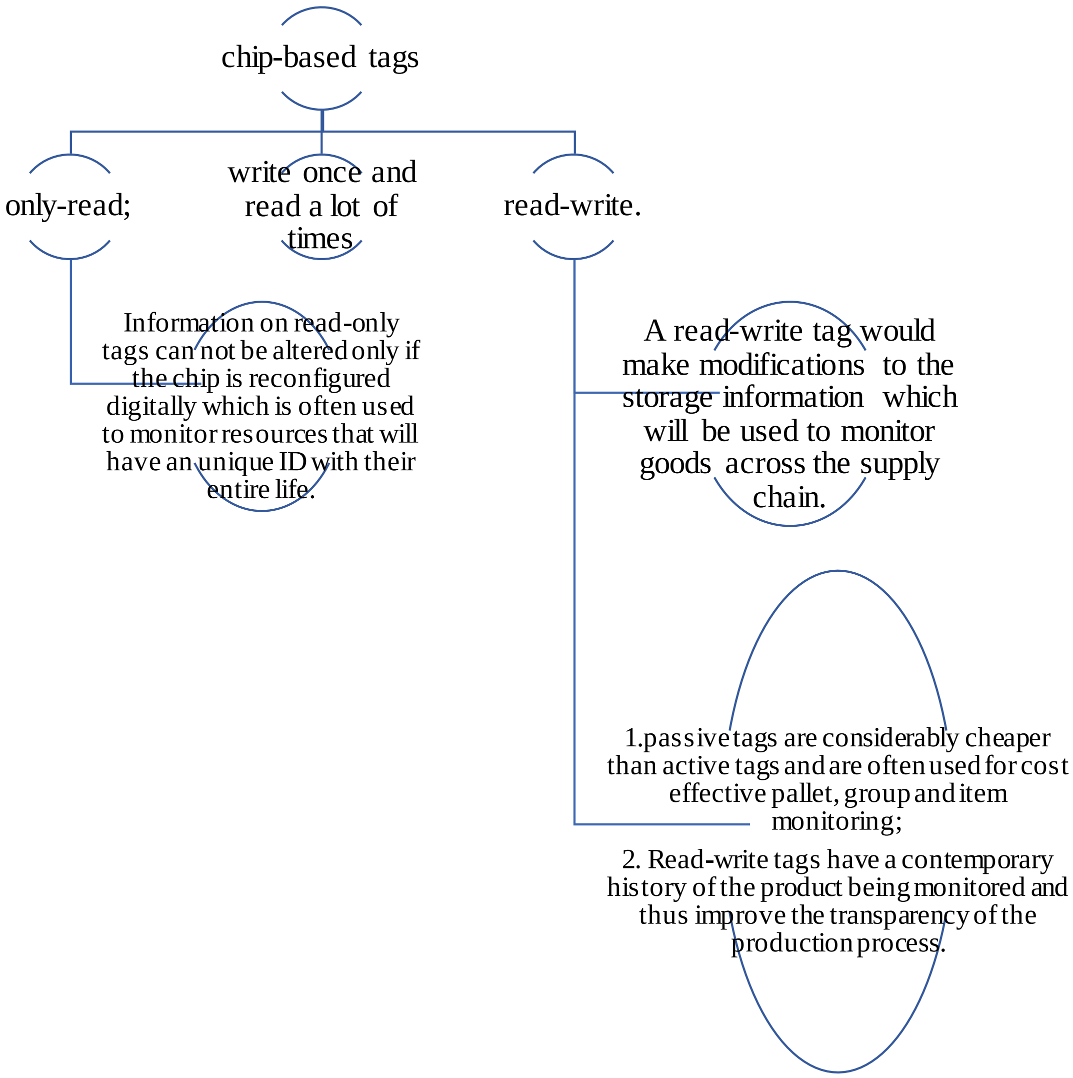


Figure 1.2-Types of chip-based tags

1.3 How radio frequency identification systems work

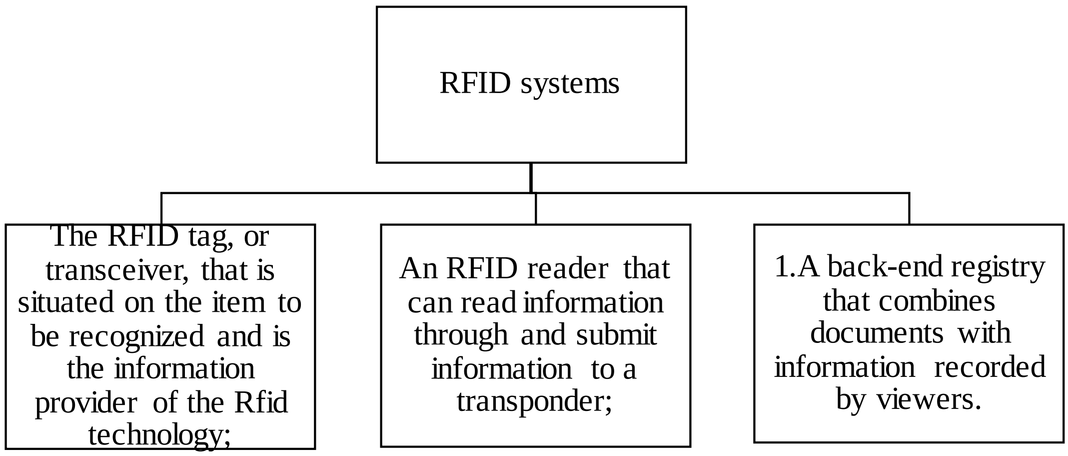
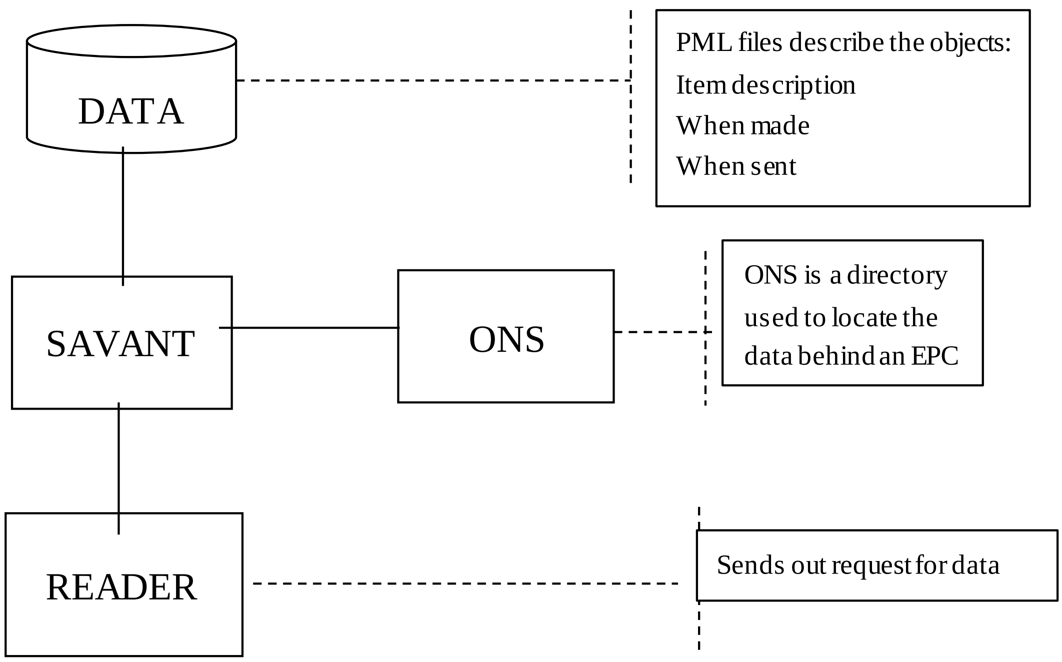


