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Research Article

A Healthcare Monitoring System Design for Elderly Living Alone

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ABSTRACT

Due to advancements in the field of medicine, the elderly population has significantly increased around the world. Since the young population is also working, elderly people are left alone at home. Problems such as Alzheimer's, sleepwalking, and decreased mobility in these elderly individuals living alone reduce the quality of life of both individuals and their families. This study aims to develop a specialized tracking system to address issues faced by elderly individuals, such as getting lost while living alone. Nowadays, thanks to GPS technology, it is possible to monitor individuals easily even from our phones. It will be easier to monitor places in the house where there is a high probability of falling and by using an infrared sensor to control the entrances and exits of the house. It is clearly seen that older people prefer simple rather than complex technological products when using them. For this reason, a design has been made that will be sufficient to carry with you without having to make any adjustments in the mobile application.

Keywords: Smart healthcare, Telemedicine, GPS, Elderly tracking

1. INTRODUCTION

Health technologies are one of the most important needs in human life. Today, the use of mobile applications in any field and the desire of people who always want to be online affect and change the development of technologies in all sectors, as well as in the health sector. With technological advancements, it is now possible to create a low-cost home healthcare monitoring system that captures bodily signals, visualizes them, and transmits them remotely. With the increase in mobile applications, patient monitoring is becoming easier. In this context, with the mobile patient monitoring system; There is no need to go to the hospital for basic measurements and continuous monitoring [1,2,3,4]. According to the World Health Organization, telemedicine; improving the health of individuals and societies, preventing diseases and accidents; It is defined as the provision of health services by all health professionals using information and communication technologies, remotely and with valid information communication methods, with the continuous training of health personnel [5,6].

Determining the location has always been an important technology for humankind. In ancient times, this was roughly determined by natural resources such as trees, mountains, stars, sun and moon. In parallel with the advancement of technology, ground stations have begun to be established [7]. However, the failure of these systems to fully meet the needs has led to new searches and allowed the development of satellite-based positioning systems used today. The widespread use of GPS technology and its ability to provide location almost without error has paved the way for the widespread use of tracking systems. The expectation of relatives of the elderly is to instantly determine the location of those they are responsible for. With today's technology, determined location information can be transmitted to a remote center via mobile communication systems.

GSM-based GPRS technology is one of the most commonly used systems for this purpose. Mobile communication systems can be used without a fixed point, offering ease of communication, time-saving benefits, and spatial independence [8]. This technology facilitates locating and responding to sick, disabled, or elderly individuals who wander from home in emergency situations. With the help of infrared sensors and NodeMCU, entrances and exits

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from the house are kept under control. The widespread use of NodeMCU and infrared sensors also provides an advantage in terms of supply and reduced costs.

2. LITERATURE REVIEW

Health monitoring systems have started to increase rapidly recently. Different smart systems are being designed to monitor the current health status of patients. In a study [9], a system using GSM/GPS technologies is proposed to control the patient's blood pressure and body temperature. This system offers an intelligent, real-time health monitoring and tracking system. In case of emergency, the values found via the GSM module will be sent via text message to the doctor's mobile phone number. In addition, GPS will allow location information to be given to the patient who is desired to be kept under constant observation.

One of the new developments in the healthcare sector is patient monitoring systems based on remote monitoring of patients, which have many advantages against the problems of increasing health problems and the rapidly aging world population. It is sufficient to choose simpler applications for monitoring patients in healthcare institutions. Technology has advanced enough to allow the patient to be monitored even while performing their daily activities at home, with the use of modern communication and sensor technologies. Sensors are available today to monitor basic vital signs such as electrocardiogram reading, heart rate, respiratory rate, blood pressure, temperature, blood sugar levels, and nervous system activity. The range of remote healthcare services has a wide range of uses, from chronic patients, the elderly, premature children and accident victims. Thanks to new technologies, patients can be monitored based on disease or condition. The technology ranges from body-worn sensors to ambient sensors attached to the environment, with new studies aiming for non-contact monitoring that only requires the patient to be a few meters away from the sensor. Fall detection systems and applications for monitoring chronic patients are already in use [10,11].

