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M-VITAL: AN EXPERT SYSTEM AIDED MEDICAL MASK TO MEASURE AND TRANSMIT VITAL PARAMETERS FOR EMERGENCY SERVICES AND COVID-19 CASES

Esra ŞATIR, Computer Engineering/Engineering Faculty/Duzce University, Turkey, esrasatir@duzce.edu.tr
(https://orcid.org/0000-0003-1793-2472)
Oğuzhan KENDİRLİ*, Computer Engineering / Engineering Faculty/Duzce University, Turkey, oguzhankendirli@gmail.com
(https://orcid.org/0000-0001-7134-2196)

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Abstract

Technology advanced to remote observation of patients from hospitals to homes. The aim of remote monitoring can be tracing the illness or the situation of patient. When accidents or sudden injuries occurs, time while patients are being transferred to hospital is important. Here, remote monitoring is helpful for immediate medical interventions in highly critical cases. In this study M-Vital was developed for detecting vital signs like temperature, pulse, respiration rate and saturation. Location of patient was detected via embedded GPS module. These information were automatically sent to National Emergency Call Center via SMS. Thus, possible human originated errors and time because of thrill or communication were aimed to be minimized. Besides, these vital parameters were saved and evaluated via an expert system to detect a vital problem. In case of a vital problem, emergency code was sent to National Emergency Call Center (112) or to any other special number. Another usage area of M-Vital is detection and tracing Covid-19. Temperature, respiration rate and saturation are the main symptoms. This study has a novelty since wide variety of effective parameters are included. Besides, it has a high potential for using in hospitals to ease the load of medical staff.

Keywords: Covid-19, Expert system, First aid, Remote monitoring, Vital signs

M-VITAL: ACİL SERVİSLER VE COVID-19 VAKALARI İÇİN VİTAL PARAMETRELERİ ÖLÇMEK VE İLETMEK İÇİN UZMAN SİSTEM DESTEKLİ TIBBİ MASKE

Özet

Teknoloji, hastaların hastane odalarından başlayarak evlerinde uzaktan izlenmesine doğru ilerledi. Uzaktan izlemenin amacı, hastalığı veya hastanın durumunu izlemektir. Ayrıca kaza veya ani yaralanma durumlarında da hastaların hastaneye sevki sırasında geçen süre oldukça önemlidir. Bu zaman aralığında uzaktan izleme, çok kritik vakalar için acil tıbbi müdahalelere yardımcı olabilir. Bu çalışmada M-Vital, sıcaklık, nabız, solunum hızı ve saturasyon gibi hayati (vital) belirtilerin tespiti için geliştirilmiştir. Gömülü GPS modülü sayesinde hastanın konumu tespit edilmektedir. Tüm bu bilgilerin Ulusal Acil Çağrı Merkezi'ne SMS ile otomatik olarak iletilmesi hedeflenmiştir. Böylece olası insan hataları ve iletişimden ötürü uzayan zaman en aza indirilmiştir. Ayrıca bu hayati parametrelerin kaydedilmesi ve uzman bir sistem aracılığıyla değerlendirilmesi ile hayati bir problemin tespiti amaçlanmıştır. Hayati bir sorun olması durumunda Ulusal Acil Çağrı Merkezi'ne (112) veya herhangi bir özel numaraya acil durum kodu gönderilmektedir. M-Vital'in diğer kullanım alanı da yaygın semptomları ateş ve nefes darlığı olan Covid-19 hastalığının tespiti ve takibidir. M-Vital ile ölçülen sıcaklık, solunum hızı ve saturasyon parametreleri hastalığın semptomlarındandır. Hastanın konum bilgisiyle birlikte bütün bu parametrelerin tümü izlenip ele alındığından, bu çalışma, dikkate değer bir yeniliğe sahiptir. Ayrıca, M-Vital, kritik vakaların izlenmesinde tıbbi personelin yükünü hafifletmenin önemli olduğu durumlarda, hastanelerde oldukça yüksek kullanım potansiyeline sahiptir.

