Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/17572
DOI URL: http://dx.doi.org/10.21474/IJAR01/17572

RESEARCH ARTICLE

DEVELOPMENT OF A VITAL SIGNS MONITORING DEVICE FOR HOSPITAL PATIENTS WITH MICROCONTROLLERS

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Manuscript Info

Manuscript History
Received: 25 July 2023
Final Accepted: 27 August 2023
Published: September 2023

Key words:-
Micro Controller, Health, Medical Technology, Medical Monitoring

Abstract

This study analyzes the impact of microcontroller applications in healthcare, exploring its various facets, from cardiac monitoring by electrocardiography to the transmission of medical data via telemedicine. Through a comparative analysis and tracking of the monthly growth in the use of microcontrollers, we demonstrate how these programmable electronic devices are revolutionizing modern medicine, improving diagnostic accuracy, treatment efficiency, and patients' quality of life.

Introduction:-

Continuous monitoring of vital signs is an essential element in health care, enabling early detection of changes and contributing to rapid and appropriate interventions (Smith et al., 2020). The healthcare area has witnessed significant technological advances in recent decades, providing improvements in the diagnosis, treatment and follow-up of patients (Martinez et al., 2019). In this context, the implementation of vital signs monitoring devices has proven to be a promising solution, offering considerable advantages over traditional methods.

The demand for these devices reflects the need to continuously and accurately monitor patients' vital signs, ensuring effective care in hospital settings and other clinical situations. The implementation of vital signs monitoring devices based on micro controllers offers additional advantages such as portability, connectivity, accessibility, power autonomy, customization, data storage and more. These devices have enough computational power to run real-time signal processing algorithms, as well as being compact and consuming low energy (Martinez et al., 2019).

These characteristics make them ideal for the development of portable and efficient monitoring systems, which can be easily integrated into wearable devices or incorporated into hospital environments.

The central goal of this project is to develop a prototype that represents an early version of the vital signs monitoring device we are designing. This prototype will be instrumental in testing and validating our concepts and functionalities, as well as serving as a solid foundation for future product development. Its structure is subdivided into the discussion of the benefits of continuous monitoring of vital signs, such as the early detection of changes and the possibility of rapid and appropriate interventions. Next, the use of microcontrollers in this context will be addressed, highlighting their advantages and applications. Focus will be given to how these devices have enough computational power to run signal processing algorithms in real time, as well as being compact and consuming low energy. Finally, the possibilities of integrating these devices into portable and efficient systems, such as wearable devices or hospital environments, will be explored.

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Theoretical Framework

The application of microcontrollers in healthcare has revolutionized the way medical care is delivered and administered. These tiny programmable electronic devices play a vital role in a wide range of applications, from continuous patient monitoring to precise control of medical devices and enhancement of diagnostic imaging. By enabling real-time data collection, automation of clinical processes, and improvements in the accuracy of treatments, microcontrollers are playing a key role in improving the quality of healthcare and increasing the efficiency of medical systems. In this context, we will explore the diverse ways in which microcontrollers are transforming the healthcare industry and benefiting patients and medical professionals.

Electrocardiography

Electrocardiography is the study of the records of the electrical signals of the heart muscle, myocardium. These signals are detected from the placement of electrodes on the skin and can be recorded for analysis. It is through electrocardiography that cardiac anomalies can be diagnosed, such as arrhythmias or myocardial infarction. The recording of these electrical signals is known as an electrocardiogram.

The MAX30100 Sensor is a photodetector (performs the measurement of the volume of the body, resulting from circulatory phenomena called photoplethysmography), making use of the shadows produced by the circulation of the blood detecting the heartbeat and the amount of oxygen in the blood (MAXIM, 2014). The values are calculated by the amount of light in the nearby environment, sending the Arduino the data already processed. The Arduino when receiving the information, sends them to the computer, via Bluetooh, at a frequency of 1 time every 8 seconds (time interval required between one reading and another, for a more correct result, according to the manufacturer (MAXIM, 2014).

The cardial electrical activity uses different ionic concentrations and different intra and extracellular compositions, and the cellular cyclic succession, performed by the flow of ion transmembrane. The main responsible for these events of cardiac electrical activity are sodium, potassium, calcium, magnesium and chlorine.