Figure 1.3- Components of RFID systems

Following figure shows the functioning of the Rfid technology. Initially, the tag adds a unique identifier, as in the computerized Product Code, to the computer chip. The computer chip also can person controlling further than simple identification, including sensing devices, see / compose processing, authentication, and connect. While ingredients / contexts / containers join a vast array of scans of the reader, the reader transmits electromagnetic radiation which establish a gravitational flux while they are "combined" to the RFID tag transmitter. The tag takes power out of the gravitational flux, afterwards and using it to move the computer chip interface. Based on its recognition or modified application, the microchip then stimulates the signal received and sends or represents the rf signal. The narrator, in effect, modulates the screen, transmits the data stored in the transponder, contains the data according to the reader's device, works on it, or transmits the data to the host via the usage of the contact channel.



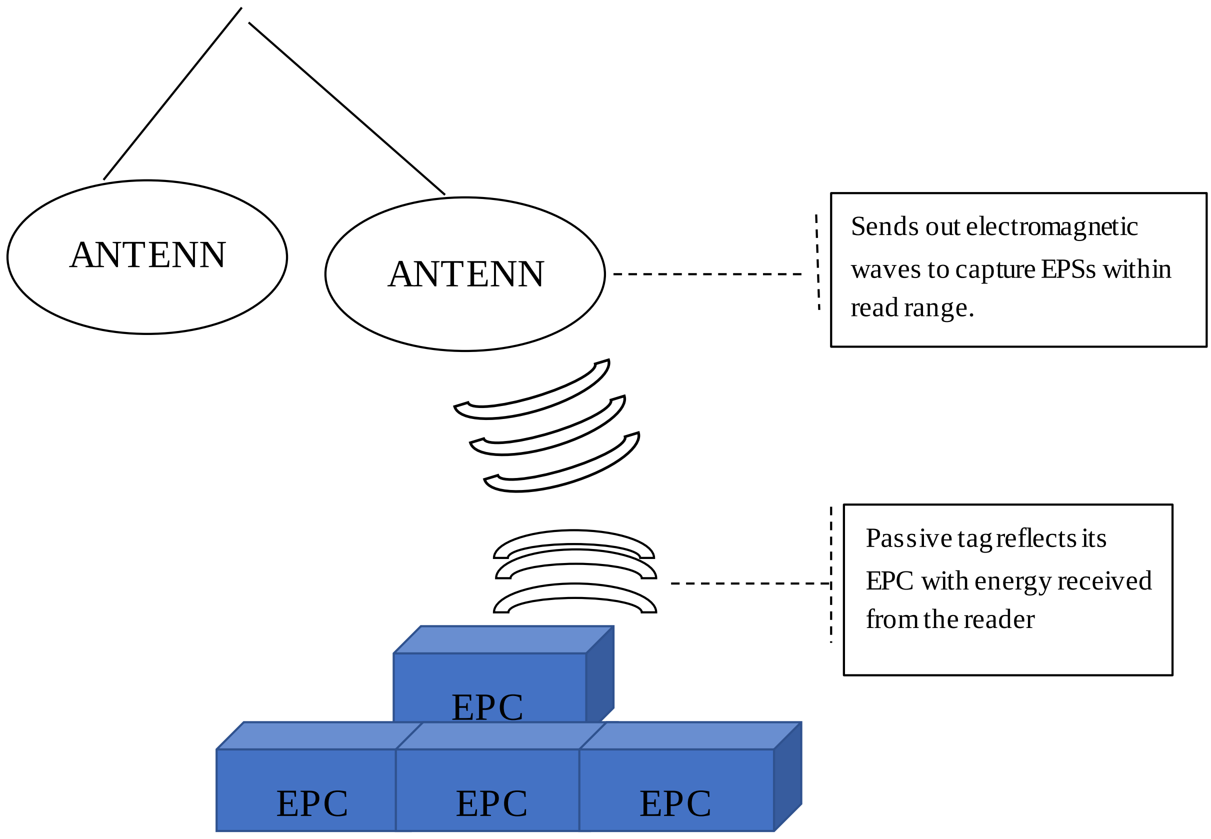


Figure 1.4-A radio frequency identification system

1.4 Radio frequency identification applications

RFID tags were used in a number of other purposes, from plant, livestock tags to suitcases and togae. Disneyland, a Danish theme park, offers family members the choice of monitoring their children with wireless tags using RFID tags. A wearable device can monitor a missing child to his or her destination within five meters. Farm animals monitoring has been among RFID's most effective applications. RFID tags are attached to more than forty million animals worldwide. RFID tags are sewn into all clothing at the star city casino in Sydney, Australia to control the eighty thousand items worn by employees. Reusable tags almost eliminate the difference between missing clothes and cleaning charges. Airline plans to set up recyclable tags to identify missing cargo, costing the airline hundreds of millions of dollars per year.

2.International standards for RFID technology

The International Organization for Standardization (ISO) is a system of national standardization organizations. ISO research is conducted from Geneva, Switzerland. While ISO is a non-profit organization, all of its member organizations are either part of national policy systems or have their own government orders to establish standards, rendering ISO more regional and more political. and government-friendly organization than EPC global.