Anahtar Kelimeler: Covid-19, Uzman sistem, İlk yardım, Uzaktan izleme, Yaşam belirtileri

Cite

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1. Introduction

Wearable telemedicine devices issue is considered to be the most significant and applicable method of the new generation medical care systems. In recent years, it has attracted an increasing rate of interest both in research and market areas. Wearable telemedicine can provide noninvasive and continuous monitoring of patient in terms of many physiological parameters. [1]. Accordingly, current efforts in health care systems have been focused on physiological signal acquisition, data processing – interpretation and some special issues like networking challenges, medical sensors, physiological data management system or sensor node [2-3]. Today, healthcare is a developing field in terms of technology and services. Remote monitoring which means remote observation of patients, is a challenging area. Nowadays technology has advanced to remote observation of patients beginning from hospital rooms to their homes by allowing them to go on their daily activities. This observation has been performed by using modern communication and sensor technologies. It is possible today to monitor essential vital signs like electrocardiogram reading, heart rate, respiration rate, blood pressure, temperature, blood glucose levels and neural system activity via sensors. The sensors can be attached to the body, ambient or can be far away only a few meters from the patient. Chronically ill patients, elders, premature children and victims of accidents are in the scope of remote health monitoring. The aim of remote monitoring can either be tracing the illness or the situation of patient [4].

In case of accidents or sudden injuries, the time while the patients are being transferred to the hospital is important. Most of the efforts have been interested in safe transfer of patient in ambulance to the hospital. This time is crucial because it can be the only time for observing. Namely, remote monitoring in this time interval can be helpful for immediate medical interventions for highly critical cases. Measurements as the result of observations in this time can help the doctors to have an idea about the situation and to give advice to the paramedics who are physically with the patients, if necessary [4]. With every minute that passes without medical action being taken, the probability of being able to save the patient's life decreases by ten percent. So developing the tools that can assist first aid for paramedics becomes very important [5].

Nowadays' another significant issue in medical process is COVID-19 (coronavirus) disease. COVID-19 is an infectious disease caused by a newly discovered coronavirus. It is foreseen that most people infected with the COVID-19 virus would experience mild to moderate respiratory illness and recover without requiring special treatment. But older people or the people who have medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes [6]. Common symptoms of COVID-19 virus are; fever, tiredness and dry cough. Some other symptoms include; shortness of breath, aches and pains, sore throat and rarely diarrhea, nausea or a runny nose. People with fever, cough or difficulty breathing should call their doctor and seek medical attention while the other ones should self-isolate and contact their medical provider or a COVID-19 information line for advice on testing and referral [7].

Here from, it can be obviously understood that time is very crucial in medical process, especially when there is an emergency situation like accidents, sudden injuries or in nowadays conditions COVID-19 [8]. Accordingly there are some novel usage scenarios, in this study. M-Vital (a mobile vital mask) has been developed with the aim of measuring and observing the vital signs of the patient via sensor technology. Additionally, location information has been aimed to be detected by means of the embedded GPS (Global Positioning System) module. The mentioned vital signs are; pulse, temperature, respiration rate and saturation (oxygen level in the blood). When an emergency situation occurs, these parameters and the location of the concerning patient have to be measured and sent to medical personnel, quickly and correctly. Thus, time in life saving actions, can be utilized efficiently. But these parameters are too difficult to measure and to transmit without any error by a person in calm manner, especially in case of an emergency situation. On the other hand, measurement and observation of temperature and saturation parameters are effective on detection and tracing of COVID-19 disease. In this study, all of these vital measurements have been aimed to be measured and sent with the location of patient to National Emergency Call Center (112) or to any other special number (if the necessary permissions cannot be obtained) via an SMS (Short Message Service). Here, the purpose is to minimize the possible human originated errors while using the time, efficiently. Another usage scenario is; these vital parameters have been aimed to be saved and evaluated via an expert system embedded in Arduino chip in order to detect whether there is a vital problem. In case of a vital problem, an emergency code has been aimed to be sent to National Emergency Call Center (112) or to any other special number. Here, the most important aim is remote monitoring of patient especially when there is no companion. Briefy, this study ha a significant technical and usage novelties since a wide variety of effective parameters are included and traced with the location of patient, simultaneously. Besides, it has a high potential for using in hospitals where it is essential to ease the load of medical staff for tracing the critical, Covid-19 cases. This study has been implemented as four sections. Similar studies have been mentioned in Section 2 titled as "Literature Review". In Section 3 titled as "Material and Method", the used methods and hardware of the developed M-Vital have been explained. Results of the performed measurements have been presented in Section 4 titled as "Experimental Results". Finally, disadvantages and precautions for the developed system have been mentioned in Section 5 titled as "Conclusions".

