MEHMET TEMİ

PULSE OXSIMETER AND HERAT-RATE SENSOR

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PULSE OXSIMETER AND HEART - RATE SENSOR

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCE OF NEAR EAST UNIVERSITY

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In Partial Fulfillment of the Requirements for the Degree of Master of Science in Biomedical Engineering

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Approval of Director of the Graduate Education Institue

Prof. Dr. K.Hüsnü Can BAŞER

We certify this thesis is satisfactory for the award of the degree of the Masters of science in Biomedical Engineering

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

In the century we live in, science and technology are developing rapidly and affecting all areas of life. The foremost area of this domain is undoubtedly the health and biomedical field. While the human body is working, the organs produce some tracking signals regarding their functions. Some of these indicators formed in the human body are taken from patients with appropriate sensors, converted into electrical data and presented to the field specialist for interpretation by processing with the help of devices. Thanks to the system implemented in this study, it will be easier to follow the pulse and oxygen saturation of the patient by a specialist. In this way, the health status of the persons can be monitored even remotely, and the patient can be intervened when necessary with the data coming to the center. Thanks to this method, it will be possible to prevent the patients from forming density in health centers. Wearable systems are one of the most popular research topics today. When studies using different sensors are examined, it is seen that physiological signs that require frequent measurements; ECG, EMG, glucose measurement, pulse, body temperature, blood pressure, oxygen saturation. This study will allow monitoring of the pulse and SpO2 values obtained with the pulse oximeter tool. SpO2 and pulse values are measured and converted into workable values by means of a device placed in a certain area of the body. These analog signals are converted into digital signals with the help of ardiuno, which contains a microprocessor. SpO2 signals are displayed and interpreted on a mobile phone screen.

Keywords: ECG, SpO2, Saturation, LCD, EMG, Glucose

ÖZET

İçinde yaşadığımız yüzyılda bilim ve teknoloji hızla gelişmeye ve yaşamın her alanını etkilemekte. Bu etki alanının en başta şüphesiz sağlık ve biyomedikal alandır. İnsan bedeni çalışırken organlar işlevleri ile ilgili birtakım izleme işaretleri üretir. İnsan vücudunda oluşan bu göstergelerden bazıları uygun sensörlerle hastalardan alınır, elektriksel verilere dönüştürülür ve cihazlar yardımıyla işlenerek yorumlanmak üzere alan uzmanına sunulur. Bu çalışmada gerçekleştirilen sistem sayesinde hastanın bir uzman tarafından nabız ve oksijen saturasyonun takibi daha kolay yapılabilecektir. Bu şekilde kişilerin sağlık durumları uzaktan da olsa takip edilebilecek merkeze gelen verilerle gerektiğinde hastaya müdahale yapılabilecektir. Bu yöntem sayesinde hastaların sağlık merkezlerinde yoğunluk oluşturmaları önlenebilecektir. Giyilebilir sistemler günümüzde en popüler araştırma konularından biridir. Farklı sensörlerin kullanıldığı çalışmalar incelendiğinde çok sık ölçüm ihtiyacı duyulan fizyolojik işaretlerin; EKG, EMG, glikoz ölçümü, nabız, vücut sıcaklığı, kan basıncı, oksijen saturasyonu olduğu görülmektedir. Bu çalışmada nabız oksimetre aracı ile elde edilen nabız ve SpO2 değerlerini izlemeye olanak sağlayacaktır. Vücudun belirli bir bölgesine yerleştirilen cihaz aracılığı ile SpO2 ve nabız değerleri ölçülüp işlenebilir değerlere dönüştürülmektedir. Analog olan bu sinyaller bir mikroişlemci içerisinde barındıran ardiuno yardımıyla sayısal işaretlere çevrilmektedir. SpO2 sinyallerinin, taşınabilir bir sistem olan telefon ekranında görüntülenmesi ve yorumlanması sağlanmıştır

***Anahtar kelimeler*:** EKG, SpO2,Satürasyon, EMG, Glikoz

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LIST OF ABBREVIATIONS

EEG:	Electro Encephalo Gram
EMG:	Electro Myo Gram
ECG:	Electro Cardio Gram
WBAN:	Wireless Body Area Networks
SPO2:	Stands Pripheral Cappillary Oxygen Saturation Sodium
NA:	Sodium
K:	Potassium
CA:	Calcium
CL:	Clorine
ENG:	Electro Neuro Gram
EGG:	Electro Gastro Gram
GP:	Late Potantialiss

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Human beings continued their lives by showing development and change according to the characteristics of the age they are in from past to present. Change is the only truth that has not changed since the day humanity existed.

social changes are taking place throughout the world since the existence of mankind. These changes have emerged by changing the living standards of human beings and adding many innovations to their daily lives. Futurist Alvin Toffler described these changes as three different waves in his work called "The Third Wave". According to Toffler, the transition of primitive societies to agriculture in the course of social and economic growth is the first wave and the transition from the agricultural society to the industrial society is the second wave and the transition from the industrial society to the information society (Valacich and Schneider 2010).

The importance of information and information technologies in the information society phase where social peace, character, and knowledgeable people gain importance is that it can be used in all areas of life from agriculture to industry, from service to education, from health to communication (Aktan and Tunç 1998).

It is thought that communicating can be one of the leading innovations. Since the communication of people with fire, communication has continued to develop in many ways. In the century we live in, rapid change and development in technology, together with the field of health, lead to the change and development of methods in many fields. It made it necessary to meet our needs anytime, anywhere, regardless of time and place. This change, which is based on human beings, has always made its impact on health services. This change we experienced caused new terms to be derived in health systems. One of the most used of these terms is Telemedicine and the other is biotelemetry.

The health services we need to provide us; We need to use communication tools in order to be able to offer quality, fastest and safest. In this sense, telemedicine provides monitoring, diagnosis, treatment, post-treatment monitoring, sending physiological and biological data, storing and providing health services with the help of communication tools between two different centers.

Telemedicine is the use of information and communication technologies to provide health services even when the patient and the doctor are in different places by eliminating the usual doctor-patient encounters. Telemedicine use has gained speed with the spread of personal computers and the internet in today's age. Today, the decrease of the young population, and the increase of the old population, the health problems of the aging societies have become the problem of many countries.

Factors such as the increase in the costs of health services in direct proportion with the increase in the population, the need to decrease the frequency of going to and from the health centers of the patient, the desire to benefit from specialist physicians, to determine more beneficial treatment methods in the light of the long-term statistical data related to the disease, caused telemedication and the widespread application.

According to the Turkish Language Institution, telemetry is "automatic transfer of measurement values or data to long distances with the help of communication tools" (İnt.Kyn.2). Apart from measuring, the telemetry system is also used for monitoring and control. Examining the movements of people, monitoring stress and exercise physiology, monitoring physiological signs such as Electrocardiogram (ECG), Electromyogram (EMG) with biological variables such as blood pressure, blood sugar, temperature, pulse, saturation, etc. It requires.

Biotelemetry is The sending of physiological and biological variables to a center that can interpret the data from a distance and make decisions about the data. Biotelemetry has great importance in telemedicine applications. Where it is impossible to observe in the same environment; Biotelemetry can be used to obtain data from behavioral, physiological, and environmental variables (Güler and Übeyli 2002).

As shown in Figure 1.1, the aim of biotelemetry is to take physiological and biological signs without transferring the movement of living things in the normal life flow and to transfer them to the environment to be observed and processed in a noiseless and safe manner. The most obvious purpose of telemedicine and biotelemetry systems is to provide widespread, inexpensive, quality, and safe health services.

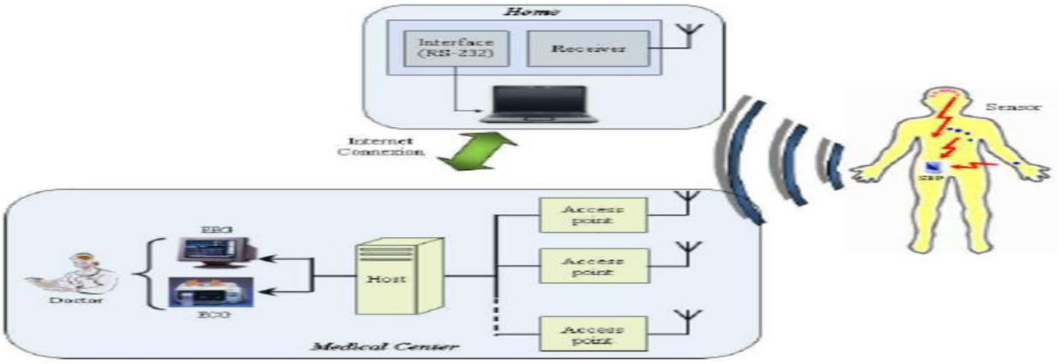

Figure 1.1: Diagram showing the workflow of the biotelemetry system (researchgate,2011)

Nowadays, the technological developments that have gained momentum in all areas of our lives, their effects especially in health He often makes his medical and medical fields. The developments in the medical field date back to the 19th century and continue its development until today.

Studies in NASA (National Aeronautics and Space Administration) have contributed greatly to the developments in medicine and medical fields. The need for health monitoring of the physiological signs of astronauts during space flights has required concentration on devices and systems in this area.It provides the delivery of physiological signs for the purpose of monitoring, diagnosis, treatment, and interpretation by using communication technologies, independent of time and place, and providing health services in order to obtain the health services we need in a quick, safe, and quality manner when desired.Physiological sign; By investigating the functions of organs and their relations with each other, the variables produced in relation to the work of the human body are called. According to another definition, physiological signs are signs of the electrical origin or non-electrical origin, measured by sensors or transducers from the living body.

While signs such as ECG, EMG, electroencephalogram (EEG), electroneurogram (ENG) are physiological signs of electrical origin, signs such as temperature, respiratory volume, skin resistance, blood flow rate, heart sounds, blood pressure are non-electrical signs. Electrically derived signs are formed as a result of electrochemical events that occur in cells. The passage of Na +, K +, Ca + and Cl- ions through the cell membranes creates potential differences, causing such signs to appear. These potential differences are utilized in the diagnosis stage after they are perceived through electrodes and undergo some processing. Physiological signs do not carry easily understandable information from the complex anatomical structure inside the body. For this, these symptoms detected by electrodes must be processed and interpreted.

Therefore, processing, storing, and transmitting these stored values are of great importance in today's clinical practice.The internet, which continues its development rapidly in the age we live, continues to contribute to medical informatics in the field of health thanks to its communication network covering the whole world. Every year, a large number of people die from chronic illnesses, delayed interventions, and lack of health care, or survive with permanent damage.

In the age of rapidly developing information technologies, people expect more from health services. With the increase in the average age of the world population, the increase of chronic diseases, psychological problems, and infectious diseases reveals the importance of health services. However, long treatments in the hospital, bed shortage, people not paying attention to health problems caused by their intensive work or not going to control can cause many mental, physical, and social problems. ECG, EMG, blood pressure, blood sugar, etc. are used to minimize such causes. measurements are made with developed and easy to use devices (Winston et al. 2008).

These devices, which are designed to measure physiological signs for diseases, chronic conditions, and conditions that need to be followed up, and daily follow-up, are used in all areas of our lives.

It is seen that every device we use in these periods when we talked about the internet of things and wearable technologies, has been replaced with smart ones in nano size. The most important features of these devices, which we use a lot in the field of health, are the ability to communicate wirelessly, to observe the physiological signs of the patient and to transfer them to the system they are connected to by means of the communication tools used."Internet of Things" (Internet of Things - IoT); It is defined as a formation where devices communicate with each other, safely accumulates information, decides in the light of the information collected, and transmit the data, without the need for any external input.

There are other definitions for the Internet of Things. For example, the definition made according to Belissent (2010) is as follows: "It is a system that enables information, such as security, health, and transportation, to be used more efficiently by using information technologies".