The International Organization for Standardization unites the needs of the government and industry, concentrating its projects on the establishment of guidelines and the performance of the agreement of all parties concerned with their adoption.

ISO 11784, 11785 Includes the form of the radio frequency recognition code for species. The airborne coupling of the transceiver and the advanced transponder design used for animal recognition (subject to ISO 11784-5 compatibility conditions) are described in the ISO 14223 standard.

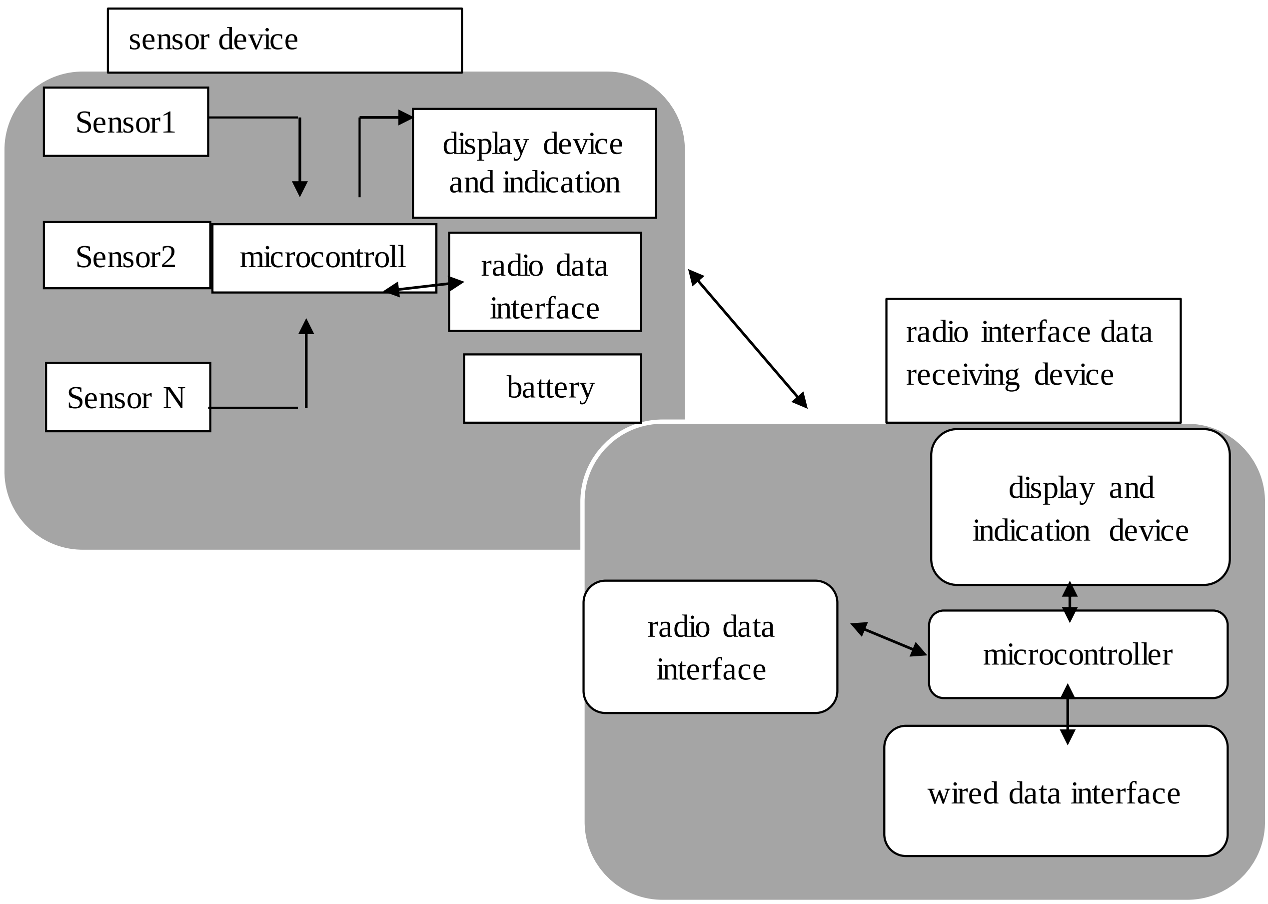
Regulation on the use of RFID in the areas of product monitoring identifies a number of standards of the 18000 series. Parts 1–6 of the ISO 18000 specification define contact criteria utilizing on-air matching at world-wide wavelengths (135 kHz, 13.56 MHz, 2.45 and 5.8 GHz, as well as inside the microwave range).The ISO 18046 standard specifies methods for testing the performance of RFID tags and readers, while the ISO 18047 standard specifies methods for testing RFID device matching. This standard is like the EPC global standard and is the point of possible alignment of the standards of both organizations.

3.Research on potential systems for remote control of feeding process based on radio signals

This work is carried out in the following areas :1 - systems to determine the location and movement of animals(SDM - M); 2 - establishment of a system for the sexual hunting of cows and heifers(SDM-PO); 3 - a remote system for monitoring the functional activities of various organs in the perineal cortex(SDM-R).

SDM - M is used to continuously determine the position of animals, their movements and individual movements. It allows you to record deviations from your normal routine while resting, eating, and exercising, and reduces the time you spend looking for the ideal animal on the farm. The technical implementation of the system is based on the application of a triangulated radio engineering method which provides the measurement of the three-dimensional coordinates of a transceiver placed on an animal.

The structure of the system is shown in Figure 5. It consists of four main modules: a sensor device, a device for receiving data via a radio interface, an interface device, a PC with installed STR and equipment. Integration of the complex of systems allows recording various physiological indicators of animals and transmitting messages to the inseminator, veterinarian, leader and herd management system for prompt decision making.