2. Related Work

Time has a very significant place in lifesaving actions. Besides, the new concept in healthcare, that aims to provide continuous remote monitoring of user vital signs, becomes prevalent. By combining these facts, many beneficial studies have been performed. Some of the most relevant studies in the literature have been explained in the following paragraphs.

Perhaps, one of the oldest studies in the literature is disposable waistcoat designed by Hill and White in 1968 it carries an inexpensive B9A valve base socket [9].

In 2003, Coakley et al., proposed an innovative system named WEALTHY. It is a smart material in fiber and yarn form which has a wide range of electro physical properties. They are integrated and used as basic elements to be woven or knitted in fabric form. Thus, WEALTHY aims to design a garment with embedded ECG sensors, respiration sensors, and activity sensor for continuous monitoring of vital signs. The authors reported that WEALTHY system was implemented by employing computing techniques, local intelligence and decision support system. The system aims to assist cardiopathic patients during rehabilitation or subjects working in extreme stressful environment conditions. However, effective GPS has not been integrated in WEALTHY [10].

In 2004, Anliker et al., developed a system called AMON that is a wearable medical monitoring and alert system. It has units like multiple vital signs monitoring, online analysis, and a cellular connection to a medical center. Besides, they mentioned that the system could not provide good performance for ECG detection. Besides, monitoring of ECG was not continuous since the device has to contact with the left hand, the right hand, and the abdomen of the wearer during a measurement [11].

In 2007, Zheng et al., proposed a wearable mobile health care system that aims to provide long-term continuous monitoring of vital signs of high-risk cardiovascular patients. They employed use a portable patient unit (PPU) and a wearable shirt (WS) for monitoring electrocardiogram (ECG), respiration and activity. Since they integrated fabric sensors and electrodes endowed with electro-physical properties into the WS, they achieved long term continuous monitoring without making patients feel uncomfortable while not restricting their mobility. In the study, the PPU is used for analyzing physiological signals in real time. Besides, it determines whether the patient is in danger or needs external help. In case of life-threatening arrhythmias or falls, the PPU alerts the patient and an emergency call automatically establishes with a medical service center (MSC). They reported that the patient could be located and rescued immediately whether he/she is indoors or outdoors in case of emergency, by means of the used Gpsone technology [1].

In 2013, Shen et al., proposed a new portable oxygen enrichment device for individuals in acute exposure to the high altitude by using a new portable oxygen enrichment device for individuals in acute exposure to the high altitude. They aimed to diminish the risk of AMS (Acute Mountain Sickness). They developed a long-lasting and portable anti-hypoxia equipment, the OIR (oxygen-increased respirator) for individuals. They reported that the OIR required additional pressure to compress the air in order to raise the oxygen density without increasing the oxygen concentration (percentage of oxygen in volume) although showing improved performance. They also mentioned that this situation sometimes caused irritation in case of low air temperature [12].

In 2015, Girhepunje and Chede developed a wearable data acquisition system capable to measure body parameters like temperature, ECG signal and heartbeats. They realized module functionality by using low power digital sensors and an ultra-low power, high performance cortex core MSP 432 microcontroller unit. For wireless real time signal transmission, Bluetooth and GSM module is used. They performed comparative power measurements in terms of voltage and current for the realized wearable module [13].

In 2018, Castelletti et al., They reported that high values of BAp indicate large differences between measurements and explained that the concerning wearable monitoring system reliably identified a prolonged QT interval and probably also subjects at risk for diLQTS [14].

In 2023, ,Dinesh and Poovitha designed an IoT-based patient health monitoring system using Arduino and a generic ESP8266. Their proposed work could collect patient health information and send it to an Internet of Things cloud server like Thing-Speak, where it could be stored in real-time by a remote healthcare professional [8].