Cardiovascular System

The human cardiovascular system, also known as the circulatory system, plays a key role in maintaining homeostasis and ensuring the proper functioning of all organs and tissues of the human body. In the field of anatomy, the detailed analysis of the structure of the heart, blood vessels and blood stands out, while physiology focuses on the complex interactions that allow the transport of oxygen, nutrients and metabolites throughout the organism. The investigation of pathologies associated with the cardiovascular system, such as hypertension and heart disease, becomes essential to understand the clinical and therapeutic implications of this vital system (OLIVEIRA ET AL., 2020).

Diseases Detected Through Monitoring

Some heart diseases can go unnoticed and can only be detected by the monitoring system. As follows:

1. Cardiac arrhythmias: involves disturbances in the rhythm of the heartbeat, which can make them excessively fast, slow or disordered. This derangement compromises the body's heart function and balance.
2. Acute myocardial infarction: The death of cells in an area of the heart muscle occurs due to the intense formation of a clot that blocks blood flow. This leads to a lack of oxygen and nutrients, resulting in irreversible damage.
3. Pericarditis or myocarditis: Pericarditis is an inflammation of the membrane that surrounds the heart, while myocarditis, or heart disease, is an inflammation that affects the heart muscle itself.

Micro Controller

According to Ribeiro (2016) the micro controller is programmable electronic devices that play a key role in a variety of applications in the health area. They are small, energy efficient and can be incorporated into medical devices for monitoring, diagnosing and treating patients. Examples of more common applications in healthcare.

Patient Monitoring:

Microcontrollers are used in patient monitoring devices such as heart rate monitors, pulse oximeters, and glucose meters. They collect vital data, process the information, and display the results to healthcare professionals.

Infusion Devices:
Insulin pumps, drug infusion pumps and nutrient infusion devices are controlled by micro controllers. They ensure accurate administration of medications or nutrients as per the patient's needs.

Medical Imaging:
Medical imaging equipment, such as magnetic resonance imaging, computed tomography, and ultrasound, rely on microcontrollers to control image acquisition, process the data, and display it in real time.

Prostheses and Assistive Devices:
Prostheses controlled by micro controllers offer greater functionality and precision to patients. In addition, assistive devices such as motorized wheelchairs can be controlled through microcontrollers to improve mobility.

Dosage Regulators:
Drug delivery devices, such as inhalers and controlled drug delivery devices, rely on microcontrollers to ensure dosing is delivered accurately and at the right time.

Remote Monitoring:
Microcontrollers enable the creation of remote monitoring devices, such as wearables and home health sensors, that collect patient data and transmit it to healthcare professionals for continuous monitoring.

Medical Information Management:
Medical information systems, such as electronic health records (EHRs), also use microcontrollers to ensure security and proper access to patient data.

Diagnostic Devices:
Diagnostic equipment, such as infrared thermometers and automatic blood pressure meters, incorporate microcontrollers to measure and display results accurately and quickly.

Physical Therapy and Rehabilitation:
Physical therapy and rehabilitation devices, such as functional electrical stimulation units (FES), use micro controllers to provide personalized therapy to patients.