The International Telecommunications Union (ITU) defines the Internet of Things as "a technology that any object can connect to, at any time, anywhere." The general structure of the Internet of Things is shown in Figure 1.2. As our commitment to the internet increases, the use of devices connected to the internet increases day by day. As a result of the studies conducted according to Cisco, while the number of devices connected to each other in 2012 was 8.7 billion, in 2017 this number increased approximately three times and 28 billion devices could be connected to the internet. By the end of 2020, it is thought that the interconnected devices will reach approximately 50 billion. Figure 1.3 shows the number of devices connected to the Internet and the Internet of Things spread expectation graph according to Cisco data by years (Evans 2011).

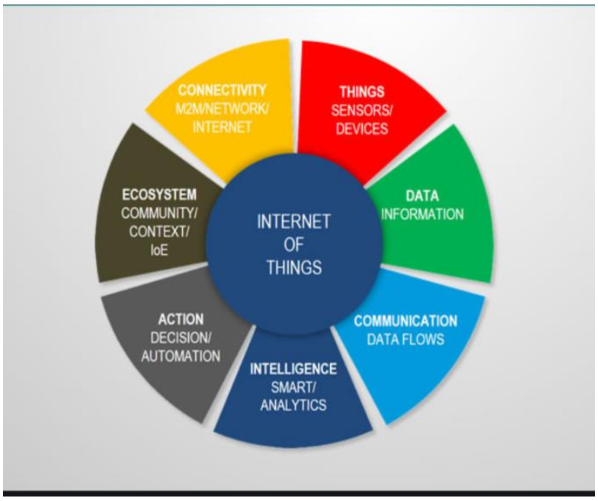

Figure 1.2:The general structure of the Internet of Things (i-scoop,2020).

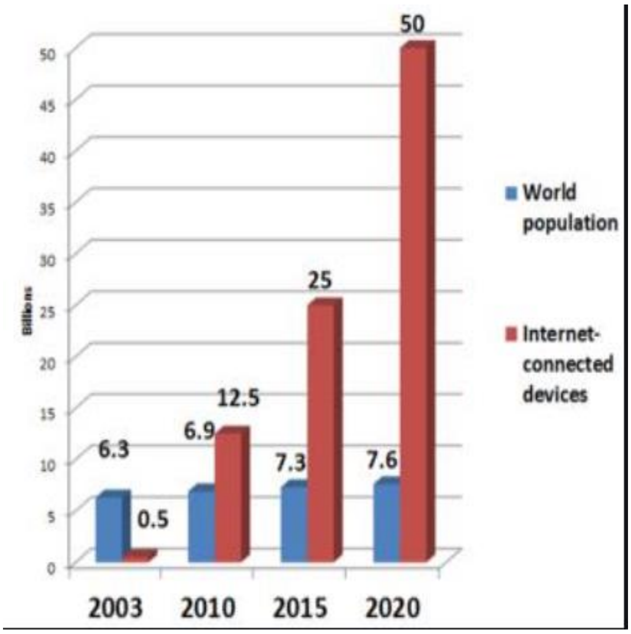

Figure 1.3: According to Cisco data, "Internet of Things Spread Expectation".

Wireless Body Area Networks (Wireless Body Area Networks), which are a component of the Internet of Things structure, are made up of smart devices that are capable of detecting human physiological signs, can communicate, be dressed on the patient, and are very small in size, which process data from sensors. Some of the smart devices used in WBAN applications in the field of health can be counted as ECG, EMG, EEG, SpO2, blood pressure, wearable and integrable sensors, swallowed cameras, temperature meters (Tachtatzis 2012).

WBAN is an important component of medical tracking systems and the internet of things technology. Physiological signs collected from patients through WBAN are mostly used for follow-up. The most important purpose of using WBAN in the biomedical field; In addition to maximizing high quality and efficiency in health, preventive measures are taken before situations requiring urgent intervention.

When today's health technology is examined, it is seen how much it is integral and integral with electronics. Electronic technology is actively used in today's healthcare areas. The effective use of electronics and the healthcare industry side by side has brought many positive results for both doctors and patients. The share of industrial electronic equipment in the field of health is increasing day by day in the developments. Undoubtedly, this situation will continue in this way for many years. Because electronic equipment can be a practical solution for many difficulties in the health sector. In daily life, people usually need to go to health centers to get physiological measurements. What should be kept under control in most people these physiological values are placed on the second plan for different reasons.

As a result of this thesis, thanks to the sensor used with Arduino; one can keep physiological value under control at any time. Thanks to the Arduino embedded system and the sensors (sensors) used, the data of the person will be read quickly via serial communication and the data will be sent to the device that is in communication with the Bluetooth connection to the device.

The main objectives of the project to be created within the scope of the thesis are; Obtaining physiological data such as SpO2 and pulse from patients using Arduino, storing the data obtained, transforming the stored data into a structure that everyone can understand, communicating physiological measurements between the patient and the physician via tools such as Bluetooth or wireless, designing interfaces according to the different communication systems used, created to enable the project to be expanded with different sensors.

In this study, in the biomedical field within the scope of Arduino embedded systems; By using various sensors such as ECG, EMG, SpO2, remote patient monitoring such as measuring their values, measuring the ambient temperature and physiological data of the person will be measured, and the data from these sensors can be evaluated and processed by the control Software microcontroller interaction.

CHAPTER 2
BACKGRAUND STUDY

2.1 LITERATURE REVİEW

When a literature review was conducted, studies in which concepts such as telemedicine, biotelemetry, remote patient follow-up, physiological signs, internet of things, and communication technologies were examined. In 1773 Walsh found the ability of electricity in the muscle tissues of Eel fish to form a spark. In 1792, published by Luigi Galvani in the article "De Viribus Electritatis In Motu Muscular Commentarius", it was proved that electricity can initiate muscle contractions.

The first real EMG recording was made by Marey and the first EMG definition was defined by Marey. With the invention of the oscilloscope, in 1924, Gasser and Erlander managed to observe the EMG signals on the oscilloscope. 4 years later, Proebster found that it was produced by these muscles and opened the clinical EMG field (Yazıcı 2008). The foundation of EMG was laid in 1786 with the experiment of Galvani. In this experiment, Galvani observed the movement of the muscles in the frog's leg by touching the scalpel in his hand to the leg of a dead frog (İnt.Kyn.3).

The electric currents of the heart were recorded for the first time in 1876. Wilhelm Einthoven used a system based on a galvanometric basis in 1903 and managed to print the electrical activities occurring in the heart. P, Q, R, S, T definitions were made by Wilhelm Einthoven for the first time in 1895.

While the first ECG recording was in the hospital environment, the ECG was recorded in the physiology laboratory 1.5 km away (Cardiol 2010). Research on telemedicine started with NASA sending people into space, and the physiological signs of astronauts were made using communication channels.

With the Apollo project in 1967, during the lunar march conducted by astronauts far away from our world, it transmitted their physiological signs such as ECG, EMG, blood pressure, pulse, carbon dioxide in the blood (Perednia 1995). In the Apollo Project (1967-1972), astronauts were planned to be 300000km away from the earth and the medical care unit. Telemedicine and biotelemetry offered astronauts specific medical equipment and the opportunity to perform a number of operations on their own. Elena et al. (2002), the Cardiosmart smart cardiology imaging system sent only the problematic ECG signal in the project they named using General Packet Radio Service (GPRS). Dong et al. (2004) designed a mobile ECG detector in their studies. By developing a mobile wearable wireless ECG detector with Bluetooth standard, they provided the transmission of ECG data via GPRS.

the physiological signs of the patient can be taken and observed independently from the location of the patient with the help of wireless sensors. With this study, a mobile tracking system has been developed. Monon et al. (2005) receives Oxygen Saturation (SpO2) and pulse signal data from people via Bluetooth and transmits via GPRS.

Chien et al. (2005), in its study, the ECG and EMG signals were sent to the receiver unit with the Radio Frequency (RF) wireless communication standard as a physiological signal. by obtaining some of the physiological signs and using a mobile communication system, have designed a system within the ambulance that the physician in the hospital can follow up (Hakan and Guler 2010).

Monon et al. (2005),

in his study of Pulse Oximetry sensors, SpO2 and pulse signal data are received from physiological signs with wireless technology, which is a wireless communication system, and data is sent via Wireless Local Area Network (WLAN) and GPRS. Thus, the data of more than one patient from a single-center are displayed.

Hassinen et al. (2006), in his study titled "Disaster Recovery Coordination Using Documentation System in an Emergency Medical Situation", the transmission of various physiological signs of patients via Bluetooth, which is the wireless communication technology, as well as the transmission of patient and treatment information detected in different ways with different wireless technologies and By recording this information in the documentation, a model that will ensure order and harmony between manpower and the materials used in emergency medical aid has been proposed.

Kumar et al. (2006), in his study, SpO2 and body temperature values were transferred to the main unit with RF, which is the wireless communication standard, and then sent to the server unit using GSM infrastructure as messages.

An application covering a very large area has been realized with the use of wireless communication technology. Visuality was provided with the LabVIEW program used in the server section. ZhuQ et al. (2006) implemented a PDA based ECG transmission system. In this study, using GPRS technology, the ECG signal was taken with PDA and transmitted to a remote medical ECG service Park et al. (2006) have created an ECG monitoring system that uses wearable, wireless, low power capacitive sensors. USB, Ethernet, and Wi-Fi, which are standard connections, are preferred in order to be used all over the world. Proulx et al. (2006) designed an ECG monitoring system via Bluetooth. According to Eşme (2006), he designed a heart device that can be controlled remotely. The designed device is modular and portable.

Communication with ECG signals and other communication data can be made with dial-up and internet, and communication with the GSM modem is preferred. According to Kabalcı (2006), he implemented a computer-centered wireless ECG biotelemetry system. He transmitted the ECG information he received from the body wirelessly and transferred it to the computer.

Fidan et al. (2007), in their study, measured the data of the main physiological signs taken from the patient such as ECG, EMG, respiratory rate, body temperature, and heart rate. In addition, they designed the 4-channel device that allows the measurement result to be transmitted to the specified distance at the same time. According to Zeybek (2007), he designed a portable ECG measuring device as part of the Internet of Things and provided the ECG data he obtained to be displayed on the computer by transferring wireless technology to a central computer using RF. Eugene et al. (2007), In the study entitled "Development of an Electronic Medical Report Delivery System to 3G GSM Mobile (Cellular) Phones for a Medical Imaging Department", electronically prepared reports are transmitted to specialist physicians using 3G (Third Generation) communication technologies. Yang et al. (2014), in their study, received and processed the ECG sign, which is one of the physiological signs, with GPRS. They conducted studies on the ECG data they received in their studies and when an unwanted situation was encountered in the ECG data, they sent an alarm signal to the server with the GPRS module (Yazıcı 2008).

According to Hu et al. (2009) conducted a study to collect and monitor multiple physiological signals and to transmit them.

In the study, in order to detect diseases such as sudden heart attacks, hypertension, and paralysis of patients over a certain age; A WBA was set up to receive and send physiological signals such as ECG, EMG, and EEG. The obtained physiological signs are provided to be examined with the software used. Radio Frequency Identification (RFID), a wireless technology, was used to obtain patient identification and location information. Simunic et al. (2009) observed in their study that the Wireless system is advantageous over the wired system. They tried to make a simple wireless channel using Bluetooth technology, which limits the transmission of ECG data received in-home and ambulance environments. in the study, a measurement was performed using ZigBee communication technology. In the study, the transmission of the signs was achieved with the ECG signs ZigBee transceiver. The received signs are drawn on the screen with a program running in a computer environment, and the images of the signs are taken. Jara et al. (2010) proposed a system that works on the Internet of Things principle and predicts side effects in order to prevent drugs from causing harmful side effects. The introduction of the patients to the system is done by RFID-NFC (Near Field Communication), which is the wireless communication technology, and the introduction of the drugs used to the system is made by the barcode reading system. After patient and drug information is introduced to the system, this information is sent to the Pharmaceutical Pharmacy Information System. In order to prevent problems that may occur, the patient's allergy status and health records are compared. The patient is warned when any problem is encountered.