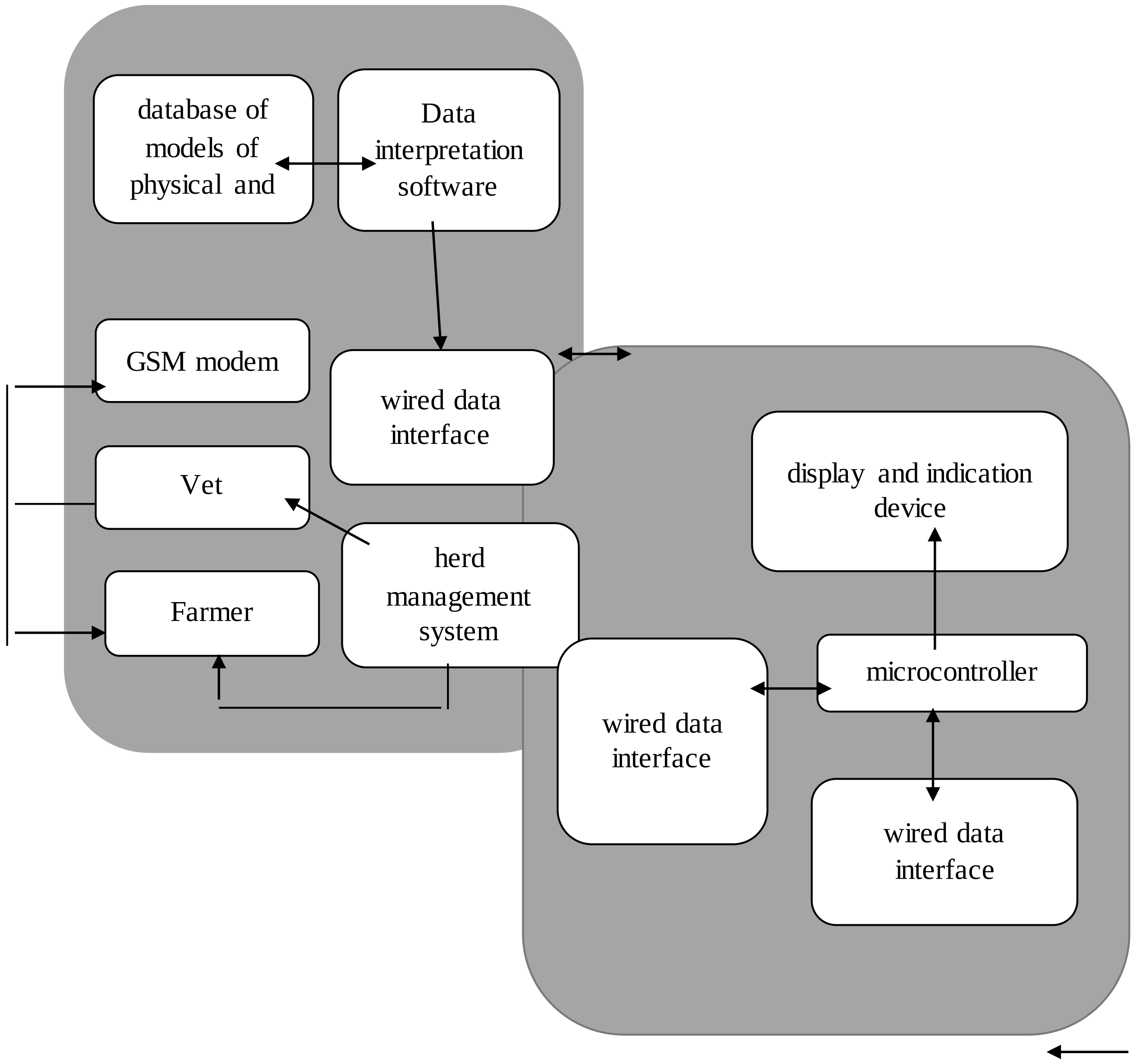


Figure3.1- structure of a microprocessor system for remote monitoring of cow signals

The sensor is mounted on the animal. It is autonomous, because It is powered by a battery located in the device's case, connected to other elements of the system via radio communication. The estimated battery life depends on the capacity of the battery and is about 50 days, depending on the mode of use. Primary measuring transducers are mounted in the sensor device. Their typical and quantitative composition depends on the type of physiological information recorded by the sensor.

The primary converters can be: MEMS module (accelerometer, magnetometer, gyroscope), humidity, temperature, strain gauge, and other sensors.

The device for receiving data via the radio interface is a remote antenna module installed in areas where animals are located. It is able to interact simultaneously with several sensor devices (from 1 to 6 inclusive).

The PC interface device is located in the immediate vicinity of it. It carries out communication between the PC and several data receiving devices via the radio interface.

A PC with specialized software is a center for processing information received from sensors. It established a software interpretation of the interpretation of data received from the sensor. The software is connected to a database of models of physiological phenomena with criteria for their identification. The software has the ability to integrate with the herd management system. A standard GSM modem is connected to the PC, through which the software can remotely notify interested parties (veterinarian, farmer, etc.) about the moment of occurrence of the event (physiological phenomenon) via SMS message. Such events, for example, are:

1 - the beginning of labor;

2 - sexual hunting;

3 - stress.

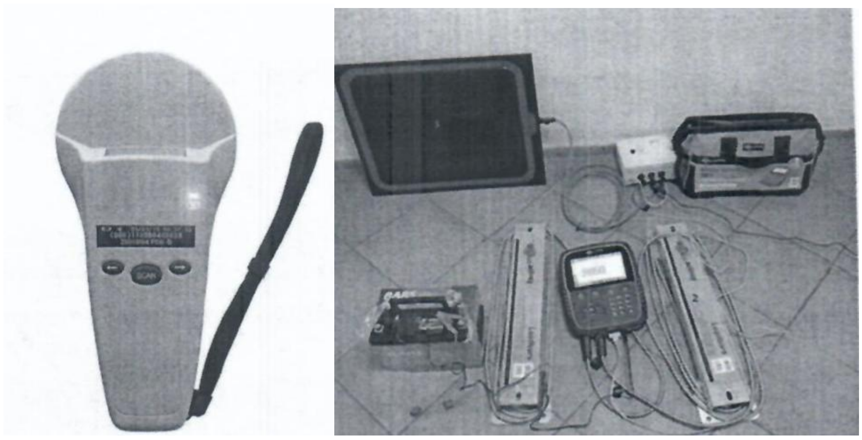
The message contains the following dimensions: 1 - name of the event; 2 - animal identification number; 3 - event time. The modem is connected to the PC via a standard serial port. Modem management and data transfer are carried out using standard AT&T commands.

The development of a complex of microprocessor systems for remote monitoring of cow signals in real time based on the modular principle and its integration into the herd management system will allow to more fully realize the genetic potential of each animal, reduce the cost of diagnosing and treating diseases, and increase efficiency farm milk production.