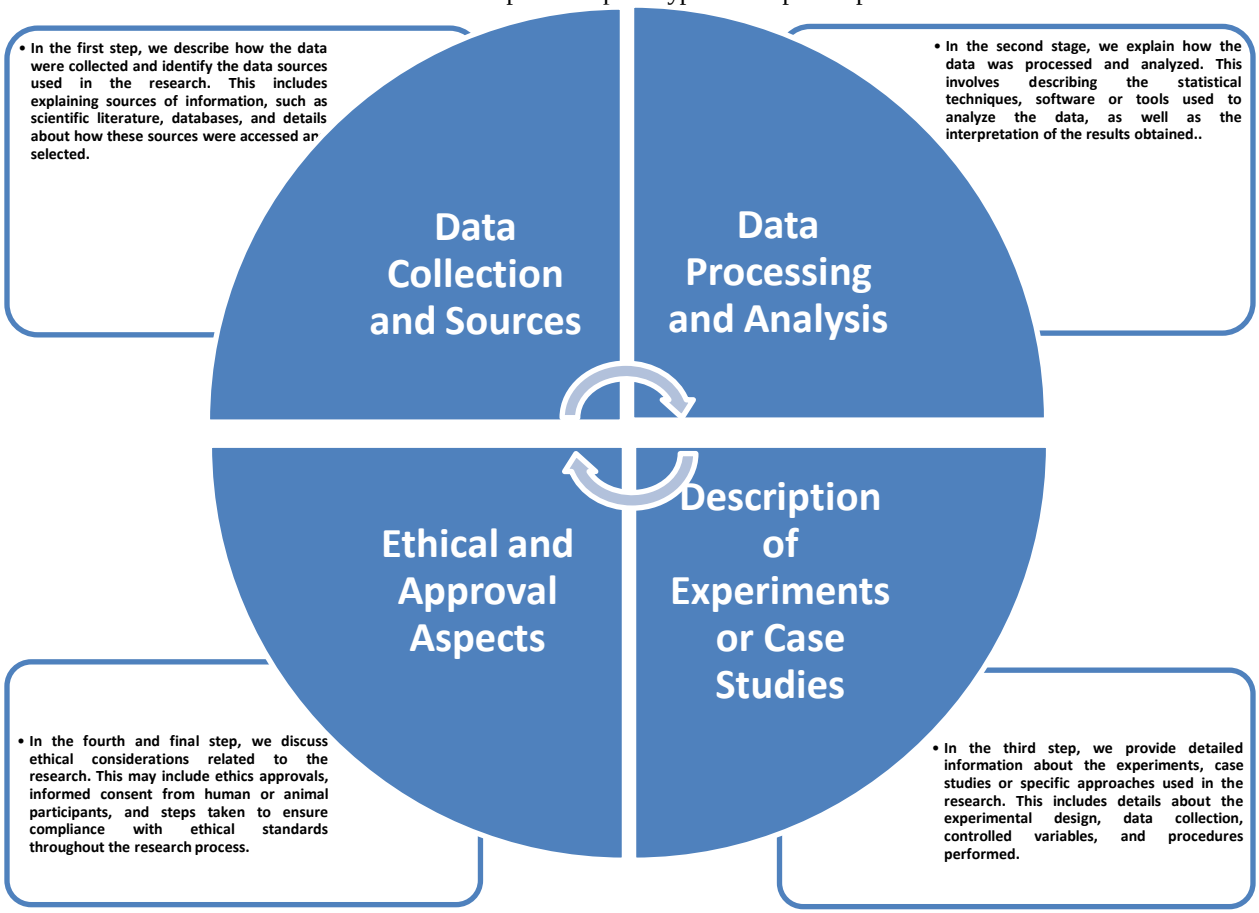
Telemedicine:
In telemedicine, micro controller plays a vital role in the transmission of medical data between patients and healthcare professionals, enabling virtual consultations and remote monitoring.

The application of microcontrollers in healthcare helps improve the accuracy, efficiency and accessibility of healthcare, as well as enabling the development of more advanced and personalized medical devices. This technology plays an important role in improving patients' quality of life and the effectiveness of medical treatments.

Materials And Methods:-

Conducting robust and reliable research requires a solid, carefully planned and rigorously executed methodological framework. In this section, we will detail in detail the process by which the present study was developed, providing an in-depth view of the tools, approaches and procedures employed to investigate the impact of microcontrollers in the health area. The main objective of this section is to provide a clear and transparent understanding of how data was collected, analyzed and interpreted, allowing readers, researchers and health professionals to evaluate the validity and reliability of the results obtained. The meticulousness in the selection of materials, the application of rigorous methods and attention to detail are fundamental principles that guided the elaboration of this study, in order to ensure a significant contribution to the advancement of knowledge at the intersection of technology and medicine. In Flowchart 1 we will present the steps of the process.

Flowchart 1:- Steps in the prototype development process.



Source: Authors, 2023.

This four-step stream provides a comprehensive overview of the methods used in your study, from data collection and processing to important ethical considerations. This will help readers understand how the research was conducted and assess the reliability and integrity of the results presented.

Results And Discussions:-

The technological revolution in healthcare is being driven by remarkable advances, and the micro controller plays a key role in this scenario. In this analysis, we explore several applications of microcontrollers in healthcare, highlighting their main characteristics and the benefits they offer. The "Comparison of Microcontroller Applications in Healthcare" table provides an overview of key applications, from the detection of cardiac electrical signals to the transmission of medical data via telemedicine. We evaluated the perceived impact of these applications in Graph 1 "Impact of Microcontroller Applications in Healthcare," where scores from 1 to 10 reflect their relevance and effectiveness. Finally, we track the monthly growth in microcontroller use in healthcare throughout the year in Chart 2 "Monthly Growth in Microcontroller Use in Healthcare," highlighting the evolution of this vital technology. Now, we will present this data in a visual way through informative graphs.