Atzori et al. (2010) conducted a study on the Internet of Things. In the study, internet applications of objects are mentioned and the importance of patient monitoring applications in biomedical applications is mentioned. According to Kaya (2010), he tried to record physiological data that patients can use without changing their daily lives and then send them to an expert via e-mail. This sending method is provided by RF modules.

In this study, ECG data of different patients can be recorded and e-mailed to specialists anywhere in the world. According to Can (2010), he designed a low-cost device and tried to send the data he obtained to the phone. With the Bluetooth module, which is a wireless technology, it provided the ECG signs to the mobile phone and displayed them. Using the Bluetooth module, data was provided to other devices within 10 meters or too long distances with GSM operators.

Yu et al. (2010) attempted to send and send ECG data compression to ensure low power consumption. For this, they have developed a new algorithm by following a way of combining Discrete Cosine Transform (AKD) and Lempel Ziv Welch (LZW) algorithms. They effectively compressed the data, resulting in low power consumption. According to Özcan (2010), he designed a seven-channel ECG measuring device in his study.

He tried to transmit the measured values to the interface he created on the computer by using wireless technology, the Bluetooth communication technology. According to Baş (2011), in his study, he developed a design proposal related to the monitoring of patients. This system has developed consists of 2 parts. The first is to monitor patients remotely, and the other is to monitor patients in the hospital. The system proposed in the study is a three-layer block structure. The first of these layers is the WBAN block, the second is the body area network server block, and the third is the medical server block.

According to Kırbaş (2013), in order to eliminate some problems encountered in KVAAs, it designed a layer that supports multi-channel communication. In the Kırbaş study, he observed the comparison of the problems detected using OPNET Modeler, which is the simulation software. Yang et al. (2014) have created a platform for an intelligent healthcare system based on the Internet of Things.

In this study, a smart medicine box (IMedBox) was developed to check whether their patients were using their medication or not. This medicine box they developed can communicate with RFID and a smart medicine box (IMedPack) is designed to warn if the patient is not taking it by checking whether he/she is taking the medicine regularly. Working logic of the system; It is in the form of warning users about the weight that does not decrease during drug intake hours by means of a weight sensor placed in the medicine box, and if the drug is not used at the specified time, this is to send an information note to the people responsible for the follow-up of the drug. Aktaş et al. (2015) sent the ECG signals obtained by conducting a study on the transmission of physiological signs from patients using WBAN, in a wireless environment. In the application, the simulation was created using the OPNET Modeler program. Considering the results, it was concluded that the physiological signs obtained from the patients were successfully transmitted according to the service quality parameters.

Babu et al. (2016) proposed an ECG imaging system consisting of three different subsystems. The first subsystem in this imaging system is used to read analog ECG signals. The second subsystem consists of a microcontroller and Bluetooth module and is used to convert ECG signals to digital and transmit to the phone with the Android operating system. The third subsystem is the phone itself, which is used to display ECG signals through appropriate graphics. In the last study on the subject, a real-time patient imaging system was proposed using LabVIEW. When the literature review is examined, it is seen that the foundations of EMG and ECG were laid with the work done by Francesco Redi in 1666 and the work done by Galvani in 1786.

Studies on physiological signs in the period until today have been examined. With the development of technology, different definitions and expressions have been said. In recent studies, it is observed that the communication technologies used to convey physiological signs to field specialists, regardless of location and time, are emphasized.

CHAPTER 3
MATERIAL AND METHOD

In this section, information about the formation, detection, and measurement of physiological signs, the physiological structure of the heart, muscle structure, electrodes, and sensors used for measuring physiological signs such as ECG, EMG, Pulse will be presented.

3.1 Formation of Physiological Signs

The systems that make up the living body produce some signs while performing various functions. These signs, called physiological signs or bioelectric signs, are generally not understandable information. These produced signs often do not carry easily understandable information from the complex biological structure occurring inside our body to the outside world. In order to make sense of these various events taking place inside our body, it is necessary to analyzer, process, evaluate, and interpret them. Body systems such as brain, heart, nervous conduction, and various muscle movements are examined under the name of physiological signs.

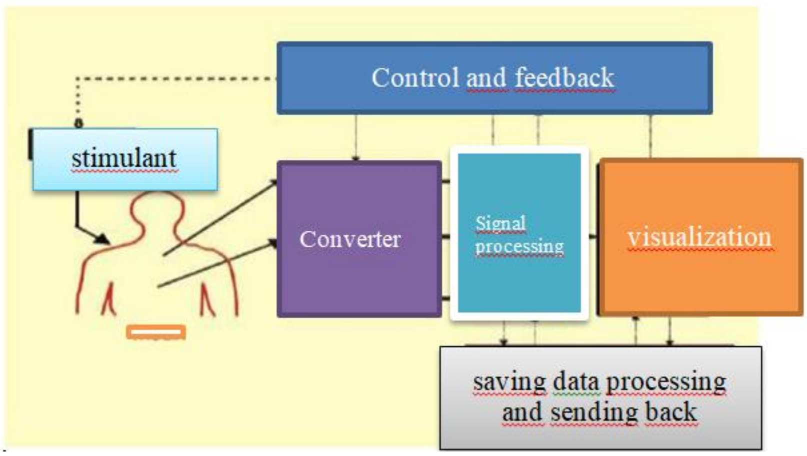

Figure 3.1: Processing of physiological signs (Yazgan and Korürek 1996).

As seen in Figure 3.1, the physiological signs are detected from the living body through stimulators or transducers, and processed after some operations, by coming to the last step of recording, data processing, and sending back. Physiological signs, heart, brain, nervous system in the human body and are formed during the work of organs such as muscles. The basis for the occurrence of these signs lies in the action potential resulting from the electrochemical events in the cells.

In the century we live in, it is seen that studies in the physiological field have increased in parallel with the developments in communication, informatics, electronics, and technology. Studies in this area have opened new horizons in the field of processing, interpretation, and evaluation of physiological signals (Yazgan and Korürek 1996). The use of physiological signs in the human body such as the brain, neural conduction, heart and various muscle movements, perceived and evaluated with the help of electrodes or transducers, and the use of them in the follow-up of some diseases are examples of developments in the biomedical field.

3.2 Formation of Bioelectric Signs

While living things maintain their vital functions, they produce some electrical symptoms. These symptoms are produced as a result of electrochemical events occurring in cells. These symptoms that occur as a result of the electrochemical activity of cells, tissues, and organs are called bioelectric signals. The source of the changes, called bioelectric signals, is a single nerve or muscle cell. The cell is the smallest part of living things in terms of structure and function that can sustain life independently. Cell; The nucleus called nucleus consists of the cell body called cytoplasm and the cell membrane surrounding the cytoplasm. The electrical signs formed in the cells are formed due to the excitability of the cell. The excitability feature in the cells varies according to the cells. The biggest stimulators are nerve and muscle cells. If the membranes of cells such as nerve and muscle cells are stimulated with a sign above their threshold level, this warning is transmitted to the whole cell. Stimulation in cells can be chemical, thermal, electrical, optical, or mechanical. Figure 3.2 shows the ion movement that occurs in the cell membrane.

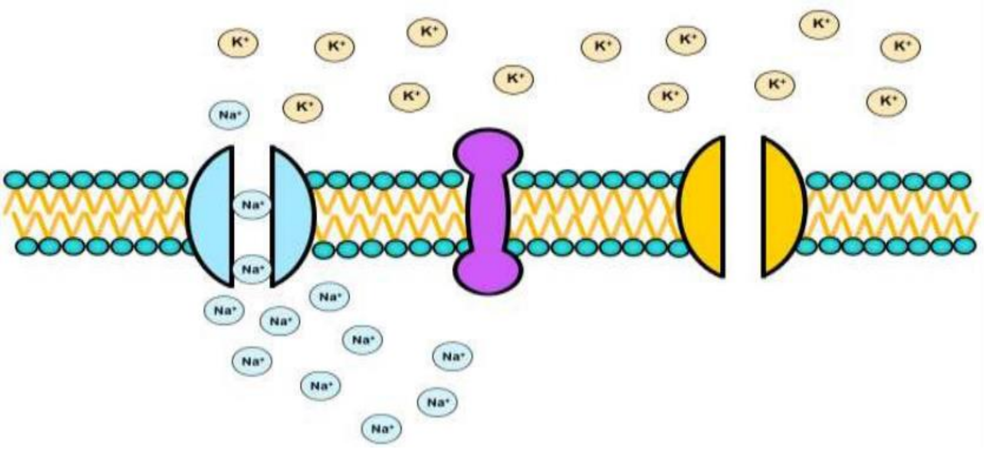

Figure 3.2:Ion movement in the cell membrane (britannica,2020).

3.3 Detection of Physiological Signs and Electrodes Used

Ionic currents are formed as a result of electrochemical events in the cells in the living body. The ionic currents formed as a result of electrochemical events cause the movements of chlorine (Cl), sodium (Na), potassium (K), and calcium (Ca) ions inside the cell and their reactions with each other (Sezgin 2006).

Transformers that convert ionic potentials and currents into electrical potentials and currents are used to measure bioelectric potentials. The transducers that we use to measure electrical origin physiological signals consist of electrodes. Electrodes measure the difference in ionic potential between the areas where they are applied on the body surface. Although it is not impossible to measure the individual action potentials produced by each cell in the living body, it is quite difficult except for some special applications.

The difficult reason is that electrodes must be placed precisely in the cell. To accurately measure bioelectric potentials, measurements are taken from the body surface. In such a measurement, the total of the action potentials of the underlying cells to the surface is taken. In some measurements, instead of electrodes used on the surface, measurements are made with needle electrodes that are immersed in the case, nerve, or certain areas of the brain. It is not known exactly how bioelectric potentials reach the body surface.

There are many theories about this topic. Measurement method Bioelectric potentials are well-known waveforms. To monitor the waveforms, it is necessary to perform some isolation operations as shown in Figure 3.3

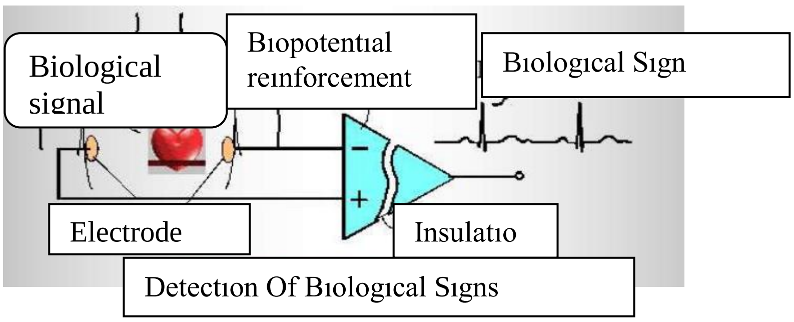

Figure 3.3:Perception of physiological signs(Alpman, 2013)

The electrode can be defined as a kind of sensor that converts the ionic potential on the body into electrical potential. According to the Biomedical Device Technologies Module of the Ministry of National Education, the Electrode is called "Electrode", which provides the communication between the body and the measuring device so that biological signals can be perceived especially for diagnostic purposes in medicine, and that provides current to the organs for various purposes and especially for the purpose of treatment. (İnt. Kyn 8). Electrodes used for different purposes are gathered under three groups

1. Micro Electrodes: Used to measure the bioelectric potential in a cell.
2. Internal (Needle) Electrodes: These are the electrodes in which bioelectric potentials are obtained by immersion in the skin.
3. Surface Electrodes: These are the electrodes used to detect physiological signs from the skin surface. There are different types of surface electrodes depending on their usage.

3.4 Measurement of Physiological Signals

Sensors and transducers are used to measure biological and physiological signals. Signs are converted into electrical energy for ease of signal processing, display, and storage in measurement devices (Yazgan and Korürek 1996).