4. Organization of the installation of RFID system equipment and the beginning of work on setting up a software product

The organization of the installation of the RFID system equipment (tags and sensors on animals, input of primary data on animals and start work on setting up the software product) was carried out according to the results of the previous year's study, taking into account technical, technological and operational indicators and characteristics of the hardware-recording means of RFID technologies, as well as commercial offers of their manufacturers and suppliers. The work was carried out in conjunction with the specialized LLP <SPC ZhiK> and individual elements of the RFID system will be test operation with the participation of subject specialists in real production processes. The latter determine the program and technological modes of functioning of RFID technologies, and the reliability and accuracy of feedback signals for the formation of a database for the purpose of information support for the adoption of production, technological and managerial decisions is ensured by the observance of operating rules by calibration of measuring and recording instruments.

A fragment of RFID technology equipment is shown in the figure:



Reader FRD5100 weight device GALLAGHER TW-1

Figure 4.1-Elements of RFID technology

The operation of the RFID system is as follows. Each in the herd is labeled with an RFID tag, which is inserted into the ear tag, and is attached to the right ear. The tag consists of two components: an antenna and a microchip. When the tag reader is brought to the animal at a distance sufficient for transmission, power is supplied to the tag microchip and antenna. A signal is generated and sent to the reader.

The ID number of the animal, which is read from the tag, is entered into the computer program. The software allows you to store and analyze data (weight, number of animals, size, gender, etc.), to sample both an individual animal and a group.

It is possible to record events, such as the time of entry, exit, stay of the animal in the zone when the animal went into the pen, how long it was, when it came out, how often it took food.

Also, feeding information is recorded in the RFID chip. This is possible due to the fact that the RFID antenna is integrated in the feeder, which fixes and regulates the filling of its feed. The RFID antenna of the feeder captures the tag with an individual number when the animal eats from it and notes that it has visited the feeder, determines the weight of the feed eaten, the amount of water consumed. This method of accounting allows you to control the weight gain of the animal, in time to introduce the necessary minerals and vitamins into the diet. The program determines a sick animal by reducing weight gain, reducing the amount of feed eaten, and a number of other factors

Additional components can be added to the RFID animal identification system to increase productivity and accuracy in measurements. One of these components is electronic scales. They are directly connected to the computer and the data from them automatically enters the database. The weighing operation is automated and simple. The animal is placed on the scales, the reader is brought up to the RFID tag and the data on the animal's weight and time are automatically transferred to the program database. Regular weighing of animals in automatic mode will allow you to diagnose diseases and respond to them in time.

4.1 Performing routing system setup and accurate animal identification

The study of the routing system in animal husbandry is, first of all, connected with the analysis of the concept of "animal movement". Moving farm animals is one of the main business processes: animals are bought and sold; animals move from one farm to another; animals are transferred to third parties for fattening under economic contracts; animals are driven to summer pastures, etc. Analysis of the main business processes at the feedlot allows you to structure the concepts of "moving" in the conditions of the feedlot from the standpoint of choosing technologies and automation tools as follows:

1) Static movement of animals, characterized by a long stay in a certain status in accordance with the rules of the technological cycle of the feedlot or at different places of deployment outside the feedlot;

2) The dynamic movement of animals, which is characterized by the presence of animals in functional areas during the day cycle.

The task in the adopted formulation is to determine the events of the animal being in various functional zones during the period of detention on the feeding site.

In relation to the conditions of technologies for keeping animals on a feeding site in Kazakhstan, the main functional areas of animal stay are:

-feeding zone

-drinking area

-zone (state) of rest

-weighing area

In a first approximation, the frequency and time spent in these areas are indicators of animal behavior, the automated recording of which can be implemented using RFID technologies. The static processing of this data and its user-friendly presentation can serve as the initial signal (promptly, accurately) characterizing the state of the animal, and can serve as input to the decision-making system, i.e. systems for the development of management (decisions) measures and the appointment of zoo prophylactic appointments.

The technical and technological aspects of the routing process were studied on a prototype to establish operational characteristics (understanding and determining the optimal structure of the RFID system for the subject area as a whole). The architecture of the software and hardware implementations of an automated animal in various functional areas of the feeding area includes: a software platform (laptop), controller (Arduino atmega), input signal generator sensors, communication cable, as well as program codes and display. The algorithm for visualizing the results of automated processing in tabular and graphical forms for analysis and management decision making provides that all data records, fixing algorithms, output reports are generated in the form of tables or graphs.

The functional operability of the software for automated recording of the object's stay in various zones developed on the Arduino atmega software platform was tested, the program code is implemented in the C ++ programming language.