The difference of this study is that; our system aims to provide measurement and if necessary, long term monitoring of vital signs like temperature, pulse, respiration rate and saturation. Sensor technology has been used for these measurements. By means of the embedded GPS module, location information of the patient has been detected correctly. All of these information have been aimed to be automatically sent to National Emergency Call Center (112) or to any other special number (if the necessary permissions cannot be obtained) via an SMS (Short Message Service). Thus, possible human originated errors because of thrill, tension and communication have been aimed to be minimized with the time used for transmission. These vital parameters have been aimed to be saved and evaluated via an expert system embedded in Arduino chip, in order to detect a vital problem. In case of a vital problem, an emergency code has been aimed to be sent to National Emergency Call Center (112) or to any other special number. The target groups in the scope of the mentioned scenarios consist of:

3. The people having phrenitis because of falling, accidents, faint etc. In this situation, the developed M-vital mask is appended by a person close to the patient. M-Vital has a pluggable usage here and it enables the measurements of the mentioned vital parameters and transmission of their values with also the location of the patient, possible.
4. Remote monitoring of patient for observing the mentioned vital signs in case of there is no companion. M-Vital has a long term usage here. This option is aimed to be utilized for elders or nursing at home patients when there is no companion with them.
5. Tracing and detection of Covid-19 disease. Here, M-Vital has a pluggable and occasional usage. Especially, fever and shortness of breath are known as apparent symptoms of Covid-19. Temperature and saturation parameters address detection and tracing of these symptoms.

All of these three target scenarios are not difficult to implement since M-vital mask is an easily wearable device. Besides, its design has the size and weight of an ordinary oxygen mask without a gas cylinder.

3. Material and Method

Remote patient monitoring systems are designed and used to observe various physiological data of patients. Most of them are Electrocardiogram (ECG), Electroencephalogram (EEG), heart beats, respiration rate, oxygen volume in blood or pulse oximetry, signals from the nervous system, blood pressure, body/skin temperature and blood glucose level. Besides, weight of the patient, activity level of the patient and sleep data can sometimes be collected [4].

In the following sub section data acquisition system, data processing system, end-terminal at the hospital and the communication network; which are the main elements of remote monitoring; have been detailed in terms of hardware, software components and operation flow chart of the developed M-Vital.

3.1. Hardware of M-Vital

The circuit design of the developed M-Vital has been provided in Fig. 1. Here, the numbers indicate the components used for data acquisition, data processing, end-terminal and communication network parts.

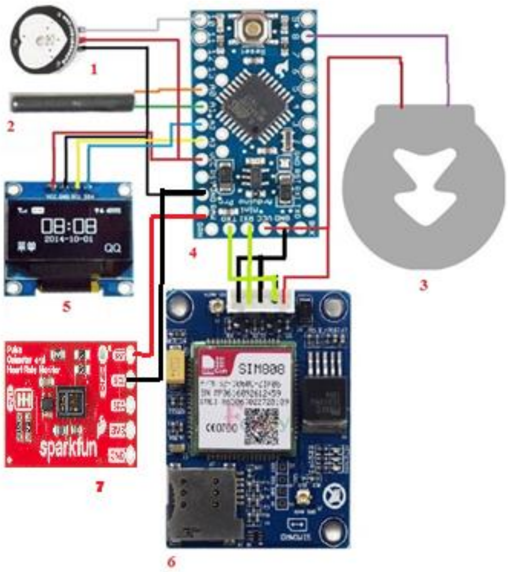

Figure 1. Circuit Design of M-Vital

By considering Fig. 1:

1. Pulse sensor: It is located on the mask and used for measuring the pulse rate of the patient.
2. Temperature sensor: It is used for obtaining the body temperature of the patient. It is employed by change of the resistance value according to the temperature.
3. Respiratory sensor: It is used for obtaining the respiratory rate of the patient. It can transmit the measured value to all the controllers which have digital inputs, like Arduino.
4. Arduino Pro Mini: It is composed of Arduino card based on ATmega328. On Arduino Pro Mini, there are 14 input/output pins, 6 analog pins, 1 internal crystal (8 or 16 MHz), a reset button and montage holes for attaching terminal sockets to pins.
5. LCD Screen: It has the size of 0.96 inches and controlled by 128×64 Graphical Screen SPI Serial Interface. It has 6 pins to display the desired content. It can be used together with the Arduino, STM32 or the similar development cards.
6. GSM, GPRS, SMS module: It is used for transmitting the measured patient data to the National Emergency Call Canter or to any other special number. Besides, this module is used to detect he location information of the patient.
7. Saturation Sensor (Pulse Oximetry): Pulse oximetry and heart rate sensor is used for detecting the oxygen level in blood.

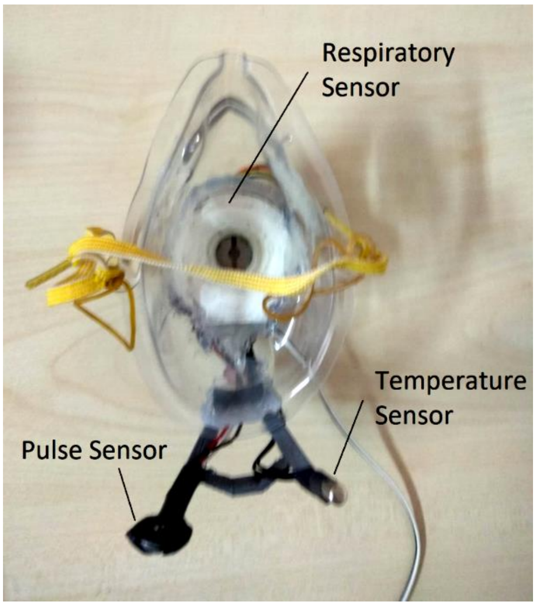

Figure 2. Replacements of electronic sensors

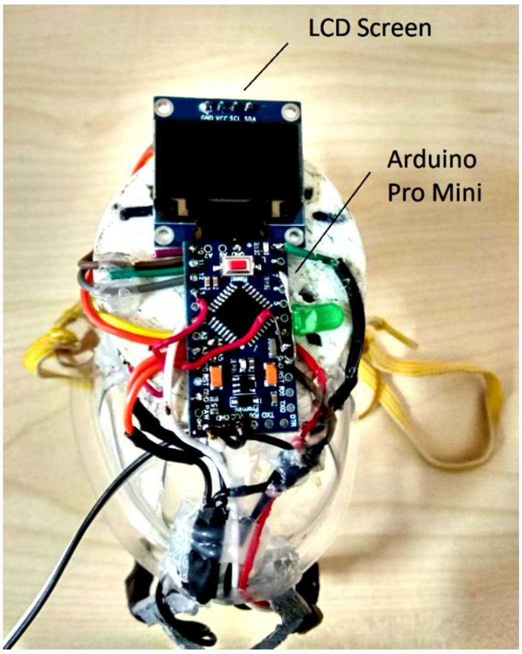

Figure. 3. Replacements of Arduino Pro Mini and LCD Screen

For a concrete concept, in Fig.s 2 and 3, actual places of sensors, Arduino Pro Mini and LCD screen on the developed M-Vital have been indicated. Besides, a basic prototype of the mask have been provided in Fig. 4. As seen in the mentioned Figures, M-Vital has an easy usage without an oxygen cylinder and accordingly, it has the weight and size of an oxygen mask without the cylinder.