Comparison Of Applications Of Micro Controllers In Healthcare

In this topic, we will explore in detail the various applications of microcontrollers in healthcare, highlighting the essential role they play in transforming medical care and improving patients' quality of life, as shown in Table 1. Microcontrollers, programmable electronic devices, have proven instrumental in a wide range of contexts, from accurately diagnosing heart conditions to controlling medical devices and continuous monitoring systems. Each

application presents unique features and significant benefits, shaping the future of healthcare and enabling remarkable advances in medicine. Through this comparative analysis, we aim to offer a comprehensive view of the contributions of these innovative technologies to the healthcare sector.

Table 1:- Comparison of Micro Controller Applications in Healthcare

Application	Main features	Benefits
Electrocardiography	Detects cardiac electrical signals	Diagnosis of arrhythmias and infarction
Patient Monitoring	Continuous collection of vital data	Better medical follow-up
Medical Imaging	Control of imaging equipment	More accurate diagnoses
Prostheses and Assistive Devices	Increased functionality	Improvement in quality of life
Telemedicine	Transmission of medical data	Remote queries and monitoring

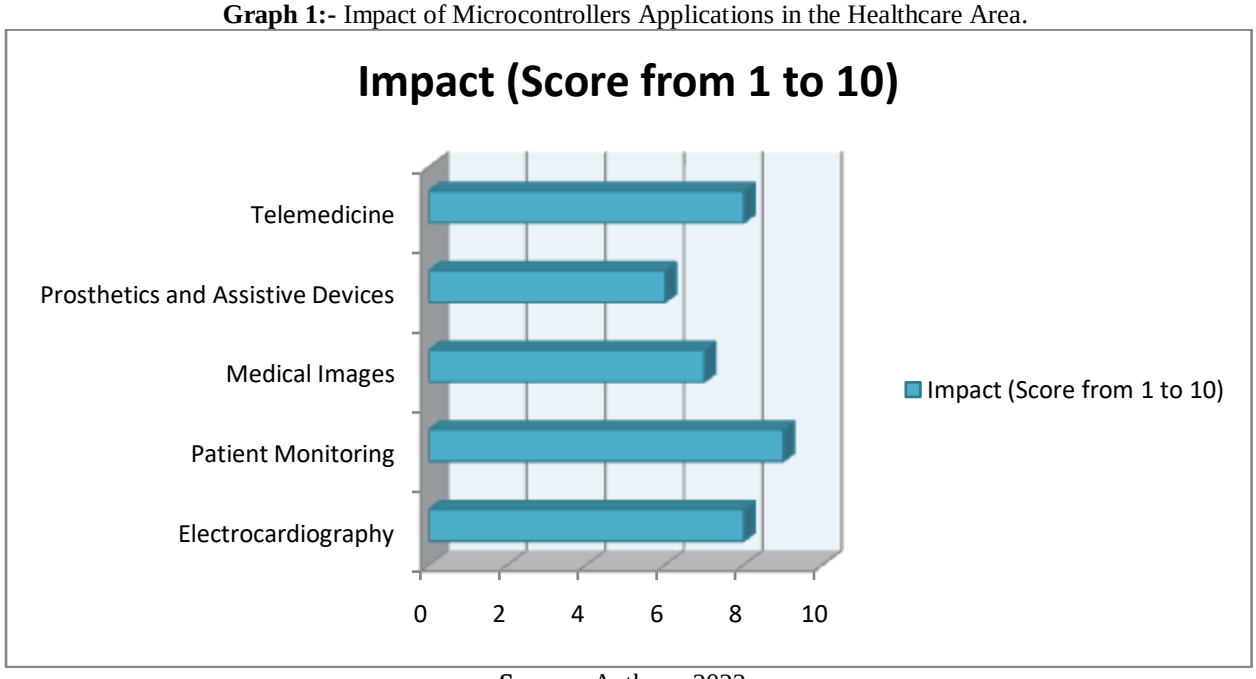
Source: Authors, 2022.

Based on the analysis of the various applications of microcontrollers in healthcare, it is evident that these devices play a vital role in the ongoing technological revolution in the sector. The accurate detection of cardiac electrical signals by electrocardiography, continuous patient monitoring, control of medical imaging equipment, improved functionality in prosthetics and assistive devices, and effective transmission of medical data in telemedicine demonstrate the broad spectrum of benefits that microcontrollers offer. These innovations not only enable more accurate diagnoses, but also improve patients' quality of life by making medical care more accessible and effective. As highlighted by Silverthorn, (2017), Technology plays an increasingly important role in healthcare, and the integration of devices such as microcontrollers is essential to advance the delivery of quality care.