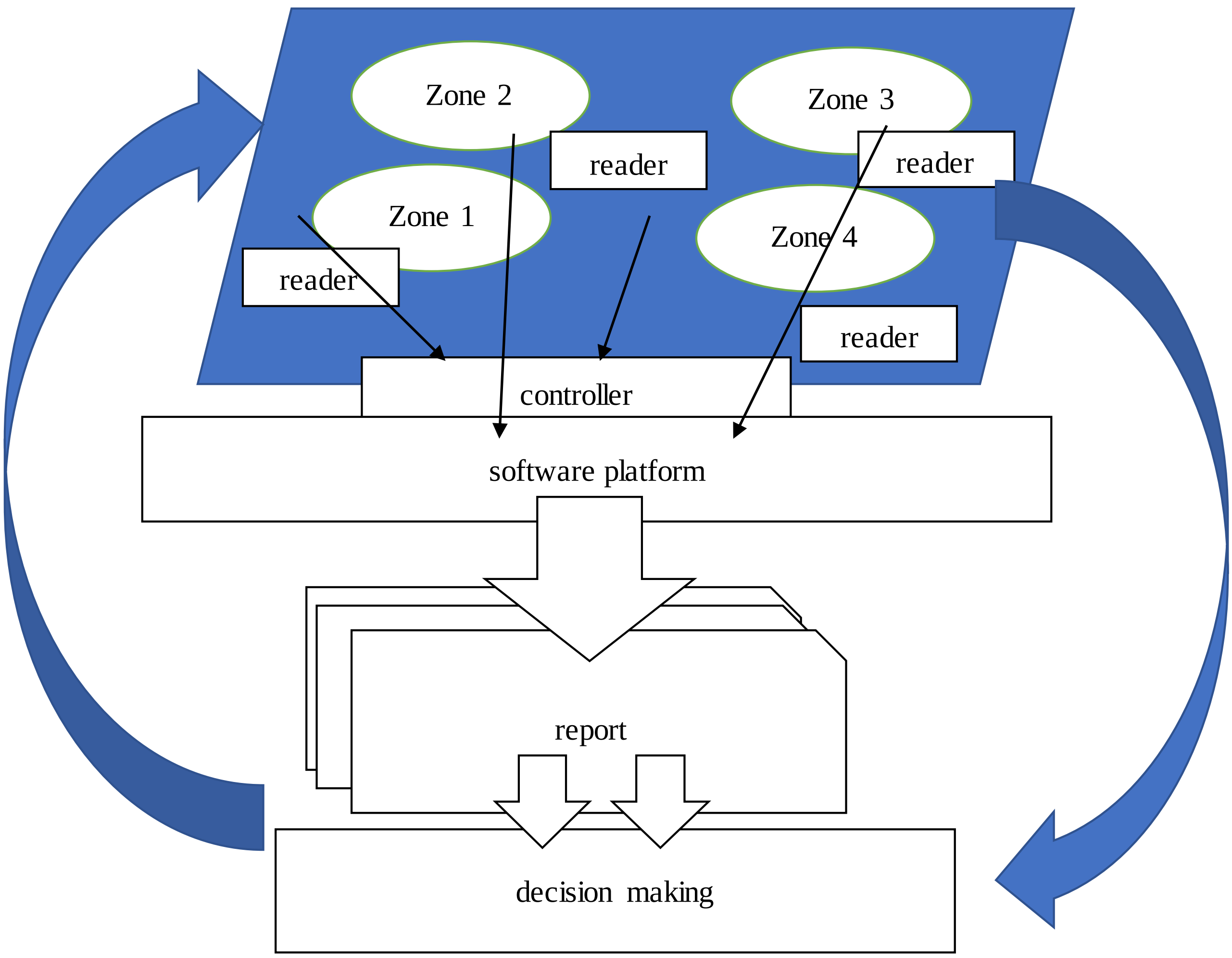


Figure 4.2-Simplified scheme of the principle of operation of the RFID system at the feedlot.

The architecture of the software and hardware implementations of the automated recording of the stay of the animal in various functional areas of the feedlot is shown in Fig.8. The main elements of which are: software platform (laptop), controller (Arduino atmega), input signal generator sensors, communication cable, as well as program codes and display.

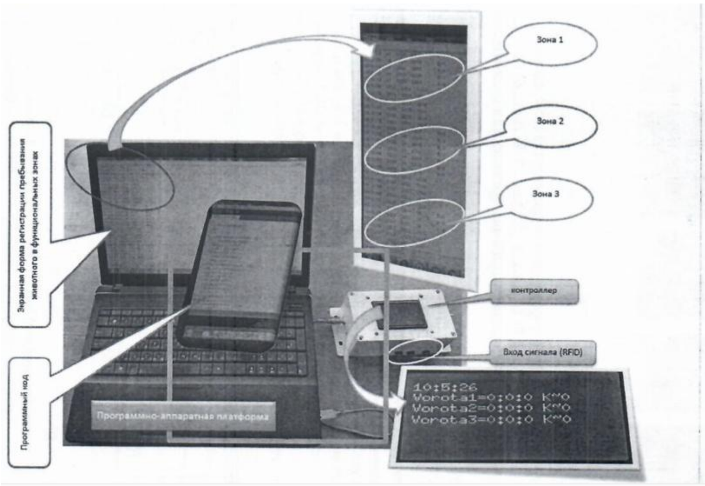


Figure 4.3-Firmware architecture

4.2 reporting algorithm

Figure.9 shows the algorithm for visualizing the results of automated processing in tabular and graphical forms for analysis and management decisions. At the same time, all data records fixing the time spent by the animal in the functional zones are exported to the table programming environment (EXEL) and, using a regular algorithm, the output report is generated in the form of tables or graphs.

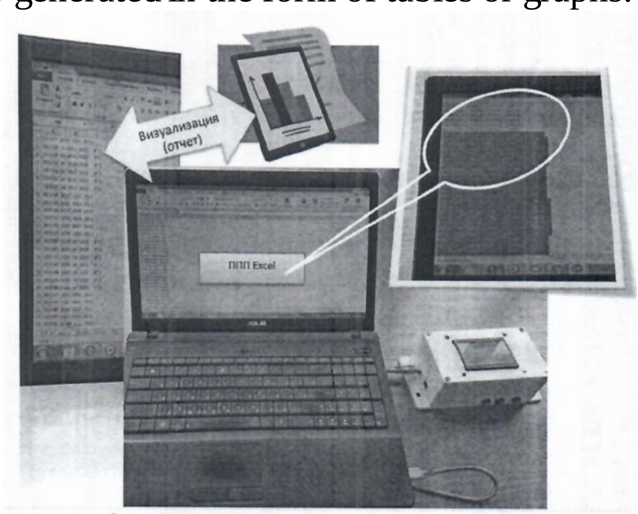


Figure 4.4-Algorithm reporting

The functional operability of the software for automated recording of the object’s stay in various zones, developed on the Arduino atmega software platform, was tested. The program code is implemented in the C ++ programming language.

The results of automated data processing are presented in the figure.10.

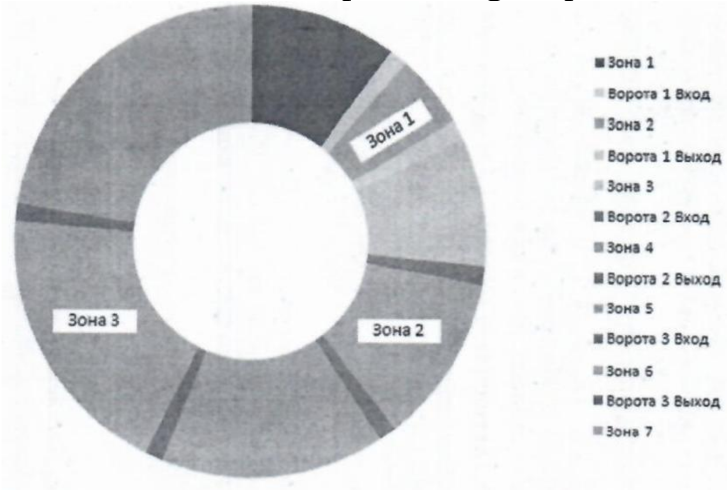


Figure 4.5-Visualization results of automated processing

5.Development of simple GIS animal monitoring systems

The most rational and efficient method of storing and processing monitoring data of natural territorial systems is the method of geographic information mapping. The basis of this method is the use of geographic information systems (GIS) intended for the collection, storage, processing and visualization of spatially coordinated data, that is, having a certain territorial reference, their elementary processing and visual presentation in the form of maps.