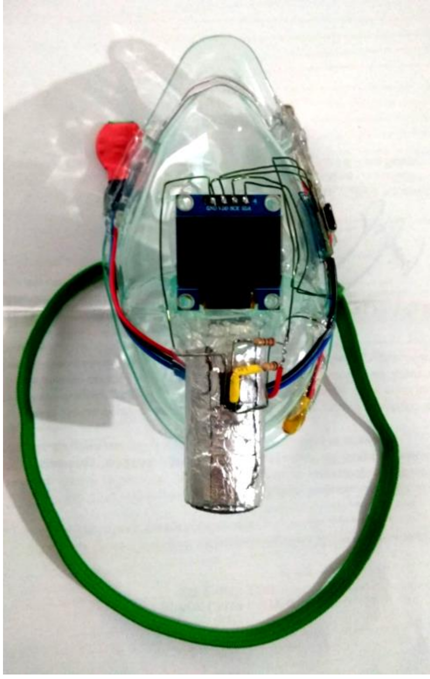

Figure 4. Basic prototype of M-Vital

3.2. Operation of M-Vital

The most serious problem in Emergency Call Centers is the transmission of patient's vital parameters and location information. M-Vital has the ability to overcome this problem by minimizing the transmission time and human originated errors. Besides, it has a mechanism to detect whether the situation of the patient is critical. Flow chart of the M-Vital has been provided in Fig. 5, in order to demonstrate the execution process.

Pulse, temperature, respiration rates and saturation of the patient have been detected via the concerning sensors on the mask. These parameters have been employed as inputs for the embedded expert system software. As known, expert systems aim to implement the expert's knowledge on the computer environment. The most important features which separates expert systems from the decision support systems are "Knowledge Base" and "Inference Mechanism". In M-Vital System, these parameters have been employed for making inferences to detect whether the situation of the patient goes critical. These inferences are aimed to be unbiased and fast by means of the designed software.

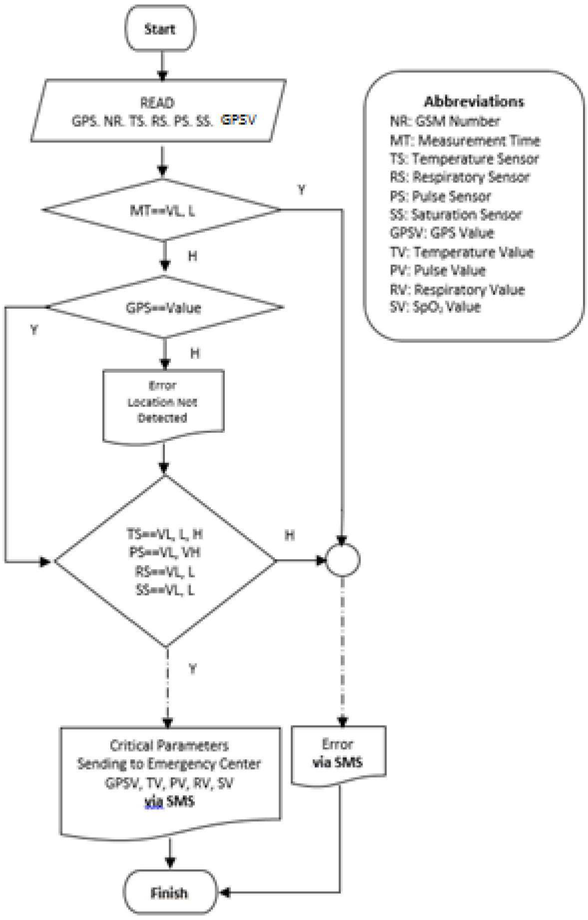

Figure. 5. A part of Flowchart for M-Vital operation

Another serious problem in Emergency Call Centers is the transmission of patient's or the patient's relatives' location information. By means of the embedded GPS module on the mask, this problem is aimed to be overcome. Namely, location information is going to be transmitted, automatically while transmission of other parameters of the patient. Thus, Emergency Crew is going to reach to the scene of accident, successfully. In today's condition, transmission of the patient data (vital parameters and location information) is carried out via the communication with the Emergency Call Center personals. This can cause the transmission to be subjective and far from scientificity. By means of M-Vital, this situation is going to be unbiased. Besides, average call time in Emergency Call Centers is about 50 seconds. Transmission time via M-Vital is about 5 seconds which means 10 times faster than the transmission by conversation. This is a very important gain especially when there is a critical situation.

3.3. Expert System of M-Vital

Expert systems have recently become popular and they are attracting more and more attention today. Most expert systems use a subset of techniques from the general area of computer science which is known as artificial intelligence. However, some expert systems have been developed that incorporate more traditional mathematical modeling techniques. The techniques used in expert systems may be the needed point to combine the classical operational research modeling and human decision making processes [15].