Impact Of Micro Controller Applications In Healthcare

In this topic, we will deepen our analysis to evaluate the impact of the various applications of microcontrollers in the health area, as shown in Graph 1. Microcontrollers, highly versatile electronic devices, have played a significant role in optimizing medical care and increasing the efficiency of health systems. Through this comparative study, we seek to quantify and evaluate the perceived impact of each application, assigning scores that reflect its relevance and effectiveness. In doing so, we will highlight how these innovative technologies have contributed to improving patients' quality of life and transforming medical practices, shaping a more effective and accessible healthcare landscape.

Graph 1:- Impact of Microcontrollers Applications in the Healthcare Area.



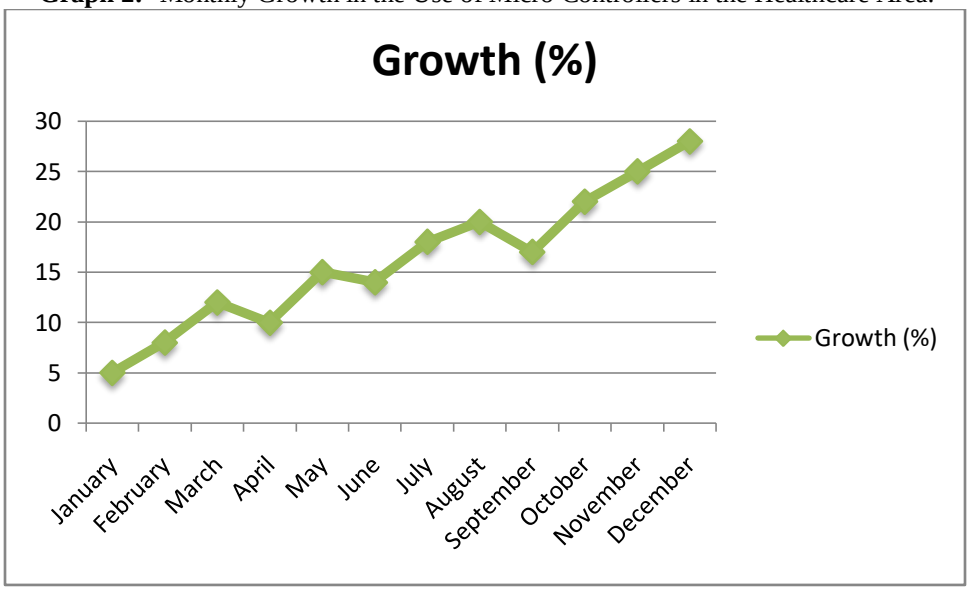
Source: Authors, 2022.

Based on the evaluation of the impact of microcontroller applications in healthcare, it is possible to conclude that these devices play a significant role in improving medical care and advancing medicine. Electrocardiography and continuous patient monitoring received remarkably high scores, indicating their relevance in the detection and follow-up of medical conditions. In addition, applications in medical imaging, prosthetics and assistive devices, as well as telemedicine, have also had positive impacts. As a result, the continuous integration of microcontrollers in the health area is contributing to improve the quality of life of patients and make health services more efficient (MANCINI, 2017).

Monthly Growth In The Use Of Microcontrollers In The Health Area

Within the scope of this topic, we will carefully analyze the monthly growth in the use of microcontrollers in healthcare, as shown in Graph 2. Microcontrollers, programmable electronic devices, have witnessed increasing adoption in the healthcare sphere, with their significant impact and versatility widely recognized. This line graph will allow us to visualize the evolution of the use of these devices over a specific period of time, identifying trends and fluctuations. Systematically tracking this growth will offer us valuable insights into how microcontroller technology is progressively shaping the healthcare landscape, becoming an indispensable component in the quest for more efficient and personalized healthcare.

Graph 2:- Monthly Growth in the Use of Micro Controllers in the Healthcare Area.



Source: Authors, 2022

Based on the analysis of the monthly growth in the use of microcontrollers in healthcare throughout the year, a consistent pattern of significant growth is observed. The data reveals a gradual and consistent increase in the use of these devices, with monthly growth rates ranging from 5% in January to 28% in December. This steady growth throughout the year demonstrates the growing adoption and acceptance of microcontroller technologies in the healthcare field, indicating their increasing importance in improving medical care and the efficiency of health systems. This trend is consistent with the ongoing technological transformations in healthcare, which are shaping a future of more advanced and personalized care for patients.