Simple GIS systems using Yandex maps were developed,For this, data on the presence of feedlots in the republic were collected and analyzed. A table of data on feedlots has been compiled (location, name, number of goals, weather, geographical coordinates). The following is a snippet of this table.

The figure shows a visualization of the location of feedlots, indicating their exact location on the map.

GIS-technologies are effectively used in beef cattle breeding in Kazakhstan as a whole, they solve the problem of monitoring the feeding sites in Kazakhstan.

The proposed automation of monitoring processes for feeding sites allows visualization by topology (i.e. analysis by region), by farm size, and if necessary provides a complete description of the farm.

The figures show fragments of visualization of monitoring of feeding sites in Kazakhstan. Analysis of indicators that in the southern regions there are larger (by number of livestock) fattening sites. Such information creates proposals for a rational solution to the issues of resource allocation and logistics for the promotion of meat products in Kazakhstan as a whole and for export.

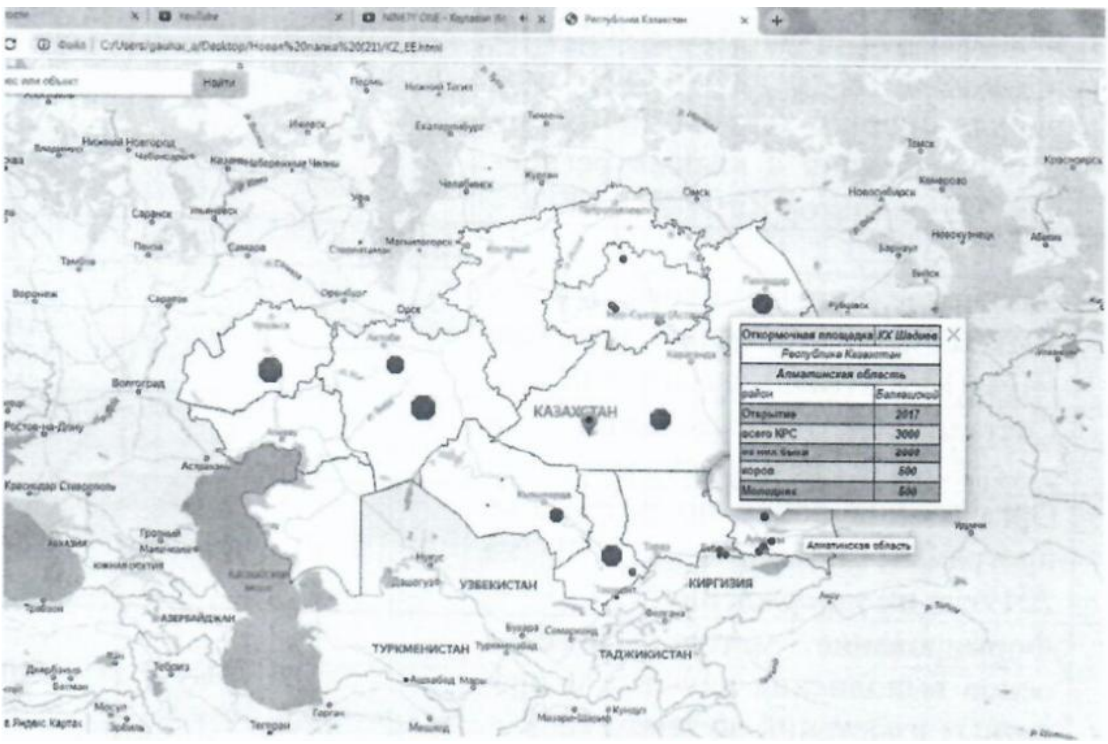


Figure 5.1- Fragments of visualization of monitoring of feeding sites in Kazakhstan

Each feedlot depicted on a geographical map is characterized by its geographical position in the coordinate system and content: name, number of animals, breed, etc.