3.5 Physiological Sign Types

Physiological signs measured by transducers or electrodes from the living body are collected in two sections as indicated in Figure 3.4. The first of these are the signs of electrical origin and the other is the signs of non-electrical origin. While signs such as ECG, EMG, EEG, ENG are physiological signs of electrical origin, signs such as blood flow rate, blood pressure, heart sounds, respiratory volume, temperature, and skin resistance are non-electrical signs.

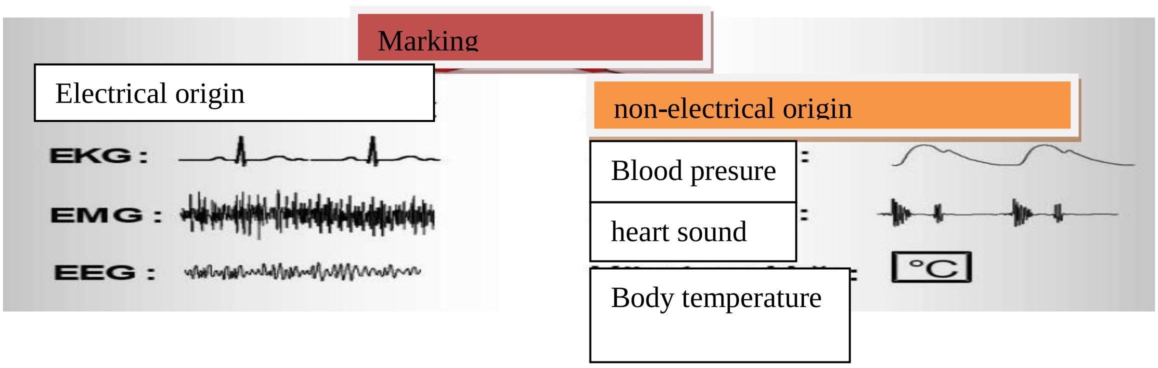

Figure3.4: Physiologicalsigns(Alpman, 2013).

Electricity-induced signs occur among chemical events occurring in their cells. Potential differences between the passages of Na +, K +, Ca + and Cl-ions from the cell membranes cause such signs to occur. Signs that are not of electrical origin; examination of blood pressures using pressure transducers, measuring blood flow velocity with ultrasonic and electromagnetic, conversion of variable definitions of the skin with plethysmograph, which is the printing tool containing the blood flow formed in the coexisting veins, the examination of respiratory volume, temperature changes of the effective or organs, pH meter measurements, exemplary heart transducers, chemical transducers of blood or air. For some terms in the graphic representation of physiological signs.

One of these words used in Latin is gram and the other is graf. In the graphical representation, you can measure the additional cause of the downward graph according to your perception of the measured waveform at the end of the organ to which the waveform belongs. The physiological signal measured is because it is of electrical origin. For example; an electrocardiogram and an instrument measuring it are called an electrocardiograph (Yazgan and Korürek 1996).

Table 3.1: Naming of physiological signs.Names of physiological signs

ECG	Electro cardio gram	Cardio	heart
EMG	Electro myo gram	Myo	muscle
EEG	Electro encephalogram	Encepharal	brain
ENG	Electro neuro gram	Nöro	boundary
EGG	Elektro gastro gram	Gastro	gastrointestinal
ERG	Electro retino gram	Retino	retina
UP (“EP”)	Evoked Potentials		the brain
GP (“LP”)	Late Potentials		heart

3.6 Heart

The heart is an organ that pumps blood and ensures clean blood on the one hand and dirty blood on the other. The heart, which provides the pumping of blood by contraction and relaxation and is of great importance for other organs in the human body, does not hinder the work of the nearby organs while performing such a vital task. The human heart, which has an important task for survival, is an organ made of muscle that is a little larger than the fist and between the two lungs inside the rib cage.

The heart's task is to provide the bloodstream that carries oxygen and nutrients necessary for the human body. As a result of this circulation, life continues. The heart, which looks anatomically like a single organ, consists of two organs, the right heart and the left heart when functionally viewed. There is oxygen-free blood in the right heart, while oxygenated blood is in the left heart. There is no connection between the right heart and the left heart, and both have two parts. Of these, the upper ones are called atria, and the lower ones are called ventricles. The structure of the heart is shown in Figure 3.5.

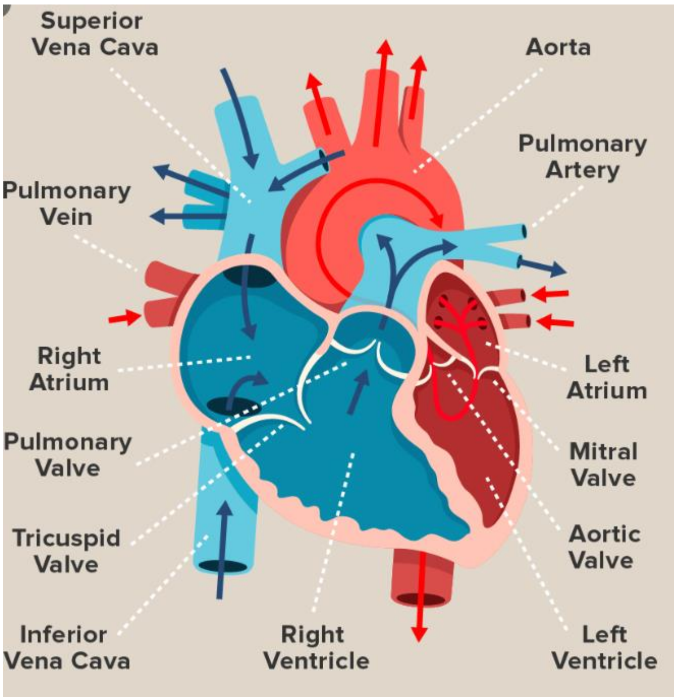

Figure 3.5: The Outerappearance Of The Hear (Healthblog,2020)

The heart pumps about 9000 liters of blood a day, beating at an average rate of 60 to 80 per minute.

The sound we hear when we put our hands on our hearts is the time it takes for the valves between the auricle and ventricle to open and close. The weight of the heart weighs 200 - 280 grams in an adult healthy woman, and 250 - 390 grams in an adult healthy man Although the heart is a single organ, it consists of two parts that send blood to the lung and other organs. Each of these two parts consists of one ventricle and auricle.

The right atrium is connected to the upper and lower balls, the contaminated blood transported from the right atrium to the heart. The right ventricle is located below the right atrium and in front of the left ventricle. Dirty blood is sent from the right ventricle to the lungs.

The left atrium is located behind the right atrium, above the left ventricle. Blood oxygenated and returned from the lung comes here. The left ventricle is located behind the right ventricle, under the left atrium. Clean blood from the left atrium is sent to other organs via the right ventricle.

3.7 Heart Study and Physiological Structure

The work of the heart is by the contraction of the heart muscle (systole) (diastole). The heart consists of two separate pumps; the right heart pumps blood to the lungs and the left heart to the peripheral organs. The right and left parts of the heart are completely separated from each other by a wall (Septum). Heart mammals have a four-compartment structure consisting of auricle and ventricle.

The auricles and ventricles in the heart contract and relax, allowing blood circulation to be pumped into other organs. This contraction is regulated by specialized node tissues located in certain parts of the heart.

The primary task of the atria is to help carry blood to the ventricles. The task of the ventricles is to provide the main pumping force that provides large and small blood circulation. Earbuds and ventricles contract and relax in a contrasting manner. While one contracts, the other loosens. The chambers in the heart pump blood in the chamber at the moment of contraction of the heart. At the moment of relaxation, the chambers are filled with blood.

As in all organs of our body, it consists of cells in the heart. And these cells need to get oxygen. Although the heart feeds the body with the blood it pumps from the chambers, it does not feed with the blood in the chambers, but with the blood, it receives from the coronary arteries.

Each heartbeat occurs without a contraction and relaxation. An average heartbeat lasts 0.85 seconds. At 0.15 seconds of this elapsed time, the atria contracts, and at 0.30 seconds, the ventricles contract. In the remaining 0.40 seconds, the heart goes to rest. The number of heartbeats in a healthy person ranges from 60 to 80 per minute.

3.8Heart Stimulation and Electrical Conduction

The heart is an organ that is capable of contracting rhythmically without any stimulation. The heart pumps blood through the pressure in the cavities. The blood pressure that occurs as a result of pumping blood flows from the strong side to the weak side so that it cannot return. This formed heart pressure causes the contraction of the heart and the place where this contraction begins in the heart is the section where the main veins enter the heart.

The contraction that started begins by spreading to the auricles and then to the ventricles. The blood that comes to him during the contraction of the heart is realized by the contraction and relaxation as a result of electrical currents occurring in the heart.

The value of electric currents resulting from contraction and relaxation is at the level of millivolts (mV). These current values measured at the level of mV are converted into a traceable and recordable form by increasing their values with special devices. All of the vertical and horizontal successive movements from an initial contraction event in the heart to the first recurrence of this event constitute the heartbeat. During the heartbeat, first the two auricles then the two ventricles contract together. The heartbeat is controlled by the autonomic nervous system.

The cardiac center that controls the heartbeat is located in the medulla oblongata at the base of the brain. While the nerve called "Vagus nerve" slows down the heart rate, the nerve called "accelerator" increases the heart rate. Both nerves terminate in a nerve-muscle tissue located near the entry point of the upper main vein of the right atrium. A heartbeat that occurs in living things begins when the area called the sinoatrial (sinus node-SA) node located on the upper sidewall of the right atrium of the heart produces an electrical stimulus. The heart is a versatile organ that constantly generates a certain electrical potential and does a mechanical job like contraction after this activity. In Figure 3.6, electrical signals resulting from the physical movement of the heart are shown.

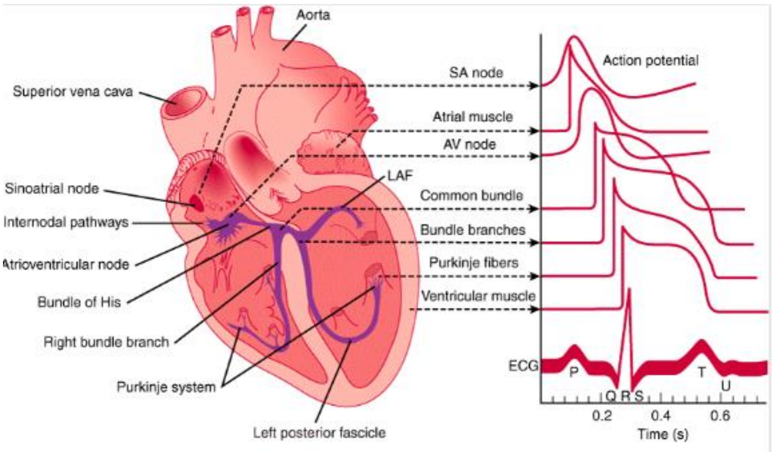

Figure 3.6: The electrical signals resulting from the physical movement of the heart.

The heart muscle has a tissue of very thin long cells. The heart muscle cells, which merge with their side extensions, are sequenced by connecting end to end through a set of discs. The prerequisite for the contraction of the heart muscle is the electrical action of the cell membrane. Calcium (Ca ++) ion is the main element that converts the electrical movement into mechanical motion. Action potential consists of contraction and relaxation stages. Following the electrical discharge of the cell, it has the potential to rest when it returns to its initial shape (Nizam 2008).

In order for the heart to repeat its electrical, mechanical activity in a certain order, the ion that enters or exits the cell in one period of the electrical period must return to its place within that period. The ion passages that ensure this flow are located in the heart cell membrane (Karadag 2009).

The heart's electrical stimulation and conduction system consist of four parts. These; (SA) are (AV) atrioventricular knots, sensory bundles and arms, and Purkinje fibers (Yazgan and Korürek 1996). Of these, the (SA) node and (AV) node warning, sense bundle, and Purkinje fibers are the message system. SA Knot; The SA node consists of special heart cells (3 * 10 mm tall) located on the back wall of the right atrium and is controlled by the central nervous system.