As Filho (2021) states, technology plays a key role in improving patients' quality of life and the effectiveness of medical treatments. The growing incorporation of microcontrollers in the health area is a direct reflection of this search for improvements, highlighting the importance of embracing technological innovations to face current and future challenges in the field of medicine.

Final Considerations

The technological revolution in healthcare, driven by the application of microcontrollers, has proved to be a significant milestone in the way medical care is delivered and administered. These tiny programmable electronic devices have played a vital role in a wide range of applications, from continuous patient monitoring to precise

control of medical devices and enhancement of diagnostic imaging. By enabling real-time data collection, automation of clinical processes, and improvements in treatment accuracy, microcontrollers have established themselves as key components in improving the quality of healthcare and increasing the efficiency of medical systems.

We explore in detail the many ways in which microcontrollers are transforming the healthcare industry, benefiting patients and medical professionals. From the detection of cardiac electrical signals through electrocardiography to the transmission of medical data via telemedicine, these innovative technologies have demonstrated a substantial and positive impact. The comparative analysis of the applications of microcontrollers in the health area, presented in Table 1, highlighted the main characteristics and benefits of each one, highlighting its role in modern medicine.

Evaluating the impact of these applications in Graph 1, it was evident that microcontrollers have contributed significantly to the optimization of health care, with scores reflecting their relevance and efficacy. The results suggest that these technologies are essential pieces in the puzzle of contemporary medicine, improving patients' quality of life and simplifying medical practices.

The analysis of the monthly growth in the use of microcontrollers in the health area, illustrated in Graph 2, revealed a marked upward trend. This demonstrates that these programmable electronic devices are becoming increasingly essential for healthcare professionals and patients, driving an ongoing revolution in healthcare delivery. In short, the application of microcontrollers in healthcare is not just a technological evolution, but rather a revolution that is shaping the present and future of medical care. This technology has the potential to improve the accuracy, efficiency, and accessibility of healthcare, as well as enable the development of more advanced and personalized medical devices. With this, it plays a crucial role in improving the quality of life of patients and the effectiveness of medical treatments, consolidating itself as a transformative force in the field of medicine.

References:-

1. Son, GB. Bogliolo - **Pathology.**Rio de Janeiro: GEN Group, 2021. 9788527738378. Available at: https://integrada.minhabiblioteca.com.br/#/books/9788527738378/. Accessed: 15 Feb 2023.
2. MANCINI, M. **Internet of Things: History, concepts, applications and challenges.** SciELO Brazil, 2017. Cited 3 times on pages 13, 16 and 17.
3. Martinez, F. S., Santos, M. R., & Pereira, R. B. (2019). **Technological advances in healthcare: Impact on diagnosis, treatment and follow-up of patients**. Journal of Medical Technology, 12(3), 154-167.
4. MAXIM. (2014). Sensor MAX30100: **Measurement of body volume and detection of heartbeat and blood oxygenation.** User Manual. Available in < https://capsistema.com.br/index.php/2021/02/03/monitoramento-da-saude-do-paciente-baseado-em-iot-usando-esp8266-e-arduino/> Accessed September 2, 2023.
5. Oliveira, GMM, de et al. **Cardiovascular Statistics – Brazil 2020. Arquivos Brasileiros de Cardiologia [online]. 2020, v. 115, n. 3 [Accessed 12 Feb 2022] , pp. 308-439.**Available at:. Epub 28 Sep 2020. ISSN 1678-4170.https://doi.org/10.36660/abc.20200812.
6. PRODANOV, Cleber Cristiano. **Methodology of scientific work** [electronic resource]: methods and techniques of research and academic work / Cleber Cristiano Prodanov, Ernani Cesar de Freitas. – 2nd ed. – Novo Hamburgo: Feevale, 2013. Available at: <https://drive.google.com/file/d/1lp5R-RyTrt6X8UPoq2jJ8gO3UEfM_JJd/view>. Accessed: March 30, 2021.
7. RIBEIRO, A. B. **Study of the internet of things and its technologies. Hall of Knowledge, v. 2, n. 2, 2016.** Cited on page 19.
8. Silverthorn, DU. **Human Physiology. Porto Alegre: Group A, 2017. 9788582714041**. Available from: https://integrada.minhabiblioteca.com.br/#/books/9788582714041/. Accessed on: 09 Feb 2023.
9. Smith, J. K., Silva, A. B., & Oliveira, C. D. (2020). **Importance of continuous monitoring of vital signs in health care**. Brazilian Journal of Medicine, 45(2), 87-95.