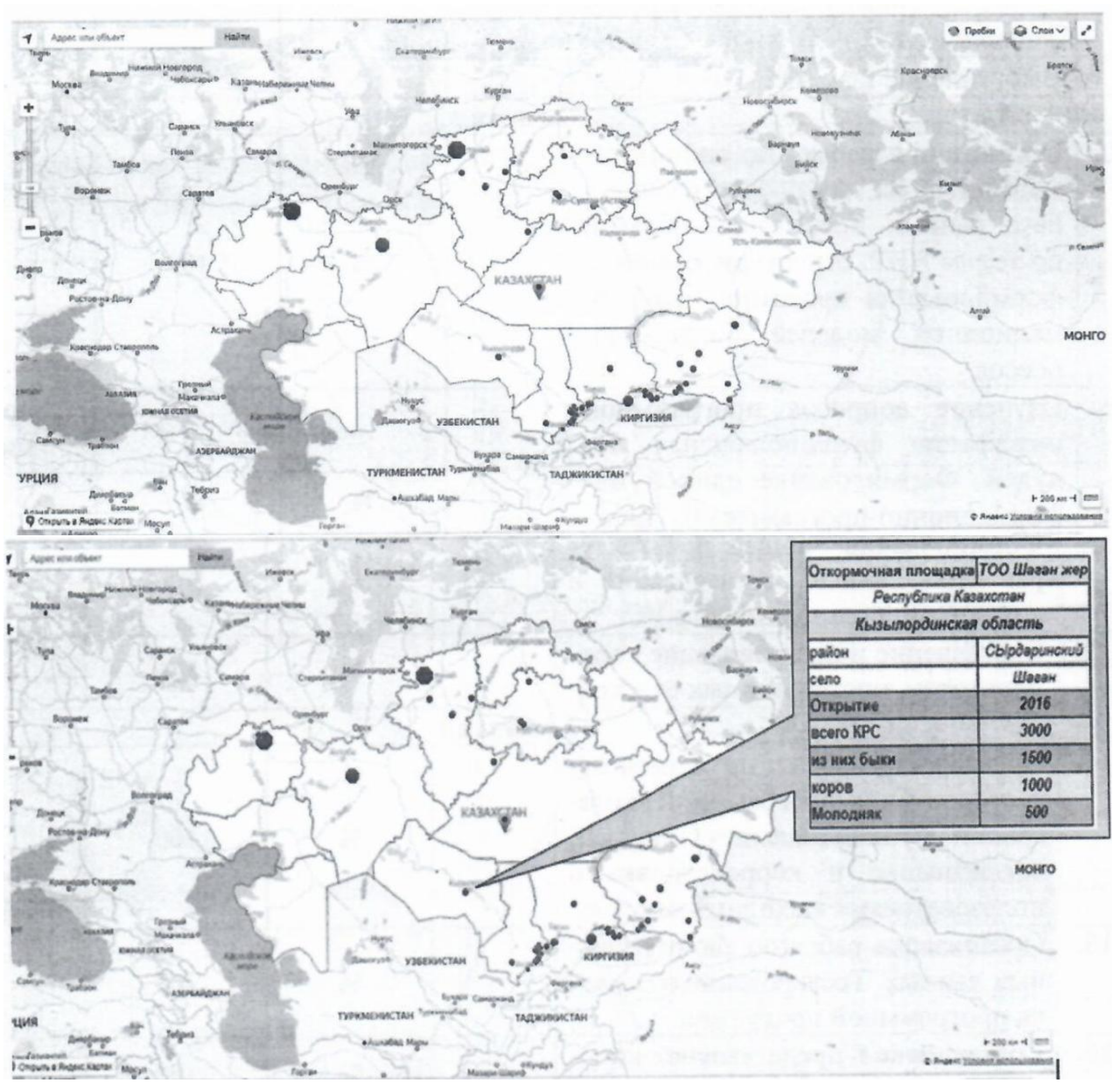


Figure 5.2- Famous feedlots in Kazakhstan

6.An algorithm of the effect of Antenna Gain on Read Range

Antenna gain affects the read/write range of the RFID system. The effect of antenna gain on the read range is next studied in backscatter RFID systems in which the reflection of electro- magnetic waves from the object is used for data transmission from the transponder to the reader.

The RF power is transmitted in all directions by the reading antenna. The power density(S) of the reverse thinking position is

$$S = \frac{pG_t}{4\pi R^2} \quad (6.1)$$

The following equation describes the power density S_{BACK}, which finally returns to the reader antenna.

$$S_{BACK} = \frac{PG_t\sigma}{(4\pi)^2 R^4} \text{ , Where } \sigma_{max} = \frac{\lambda_0^2}{4\pi} G_r \text{ , So } S_{BACK} = \frac{PG_t\lambda_0^2 G_r}{(4\pi)^3 R^4}; \quad (6.2)$$

The reception power P_{BACK} of the reader antenna is then

$$P_{BACK} = S_{BACK} A_e = \frac{PG_t^2\lambda_0^4 G_r}{(4\pi)^4 R^4} \quad (6.3)$$

To show the effect of the antenna gain, the read range R is solved from the equation (3).

$$R = \frac{\lambda_0}{4\pi} \sqrt[4]{\frac{P\cdot G_t^2 \cdot G_r}{P_{BACK}}} \quad (6.4)$$

The read rang is calculated from equation (6.4) for the system in which the sensitivity of the reader P_{BACK} is – 70dBm and the transmitted power P is 20dBm at the frequency 2.45GHz($\lambda_0 = 0.122m$). The read rang for three different transponder antenna types is illustrated in figure 13.

Figure 6.1-The read rang for three different transponder antenna types

Table 6.1 -The effect of reader antenna gain on the range.

Reader antenna type	Read range (m)
Dipole(G=2.2dBi)	2.76
Patch(G=6.7dBi)	4.64
Patch array(G=13.2dBi)	9.80

These calculated values in figure.6.1 and in table 6.1, are theoretically the maximum read range, where the reader unit can detect reflections from the transponder antenna under ideal conditions. When the RFID system is operating in the real environment, reflections from the conductive surface, background noise and antenna alignment reduce the reading range to at least half of the theoretical maximum.

As can be seen from figure.13, the reading range is highly dependent on the RFID reader antenna gain. Gain can be increased by using multiple antennas connected to reader units or antenna arrays. Even the addition of several elements to form an antenna array can significantly increase the gain of an antenna system.

CONCLUSION

This paper has completed the detailed design and implementation steps of the automatic feeding system for cows based on RFID technology. In the process of this subject, the following aspects are mainly completed:

1) Analyze modern technologies for building RFID identification systems.
2) Study of potential systems for remote control of feeding processes based on radio signals.
3) Development of satellite communications application algorithms for monitoring pasture quality.
4) Calculate the reading range of RFID codes.

The automatic feeding control system proposed in this paper also needs to be improved in practical application. We can see that this system still does not fully automate the cow feeding process, which requires further design and planning. The effective distance of the rf card is too short, and communication may not be smooth, and the problem of double reading may occur. There may be more concrete problems to be discovered and solved in practice.

REFERENCE LIST

1) Clark, D.A.; Litherland, A.; Mata, G.; Burling-Claridge, R. 2006. Pasture monitoring from space. pp 108-123. *In*: Proceedings of the South Island Dairy Event

2) J. Side´n, P. Jonsson, T. Olsson and G. Wang, “Performance degradation of RFID system due to the distortion in RFID tag antenna, 11th International Conference, Microwave and Tele- communication Technology, Sevastopol Crimea, Ukraine, 10–14 September 2001.

3) M.Keskilammi,P.Salonen,L.Syda¨nheimoandM.Kivikoski, “Radio wave propagation modeling in paper reel for novel radio frequency identification system”, JamCon 2000 Technology for Economic Development, Ocho Rios, Jamaica, 11–13 August 2000.

4) C. A. Balanis, Antenna Theory: Analysis and Design, 2nd edn, John Wiley, 1997.

5) Thomson, N.A.; McCallum, D.A.; Howse, S.; Holmes, C.W.; Matthews, P.N.P.; Matthew, C. 1997. Estimation of dairy pastures – the need for standardisation. *Proceedings of the New Zealand Grassland Association 59*: 221-225.

6) A.N. Altybaev, B.S. Aryngaziev, E.V. Naidenko, A.A. Kuandykov .International Agricultural Engineering 2018.No4.

7) Chow, H.K.H., Choy, K.L. and Lee, W.B. (2007) ‘Integration of web-based and RFID technology in visualizing logistics operations – a case study’, Supply Chain Management: An International Journal, Vol. 12, No. 3, pp.221–234.

8) Department of Agriculture and Food (2008) ‘NLIS Cattle in Western Australia: Directory’, http://www.agric.wa.gov.au/content/AAP/SI/NLIS/NLIS_ABOUT.HTM (access May 2008).

9) Ibrahim, T. (2005) ‘A study of RFID privacy & security’, Term Project, Department of Computer Science and Computer Engineering, University of Arkansas, Fayetteville.