The SA node is the region where electrical impulses begin, which initiate the beating of the heart and control the rhythm of the heart. For this reason, this node determines its movement speed, and its event is called Pacemaker, which means the heart's natural battery. In abnormal situations such as the transmission of messages from this node, the atrioventricular node or other departments assume this task. AV Node; The potential in the SA node reaches the AV node after a short time. The time spent here is not enough to transfer the blood in the auricles to the ventricles completely.

Therefore, a delay is required. This delay is provided by the AV node. His Harness and Arms; The warnings reaching this bundle proceed from the right and left branches and reach the Purkinje part located in the muscle of the ventricles.

Purkinje Fibers; Stimulations that reach here from the bundles of His bundle are transmitted to the ventricular muscles by the Purkinje fibers (Yazgan and Korürek 1996). The heart continues to operate functionally due to this system of messages. As a result of this contraction of the heart muscles, an electrical signal occurs. This Electrocardiogram mark can be detected from the human body thanks to the ECG device.

3.9 ECG Features and Description

Physiological signs that can be detected by electrodes placed on the human body and occur as a result of the electrical current that occurs during the contraction and relaxation of the heart are called an electrocardiogram, electrocardiographic sign, ECG sign or ECG for short. ECG signs, which are indicators of the disorders occurring during the work of the heart and can be obtained without performing a surgical operation with the electrodes placed on the human body, are of great importance for the evaluation of heart function (Meriç 2007).

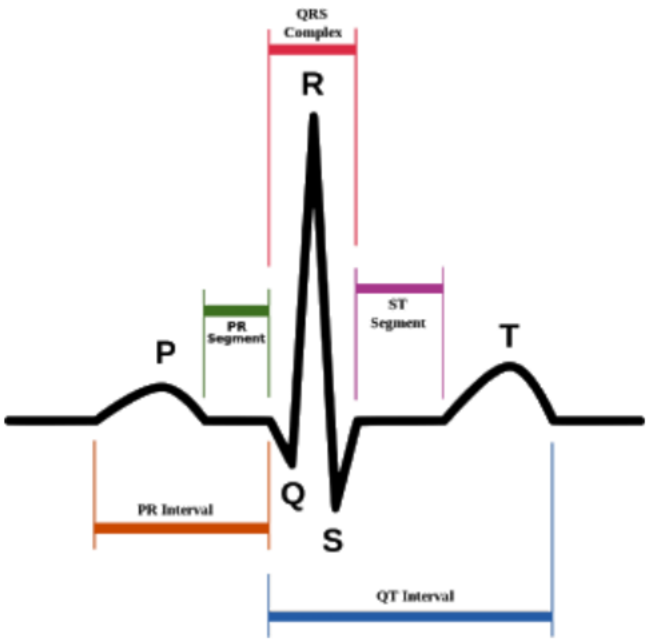

Figure 3.7: An example electrocardiogram mark (Alpman, 2013).

As seen in Figure 3.8, a normal ECG graphic consists of three basic waveforms. Regular recording of ECG signs starting with a P wave, continuing with QRS and ending with T wave, gives information about whether the heartbeat is normal. The heartbeat is a random process, mostly measured in the R - R range. While ECG signs of a person without heart disease show routine and similar progress, the patient is considered to have a heart condition in routine and unlike ECG signs. As can be seen in Figure 3.8, the heartbeats 1, 2, and 3 are beats coming in the normal time. The 4th shot came earlier than expected; It is an "early" beat, "extrasystole".

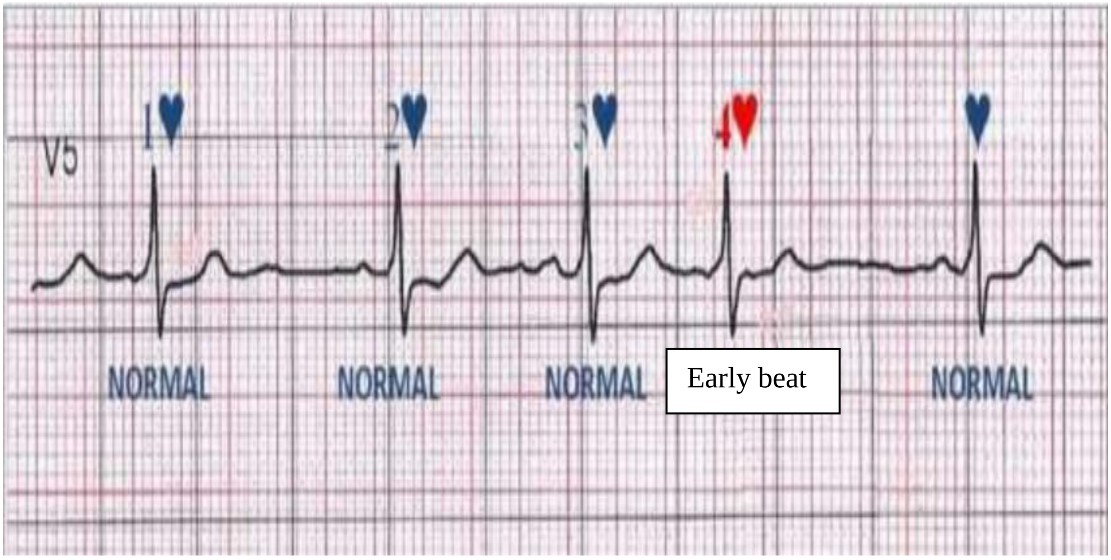

Figure 3.8: Non-routine ECG graph.

Usage areas of ECG;

- To determine whether the heart rate is normal or if there are some abnormal conditions such as rhythm disorder,
- In determining the damages of the previous heart attacks,
- Determination of calcium, magnesium, potassium and other electrolyte disorders,
- Determining conduction abnormalities such as heart obstruction,
- In obtaining information about the physical condition of the heart,
- It is used as an imaging tool during the EFOR test to determine heart disease.

3.10 ECG Measurement

The electrical signals produced by the heart and transmitted to the body surface are measured by means of electrodes placed on the arms, legs, and certain points on the chest via ECG channels. The current lines (or force lines belonging to the electric field) that a dipole will form in the body, which is the volume conductor, and the equipotential lines that are always perpendicular to these lines are shown in Figure 3.9. The heart dipole is considered in the center of gravity of an equilateral triangle called the Einthoven triangle, with corners in the left arm (L), right arm (R), and left leg(F).

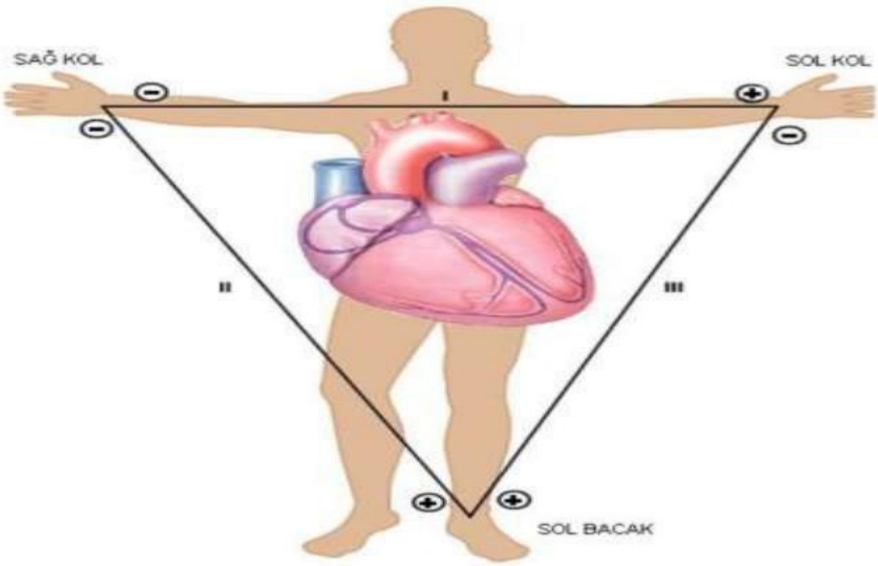

Figure 3.9: Einthoven triangle (Medicalopedia,2011).

3.11 EMG Sign and Measurement of Signals

One of the characteristics that distinguish humans from other living things is that they use their organs efficiently. In the period from the day, humanity has existed, humanity has made studies to understand its own movement system. The electrical signals occurring in the muscles are used to understand the function and structure of the muscles, the most important element of our motion system. Biopotential signs that occur during the contraction and rest of the muscles are called EMG signals. Electromyography is the measurement of EMG signals, and the system that records this process is called electromyography. EMG is often used for purposes such as the detection of disorders that occur in the work of the muscles.

However, with the development of technology, it is used in research such as prosthesis and robot limb today. In areas where muscle clusters are concentrated, the biopotentials formed in the muscles overlap each other, which affects the way EMG signals appear. Figure 3.10 shows a typical EMG signal.

EMG signals take different forms according to the location of the muscle set, the location of the electrodes, the strength spent in the muscles, and the intensity of arousal. Electrodes are used to receive EMG marks. Superficial electrodes are used on the body, and needle electrodes are used in applications that need to be entered directly into the muscle. Figure 3.10 shows a sample EMG signal graphic.

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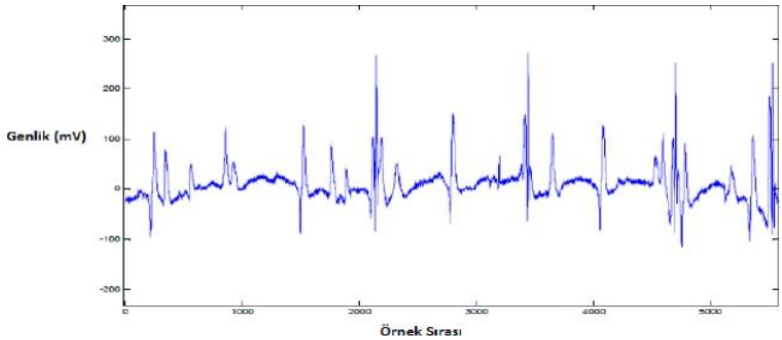

Figure 3.10: Example EMG Signal.

3.12 The Structure Of The Muscles

The muscular system is the system that provides the body with the ability to move. Muscles make up approximately half of the creature's body weight. By protecting and supporting the shape of your body by wrapping it on your living skeleton, such as excretion, circulation, digestion, etc. Regular operation of the systems necessary for the survival of the creature is possible thanks to the muscles that make up these organs.

The nutrients necessary for the muscles to work are carried through the blood vessels and the stimulation through the nerves. It is not possible for the bones that make up the skeleton to move on their own. The movement of bones is possible thanks to the muscles in living things. Voluntary muscle movements are a feature of striated muscles, and the action potentials that occur in the brain are caused by the transmission of muscles through the nerves. The functional basis of skeletal muscles is motor units.

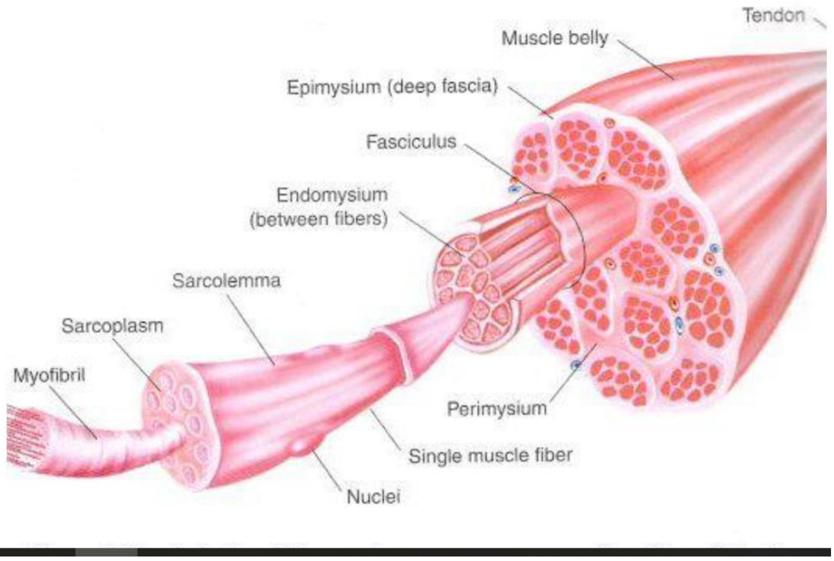

Figure 3.11: The structure of the muscles.