This section addresses to explain the general structure of expert systems and how expert systems techniques are being used in the proposed study. An expert system has five main components; knowledge base, data base, inference engine, explanation facilities and user interface.

A knowledge base contains the set of statements named as production rules, which are in the form of IF (condition) THEN (action) statements. A data base is the collection if structured data. Inference engine matches the ruler of the knowledge base with the actual data in the data base. It finds, inferences from the facts in the data base. Here, the reasoning works like IF… THEN rules. The design of user interface is important for presenting the needed data for the system. Explanation facilities module shows the flow of experts systems' reasoning. In Fig. 6, basic structure of an expert system has been indicated [16].

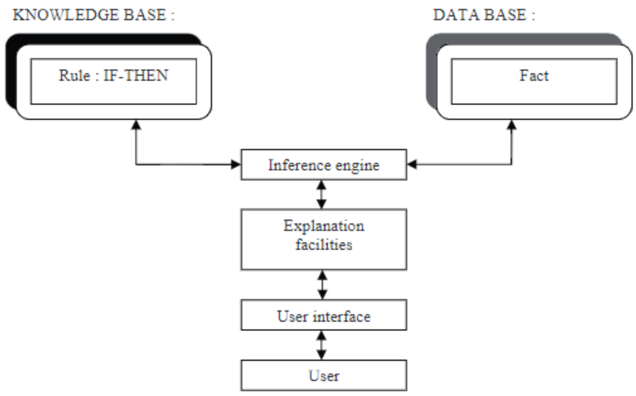

Figure 6. Basic structure on an expert system [16].

Table 1. The ranges and linguistic sets of the measured parameters via M-Vital

Linguistic Variables and Their Ranges						
Linguistic Value	Notation	Numerical Range (Temperature – Deg.)	Numerical Range (Pulse bpm)	Numerical Range (Respiration)	Numerical Range (SpO2)	Measurement Time (sec.)
Very Low	VL	[32-34]	[0-40]	Negative	[0-50]	[0-30]
Low	L	[34-35,5]	[40-60]	Negative	[50-90]	[0-30]
Medium	M	[35,5-37]	[60-100]	Positive	[90-100]	[30-90]
High	H	[37-40]	[100-150]	Positive	100	[90-120]
Very High	VH	[40-42]	[150- 220]	Positive	100	[120-180]

Some of the rules, in the designed rule base have also been explained as follows:

IF Temperature M, H THEN case is none

IF Temperature VL, L, VH THEN case is SMS

IF Pulse L, M, H THEN case is None

IF Pulse VL, VH THEN case is SMS

IF Respiration is M, H, VH THEN case is None

IF Respiration is VL, L THEN case is SMS

IF Saturation M, H, VH THEN case is None

IF Saturation VL, L THEN case is SMS

IF Measurement Time M, H THEN case is None

IF Measurement Time VL, L, VH THEN case is Error

…

…

Some of the rules can be explained in detail as follows by considering Table 1:

IF Temperature M and Pulse M and Respiration M and SpO_2 M and Measurement Time M THEN case is none (user 1)

IF Temperature VL and Pulse VL and Respiration M and SpO_2 M and Measurement Time VL THEN case is Error (user 2)

IF Temperature M and Pulse M and Respiration M and SpO_2 M and Measurement Time M THEN case is none (user 3)

IF Temperature M and Pulse M and Respiration M and SpO_2 L and Measurement Time VL THEN case is Error (user 4)

IF Temperature H and Pulse M and Respiration M and SpO_2 L and Measurement Time M THEN case is SMS (user 5)

IF Temperature M and Pulse M and Respiration M and SpO_2 M and Measurement Time M THEN case is none (user 6)

IF Temperature M and Pulse H and Respiration M and SpO_2 M and Measurement Time M THEN case is none (user 7)

IF Temperature M and Pulse M and Respiration M and SpO_2 M and Measurement Time M THEN case is none (user 8)

IF Temperature H and Pulse H and Respiration M and SpO_2 M and Measurement Time M THEN case is SMS (user 9)

IF Temperature M and Pulse M and Respiration M and SpO_2 L and Measurement Time M THEN case is SMS (user 10)

4. Experimental Results

In this section, the performed experiments for the proposed study have been explained. Implementation of M-Vital and the corresponding experimental measurements have been carried out in Electrical - Electronic Laboratory of Engineering Faculty in Duzce University. After completing the prototype, the measurements have been performed on 10 volunteers by implementing the mask. Results of the performed measurements have been provided in Table 2.