The outer surfaces of their muscles are covered with a cell membrane called necrolysis. The skeletal muscles seen in Figure 3.11 are formed by the gathering of a large number of muscle cells called fiber, ranging from 1 mm to 50 cm in width and 10-100 microns in width. These fibers, which are formed by muscle cells, are connected to each other by cartilage tissue. With the shortening and swelling of the fibers that make up the muscles, contractions occur in the muscle. There are three different ways of contraction in the muscles. These; isometric contraction, isotonic contraction, and tetanic contraction. The structure of the muscles varies according to the types of work. The creature's skeletal system includes three main types of muscles: striped muscles, smooth muscles, and heart muscle. Each of these allows the skeletal system to work differently. Therefore, the different structural shapes of the muscles reveal that the working styles are different.

3.13 Electrodes Used in EMG Measurement

The first physiological signs are taken from the body thanks to the electrodes used. The electrode is the name given to the interface elements that provide communication between the body and the measuring device, electrical current for various purposes, especially for diagnosis and treatment purposes.

Electrodes perform their expected functions by converting the electron current to ion current or ion current to electron current. Electrodes perform the conversion process in the electrolyte in which the electrodes are located and on the surface close to the electrode. Surface electrodes and needle electrodes are shown in Figure 3.12 are generally used in EMG measurements. Surface electrodes are used to measure the muscles close to the skin surface, and needle electrodes are used when more precise measurements are required or to measure the muscles away from the skin surface.

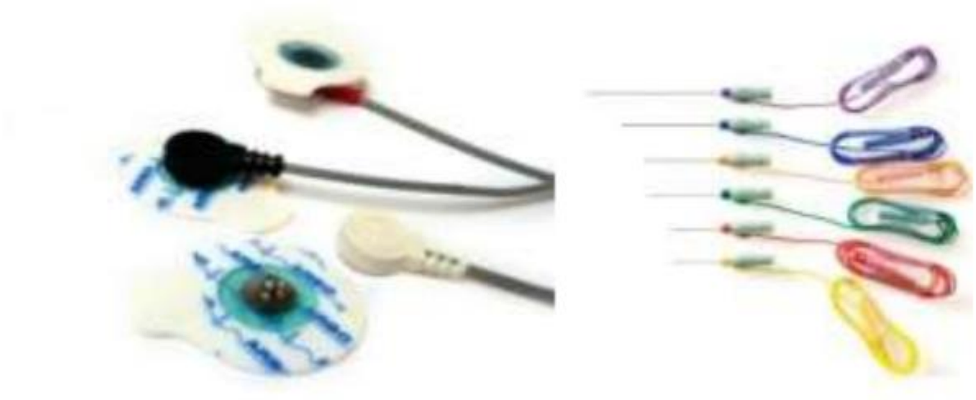

Figure 3.12: Surface and Needle Electrode.

Electrodes used to measure EMG signals have important roles in influencing the characteristics of the received signal. While the EMG signal is being recorded, the electrical signals in the muscles near the measured muscle may affect the value of the actual signal in the measured muscle, thereby impairing the property of the signal.The occurrence of this condition, called sound or noise, has the effect of using electrodes with large surfaces or not placing the electrodes correctly.

Keeping the electrode surface as small as possible in order not to encounter these problems is one of the methods applied to obtain a healthy EMG signal measurement. Another issue to be considered to receive the signal correctly is to determine the contact points of electrodes placed on the muscle surfaces correctly. The electrodes must be placed in the mid-point of the muscle so that they can detect the electrical signal formed in the muscle precisely and accurately.

3.14 EMG Measurement Process and Types

During EMG inspection; With the stimulating electrodes adhered to on the skin, the electrical impulses given to certain points of the nerves and the signals in these nerves are revealed. These resulting signals are recorded with the inserted recording electrodes. Needle and surface electrodes are generally used in EMG examinations

3.14.1 Needle Electrode

Needle electrodes used to perform more precise measurements are used to immerse electrodes in muscle tissue and to record electrical signals on muscle fibers. The signals produced by the muscle fibers during their light and strong contractions are evaluated. Thus, information about where the detected disease is in the body or the extent of the disease in case of a common disease is reached.

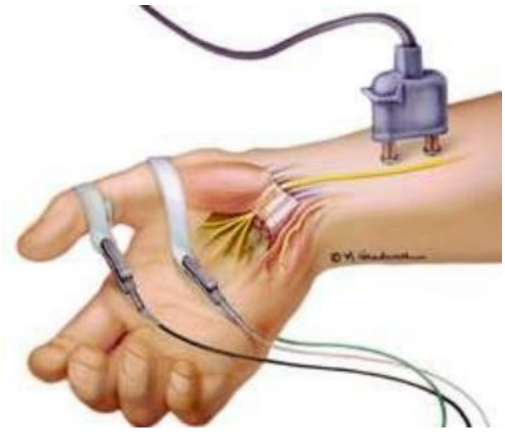

Figure 3.13: Needle electrode(Healthline,2018).

3.14.2 Surface Electrode

Initially, the recording of the EMG signal was done by inserting the needle electrodes to be measured and transmitting the signals to the cables connected to these pins. Although the measurements made using the needle electrode give more accurate results than the superficial measurement method, this method makes the measurement people feel painful, create stress and the measurement made with this feature is also difficult.

As a result of the acceleration of technological developments and studies on biomedical studies, the accuracy of the results obtained in measurements using surface electrodes has been almost improved as much as the results obtained in needle electrodes.

3.15 Pulse Oximeter

SpO2, one of the non-electrical physiological signs, is among the important vital signs to be followed. It measures SpO2 how much oxygen molecules in the patient's blood are retained by hemoglobin molecules and thus calculates the pulse. Pulse Oximeter is used to measure SpO2. Pulse Oximeter technology provides experts with very important data to assess the patient's condition. Pulse Oximeter, which was first used during the surgical procedures in the 1980s and is used extensively today, is an alternative to blood collection, does not require special training, does not depend on the experience of the person using the activity, does not carry any risks, is safe, painless, easy to use and quick. is an application that gives results.

These aspects of Pulse Oximeter make it important in determining the patient's need for oxygen and evaluating the effectiveness of the treatment. Pulse Oximeter gives saturation of hemoglobin in arteries continuously and instantaneously. While the SpO2 value above 95% is considered normal, values less than 93% require oxygen therapy and require closer monitoring of the patient. The value of 100% is seen as a sign of carbon monoxide poisoning.

the measurement is carried out with the help of light passing through the sensor tissue placed on the fingertip or earlobe. The operating logic of Pulse Oximeter As seen in Figure 3.14, one of the clamps of the finger inserted probe has an infrared beam or a red light source. Inside the other is a sensor or phototransistor. Infrared ray or red passing through the tissue light reaches the sensor. Meanwhile, the amount of infrared light or red light passing is measured by the sensor and reflected on the SpO2 indicator on the control panel.

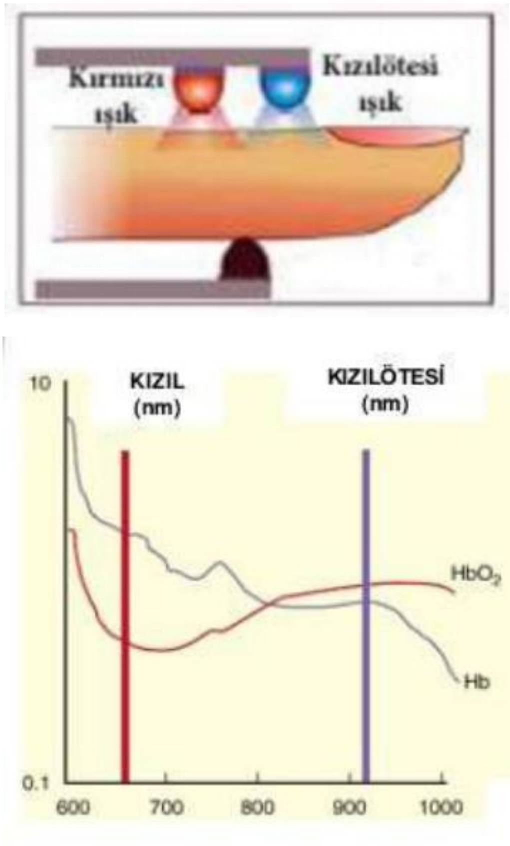

Figure 3.14: Pulse Oximeter and its logic.

Figure 3.15: Pulse Oximeter.

Pulse Oximeter tools are often used to diagnose sleep apnea and respiratory diseases. Pulse Oximetry tools are used in diseases such as chronic bronchitis, asthma, pulmonary edema, and congestive heart failure Pulse Oximeters measure the pulse along with the SpO2 concentration .

3.16 What is Pulse?

Pulse (heart rate/number) is the fluctuation that occurs in the arteries at the endpoints due to the ability of the vessels to stretch when the blood is thrown into the arteries in the left ventricle. Feeling the heartbeat from the arteries at the tip is called a pulse.

The pulse is a sign that the heartbeats. It shows how many times your heart has contracted within one minute, that is, the speed of the heart. The pulse not only informs us about the heart rate but also gives information about whether the heart is working regularly, that is, the rhythm of the heart. Pulse is not constantly in the same fluctuations, sometimes increases and sometimes decreases. This increase and decrease in the pulse are due to the excitement, fear, or physiological effects of some diseases.

Table3.2: Age-pulse relationship

Age	Pulse
0 - 1	120 - 140
1 - 3	90 - 120
3 – 7	90 - 100
7 - 20	80 - 90
> 20	60 - 80

3.17 Factors Affecting Pulse Rate

Pulse, which can also be expressed in the form of heart rate, is one of the parameters handled at the diagnosis stage of many ailments. Pulse rate, heart rate, can vary depending on many factors. Excitement, fear, and some illnesses are the main factors affecting the heart rate.

Table 3.3: Factors affecting pulse rate

ACTİVE	EFFECT
Body temperature / Fire	When the creature's body temperature rises, the pulse rate also accelerates
Pain, Anxiety, Fear, Anxiety	Due to the sympathetic alert, the pulse is accelerated
In Long Pain	Pulse accelerates in prolonged pain
Drug Effects	An increase or decrease in pulse rate is observed according to the properties of the drugs used.
Blood Loss	Blood loss of the creature speeds up the pulse
Heart Rate According to the Posture of the Body changes	Lying: Pulse rate is slow, Standing: Pulse is fast, Sitting: Pulse is fast

CHAPTER 4

CONNECTION OF THE SYSTEM TO BE APPLIED, SENSORS USED AND ANDROID APPLICATION

4.1 Blood Oxygen and Pulse sensor with MAX30100 Pulse Oximeter and Arduino

The circuit diagram and connection method for the Arduino and HC-06 blueooth Module interface of the MAX30100 Pulse Oximeter are showing below.

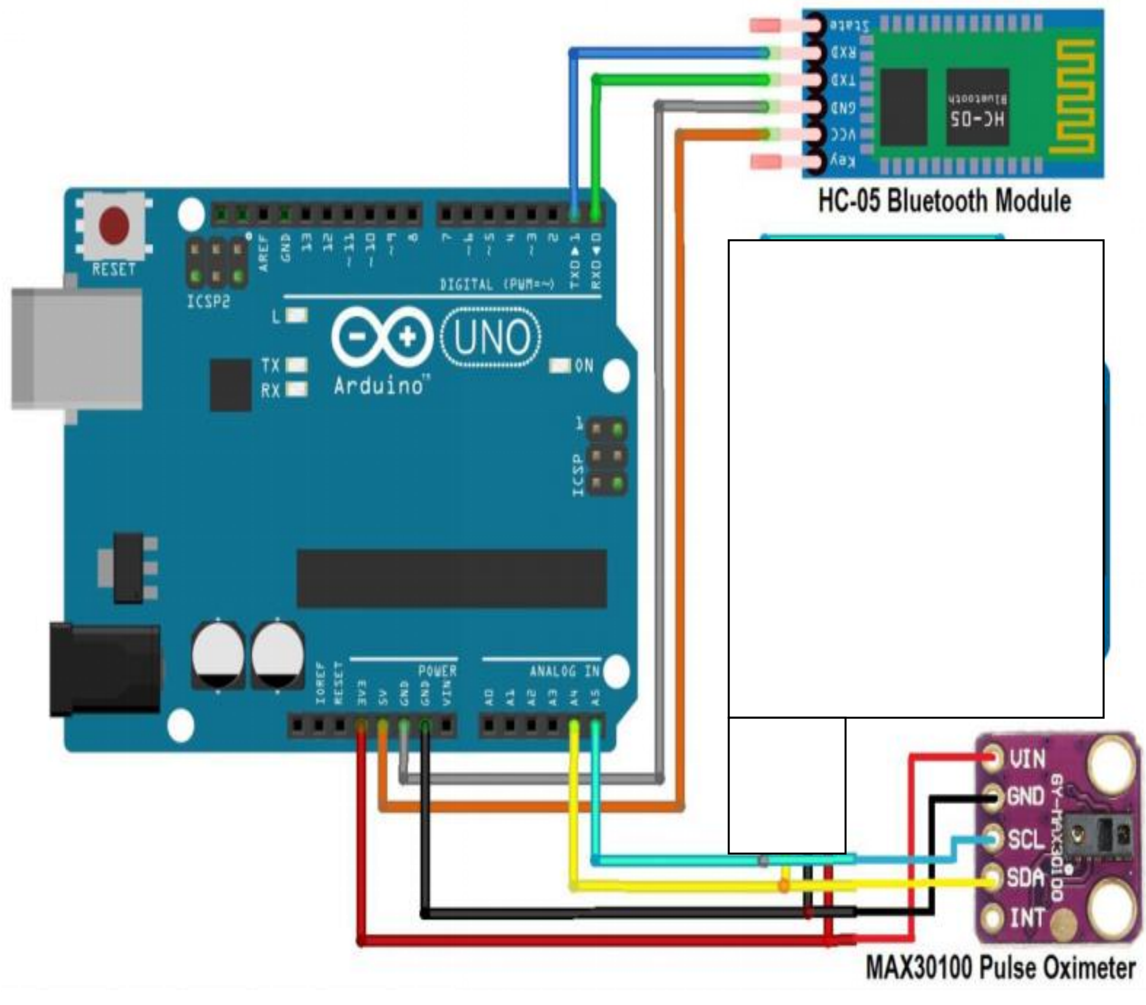

Figure 4.1: The circuit diagram

4.2 MAX30100 Pulse Oximeter

The Sensor shown in the image below illustrates an integrated pulse oximeter and pulse tracking sensor. There are two LEDs and a photodetector inside the sensor to detect pulse and heart rate signals. The LEDs in it send two different wavelengths of light (red light and IR) and measure the absorption in the bloodstream with the photodetector on it and send us the results. The sensor is operated by 1.8V and 3.3V power sources

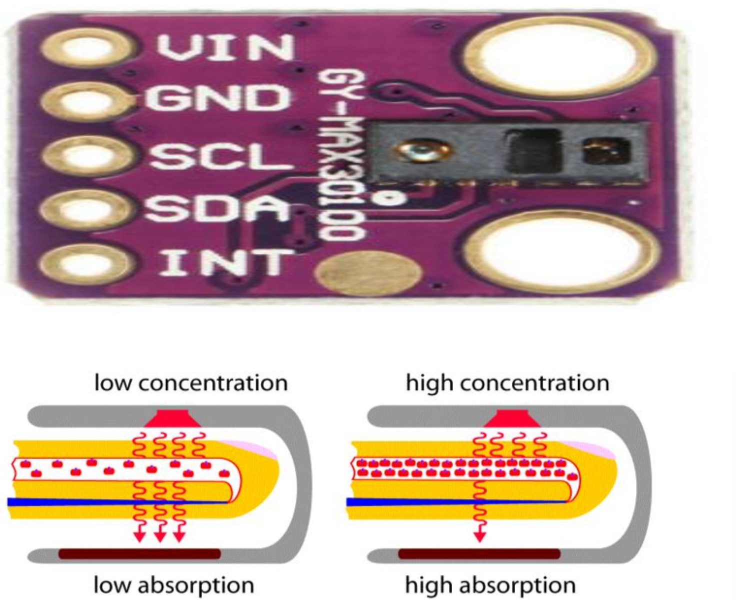

Figure 4.2: Working Pulse Oximeter and Heart-Rate Sensor

LEDs on the device have separate functions. Only infrared (IR) light is needed to measure the pulse rate. Both infrared (IR) and RED light are needed to measure oxygen levels in the blood. When the heart pumps blood around the body, oxygenated blood increases as there is more blood in the body. When the heart relaxes, the volume of oxygenated blood in the body decreases. The pulse rate determines the time between the rise and fall of oxygenated blood, so that oxygenated blood… absorbs more infrared light and transmits more red light, while deoxygenate blood, in contrast, absorbs red light and transmits more infrared light. Speaking of the main function of the spo2 sensor is to calculate the absorption levels between both light sources.

4.3 HC-06 Bluetooth Module

The pulse and oxygen saturation of the patient's finger can be improved by adding the new version HC-06 or wireless access module, which is used to transfer the patient directly from the application to the phone when the doctor or healthcare professional is paired with the application.

Figure 4.3: HC-06 Bluetooth Module (Reichelt,2020).

4.4 Arduino

Today, revolutionary developments are taking place in electronics. Smart watches, smart robots, drones, computers, homemade wearable technologies, etc. All these developments reveal innovations. Today, traditional electronic circuits have been replaced by embedded systems, each of which can be called microcomputer systems, and it is becoming widespread all over the world.

Arduino is the first electronic circuit that comes to mind when it comes to an embedded system. Arduino is a microcontroller board with open source codes as software and hardware by Italian electronic engineers. Since it is open source, it provides an opportunity for anyone who wants to prepare their Arduino according to their own printed circuit models. Arduino is a flexible, easy-to-use hardware and software-based physical programming platform where a computer can detect and control multiple sensors at the same time.Arduino is a flexible, easy-to-use hardware and software-based physical programming platform that a computer can do to detect and control multiple sensors simultaneously.

Developed for hobby and programming for those who have no experience in Arduino Electronics. It has a development environment in which processing / cabling language is used for software development.

This type of microprocessors are programmed with the Arduino software language. and this program is loaded into the device with the help of the Processing Based Arduino Software Development Environment (IDE). Figure 4.4 shows the Arduino and IDE software development environment.

.

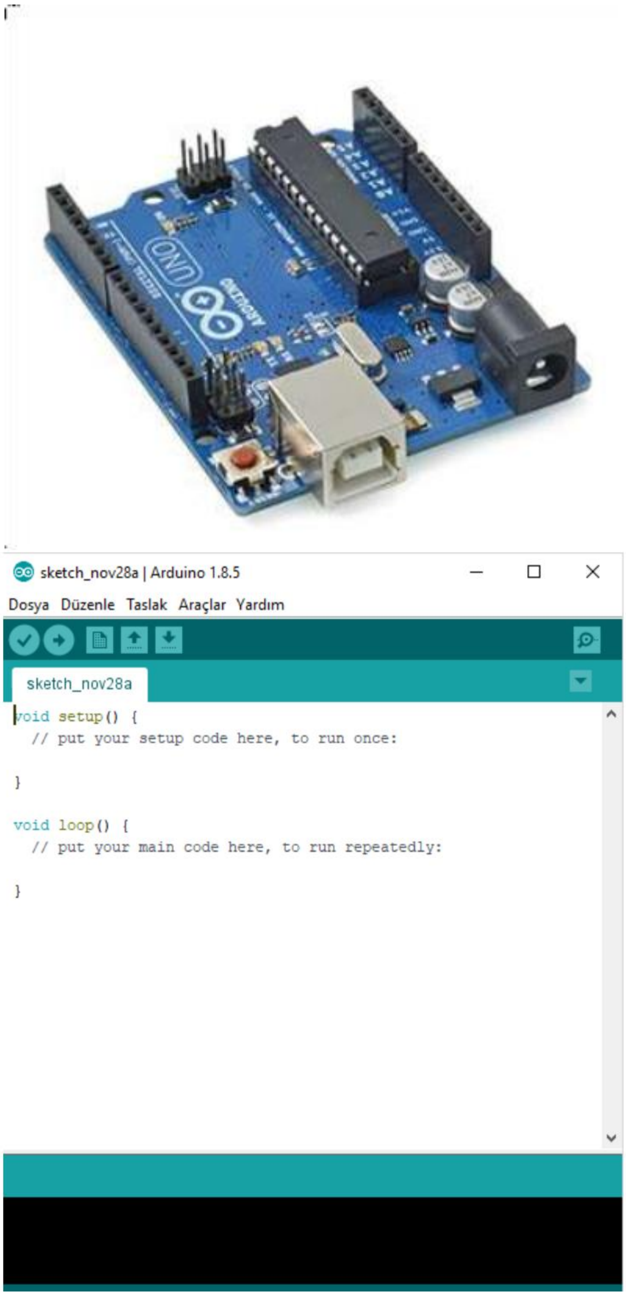

Figure 4.4: Arduino Uno and IDE software development environment.

Today, Arduino is used in many different applications, especially robotic projects. There are different libraries for this development card, which is getting popular day by day. Among the reasons why Arduino is preferred so much today;

Low cost,

• Easy to be supplied,

• Open source,

• It can run smoothly in different operating systems,

• Ability to offer additional equipment,

• The spelling language is easy,

• Robotic applications can be made easily,

• Being open to development,

• Ability to process analog-digital data.

Many shields can be used simultaneously with Arduino, which has a flexible and modular infrastructure. These shields are combined with Arduino with the help of pins, and the projects to be prepared will be given more features.

4.5 3D-Printing

It is the production of virtual objects designed in three dimensions as a result of thermal or chemical processing of materials such as polymers, composites, resins. The device that performs this process is called a three-dimensional printer. The working principle of the most used 3D printers is based on the virtual division of any three-dimensional object prepared in computer environment into layers and pouring the molten raw material of each layer on top of each other. The effect and saturation of the established system provides easier data acquisition and keeping the installed system in order. The design made is as shown in figure 4.5 below.

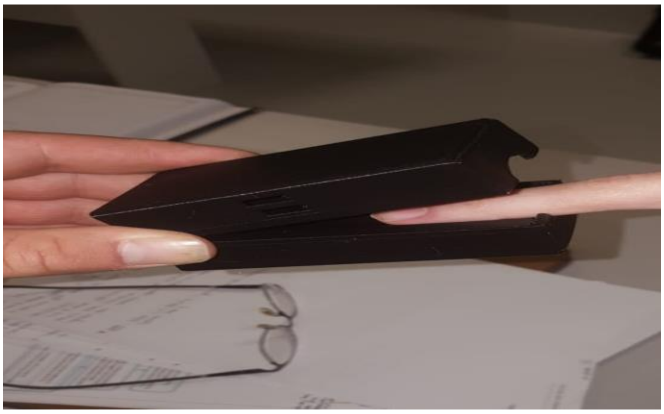

Figure 4.5: Three-dimensional printing

4.6 The Android Application

By device The calculated Blood Oxygen concentration and Pulse Rate are wirelessly transferred to the Android device using the Andorid Application via Bluetooth Connection.