The obtained measurements have been compared with the actual values of the given parameters. The measured parameter are temperature, pulse, respiration and saturation. Additionally, position information of the individual and the total measurement time have been provided. Deviations of temperature and pulse have been provided in terms of numerical values while deviation of the SpO_2 (Saturation) has been given in terms of percentage value. Case column mentions the status of each measurement. “SMS” indicates an emergency situation about the patient (refer to Section 2, item 2 of usage scenario). “None” indicates that there is no critical case (refer to Section 2, item 1 of usage scenario). “Error” indicates that the measurement performed incorrectly.

Table 2. Results of the performed measurements via M-Vital.

Users	Temperature (deg. ±0,2)	Pulse (bpm ±2)	Respiration	Saturation SpO2 (%±1)	Position (North/East)	Measurement Time (sec)	Case
1	36,2	82	Positive	96	40°50'14.0" 31°09'19.7"	40	None
2	27,8	30	Positive	94	40°54'25.5" 31°10'58.5"	14	Error
3	37,2	96	Positive	95	40°52'44.6" 30°57'01.0"	50	None
4	36,8	86	Positive	94	- -	-	None
5	38	70	Positive	88	40°52'27.3" 30°56'54.2"	38	SMS
6	36,6	78	Positive	94	40°50'44.9" 30°56'17.4"	54	None
7	36,2	102	Positive	90	41°01'39.5" 29°04'08.8"	40	None
8	36,4	90	Positive	96	38°25'20.3" 27°07'47.0"	36	None
9	37,6	104	Positive	98	40°50'14.4" 31°09'17.7"	60	SMS
10	36,2	88	Positive	86	39°53'12.2" 32°51'22.6"	80	SMS

5. Conclusion

Traditional systems collect data via sensors which are attached to the body. However, these systems pose difficulty in terms of mobility for the patient and a patient’s activities in daily life. Since this kind of devices influence patient’s comfort, sensitive physiological data set influenced, too. Technology has advanced to remote observation of patients beginning from hospital rooms to their homes by allowing them to go on their daily activities. This observation has been performed by using modern communication and sensor technologies. It is possible today to monitor essential vital signs like electrocardiogram reading, heart rate, respiration rate, blood pressure, temperature, blood glucose levels and neural system activity via sensors.

In this study, M-Vital system has been developed for detection of vital signs like temperature, pulse, respiration rate and saturation. Sensor technology has been used for these measurements. By means of the embedded GPS module, location information of the patient has been detected correctly. All of these information has been aimed to be automatically sent to National Emergency Call Center (112) or to any other special number (if the necessary permissions cannot be obtained) via an SMS. Thus, possible human originated errors because of thrill, tension and communication have been aimed to be minimized with the time used for transmission from 50 seconds to 5seconds. Experimental results showed that these vital parameters were measured with only a very few and harmless deviations, quickly. Besides, these values were saved and evaluated via an expert system embedded in Arduino chip, in order to detect a vital problem. Another usage area of M-Vital was tracing and detection of Covid-19 disease where common symptoms are fever and shortness of breath. Temperature and saturation parameters were employed for detection and tracing of these symptoms. This study has significant technical and usage scenarios as well as measuring and tracing wide range of parameters for critical cases and Covid-19. As the result of performed experiments, all mentioned aims have been addressed, successfully.

For future studies, observing these vital signs of the patient for nursing at home and for intensive care have been aimed by advancing the expert system embedded in Arduino chip. Here, remote monitoring of patient has been aimed to be provided especially when there is no companion and also for tracing the status of the patient for intensive care process.

Being more non-invasive is another aspect of this study. We also aim to achieve this goal by improving the technical structure of M-Vital.

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