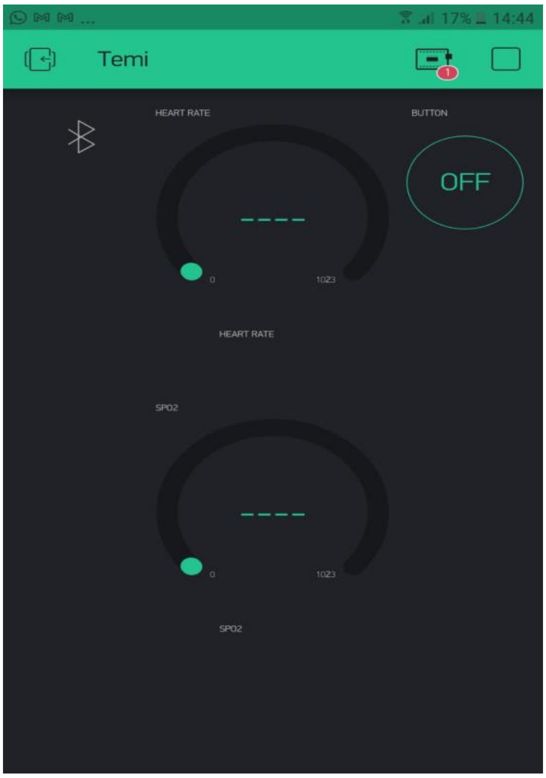

Figure 4.6: The Android App

Blynk is a news system for the Internet of Things. It can control hardware, query sensors, store content, visualize, and everything else. Blynk App - allows you to create great interfaces for your projects using our offer. It can be connected to Android device and HC-06 bluetooth module

CHAPTER 5
RESAULT

5.1 Resault

First, all the parts were placed on the bread board to try and the necessary connections were made, and the trial was made thanks to the codes thrown into the arc, but no result was obtained. Then, after placing a 1k resistor on the INT, SCL, SDA pins of the MAX30100 sensor, BPM and SPO2 values started to appear after a while after placing our finger on the sensor. But the value shown was not correct at first, we started to see the correct one after a few seconds, so we soldered the system we made, placed it in the system made with a 3D printer and got the values instantly from the phone screen.

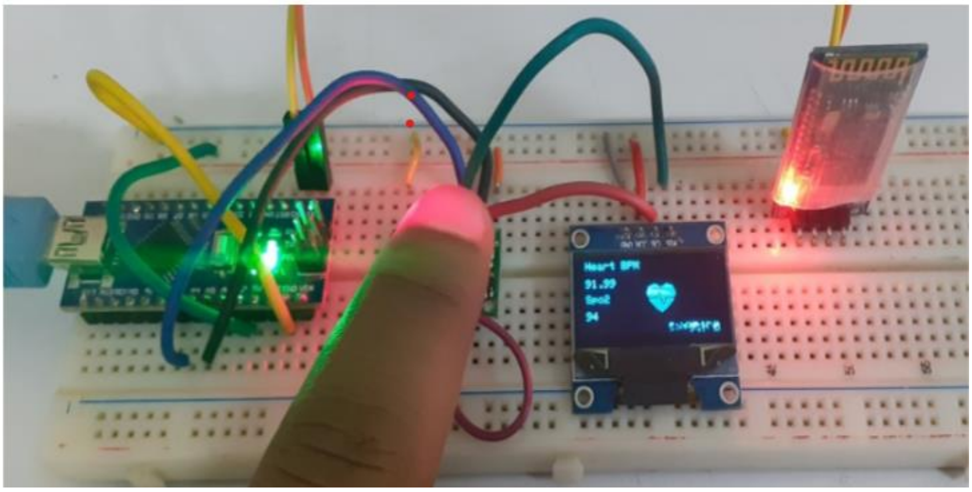

Figure 5.1: System Built on Circuit Diagram

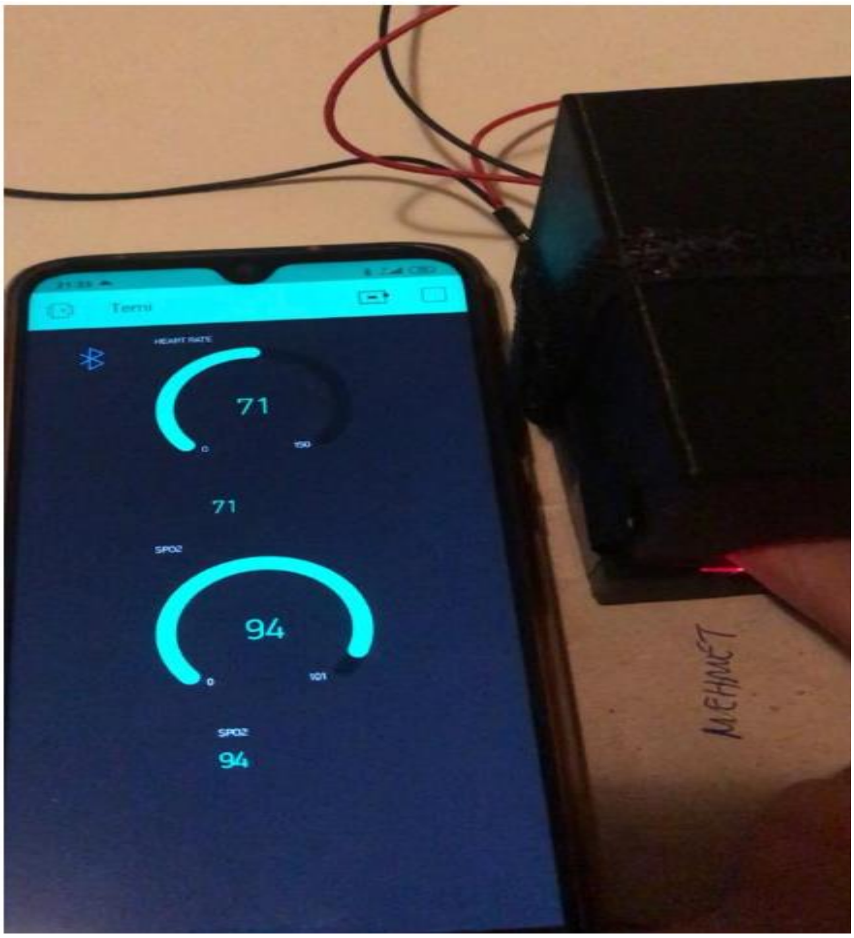

Figure 5.2 instant transfer of the system made to the phone

CHAPTER 6
CONCLUSION

6.1 Conclusion

While installing this device, first we placed the max30100 sensor and the hc 06 module on the breadboard, then we made their connections with the help of pins, then we wrote the codes into the computer program and transferred it into it. arduino. At first we could not get any feedback from the device, again as a result of long efforts, we were able to get results from the device after 1k resistor was placed on the IND, SCL, SDA input pins of the max30100 sensor. 3D printer and finger module are made to have a beautiful appearance and keep the system in shape. then the whole system was placed in this created module. In the phone application, an interface application has been designed to instantly display the pulse and spo2 on the phone screen using the ready-made keypads used by the large application. Thus, the detected pulse and spo2 was detected after waiting a few seconds for the device to be detected. Thanks to the Bluetooth module hc-06, the big application can be seen on the downloaded phone screen instantly and the results are transferred successfully.

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APPENDICES

APPENDIX 1
CODES

```
# include  " MAX30100_PulseOximeter.h "

# include  " Wire.h "
# include  " Adafruit_GFX.h "
# dahil  " OakOLED.h "
# define  REPORTING_PERIOD_MS  1000
OakOLED oled;

PulseOximeter pox;

uint32_t tsLastReport = 0 ;

const  unsigned  char bitmap [] PROGMEM =
{
, 0x00 ,  0x00 , 0x00 , 0x01 , 0x80 , 0x18 , 0x00 , 0x0f , 0xe0 , 0x7f , 0x00 , 0x3f , 0xf9 , 0xff ,
0x7f , 0xf9 , 0xff , 0xc0 , 0x7f , 0xff , 0xff , 0xe0 , 0x7f , 0xff , 0xff , 0xe0 , 0xff , 0xff , 0xff ,
0xff , 0xf7 , 0xff , 0xf0 , 0xff , 0xe7 , 0xff , 0xf0 , 0xff , 0xe7 , 0xff , 0xf0 , 0x7f , 0xdb , 0xff ,
0x7f , 0x9b , 0xff , 0xe0 , 0x00 , 0x3b , 0xc0 , 0x00 , 0x3f , 0xf9 , 0x9f , 0xc0 , 0x3f , 0xfd ,
0x1f , 0xfd , 0xbf , 0x80 , 0x0f x7f , 0x00 , 0x07 , 0xfe , 0x7e , 0x00 , 0x03 , 0xfe , 0xfc , 0x00
0x01 , 0xff , 0xf8 , 0x00 , 0x00 , 0xff , 0xf0 , 0x00 , 0x 0xe0 , 0x00 , 0x00 , 0x3f , 0xc0 , 0x00
0x00 , 0x0f , 0x00 , 0x00 , 0x00 , 0x06 , 0x00 , 0x00 , 0x00 , 0x00 , 0x00 , 0x00 , 0x00 ,  0x00
};
{
Seri. println ( " Dövün! " );
OLED. drawBitmap ( 60 , 20 , bitmap, 28 , 28 , 1 );
oled.display();
}
void setup()
{
Serial.begin(9600);
oled.begin();
```

```
oled.clearDisplay();
oled.setTextSize(1);
oled.setTextColor(1);
oled.setCursor(0, 0);
oled.println("Initializing pulse oximeter..");
oled.display();
Serial.print("Initializing pulse oximeter..");
if (!pox.begin()) {
Serial.println("FAILED");
oled.clearDisplay();
oled.setTextSize(1);
oled.setTextColor(1);
oled.setCursor(0, 0);
oled.println("FAILED");
oled.display();
for(;;);
} else {
oled.clearDisplay();
oled.setTextSize(1);
oled.setTextColor(1);
oled.setCursor(0, 0);
oled.println("SUCCESS");
oled.display();
Serial.println("SUCCESS");
}
pox.setOnBeatDetectedCallback(onBeatDetected);
}
void loop()
{
pox.update();

if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
Serial.print("Heart BPM:");
Serial.print(pox.getHeartRate());
Serial.print("-----");
Serial.print("Oxygen Percent:");
Serial.print(pox.getSpO2));
```

```
Serial.println("\n");
oled.clearDisplay();
oled.setTextSize(1);
oled.setTextColor(1);
oled.setCursor(0,16);
oled.println(px.getHeartRate());

oled.setTextSize(1);
oled.setTextColor(1);
oled.setCursor(0, 0);
oled.println("Heart BPM");

oled.setTextSize(1);
oled.setTextColor(1);
oled.setCursor(0, 30);
oled.println("Spo2");
oled.setTextSize(1);
oled.setTextColor(1);
oled.setCursor(0,45);
oled.println(pox.getSpO2());
oled.display();
tsLastReport = millis();
}
```

APPENDIX 2
ETHICAL APPROVAL DOCUMENT

NEAR EAST UNIVERSITY

ETHICAL APPROVAL DOCUMENT

Date:20/01/2021

To the Graduate School of Applied Sciences

For the thesis project entitled as “PULSE OKSIMETER AND HEART-RATE SENSOR” the researchers declare that they did not collect any data from human/animal or any other subjects. Therefore, this project does not need to go through the ethics committee evaluation.

Title: PROF. DR.
Name Surname: AYŞE GÜNAY KİBARER

Signature:

Role in the Research Project: Supervisor

APPENDIX 3

SIMILARITY REPORT

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