P. Varady and colleagues introduce an innovative approach to patient monitoring in their work [12]. With this approach, a patient tracking application was built based on an existing industry standard communication network created using standard hardware tools and software technologies. Thanks to this patient monitoring application, open architecture system modeling, scalability, standard interfaces and flexible signal interpretation opportunities are offered.

In their study, Mohammad Salah and his colleagues [13] proposed an intelligent patient monitoring system to automatically monitor the health status of patients through connected networks based on sensors. Various sensors are used to collect the patient's biological behavior. The important biological information obtained from the sensors is then sent to the IoT cloud. The system is a patient monitoring system that can detect the critical condition of a patient by processing sensor data and provide instant notification to doctors/nurses and hospital responsible staff. In addition, patient relatives can also benefit from this system with limited access.

3. PART OF HEALTHCARE MONITORING SYSTEMS

3.1. GPS Module

Global Positioning System is a system that uses the 1.5 GHz band and enables the determination of the exact location (with a margin of error of 5m) thanks to the satellite network that operates continuously around the world [8]. In order to determine its own position, the GPS receiver must know the exact location of the satellites and its distance to the satellites. The basic measure to determine the distance to satellites is the travel time of the signal between the satellite and receiver antennas. The distance to the satellite is equal to the arrival time of the sent signal multiplied by its speed. The arrival time is included in the coded signals coming from the satellites. The GPS receiver tries to match the code it produces with the code coming from the satellite. By comparing these two codes, it detects the delay. Multiplying this delay with the speed of light gives the distance to the satellites. Different measurement methods are applied in GPS depending on the type of points measured, the desired sensitivity and the purpose. The coordinates obtained as a result of the measurement vary depending on the receiver type, observation period,

location and number of satellites, and measurement type. If the point to be determined is stationary, static position determination; If it is mobile, we are talking about dynamic positioning. The basic parts of GPS are given in Fig 1.

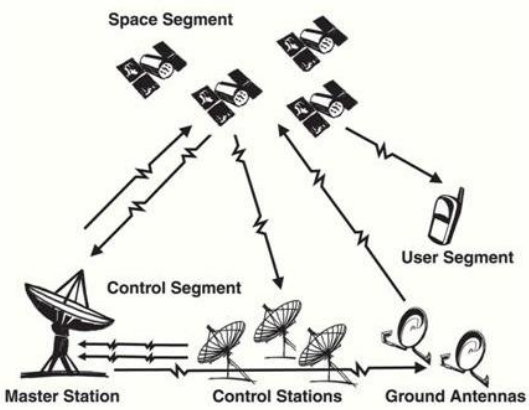

Fig 1. Basic working mechanics of GPS

NEO-6M module is used for location control and tracking using GPS. This module has many connection options. The 50-channel u-blox 6 positioning engine offers first correction time under one second. Thanks to the 3V-5V converter unit, it can be interfaced with 5V Microcontrollers It consists of four pins: 5V, TX, RX and GND. There is no need for external components in this independent 5V GPS module.

Fig. 2. NEO-6M GPS module

3.2. PIR Sensors

PIR sensors are electronic sensors that detect presence and movement in the environment. PIR sensors detect differences in the rate of IR-infrared radiation that vary depending on the temperature and surface properties of objects in front of the sensor. When a person passes in front of a background, such as an object or a wall, the temperature at that point in the sensor's view changes from room temperature to body temperature and then back to its initial state. The sensor converts the resulting change in incoming infrared radiation into a change in output voltage and this triggers detection. The PIR sensor has a detection range, ranging from 2-3 meters. The PIR sensor back view is as shown in Fig.3 [14].

Fig 3. PIR sensor

3.3. Wi-Fi

The WLAN standard operating in the 2.4 GHz ISM band has become a popular positioning technology in corporate and public organizations in recent years. Since Wi-Fi signals, whose frequency and wavelength are given in Fig 3, are located in most buildings and are available on almost every mobile device, the demand for positioning systems with Wi-Fi signals is increasing day by day. Coverage range between 50 m and 100 m and 11, IEEE 802.11, a standard with a bit rate of 54 or 108 Mbps, is the standard that dominates local wireless networking today. Therefore, using the existing WLAN infrastructure by adding a location server for positioning has become attractive for individual and commercial positioning systems [15].

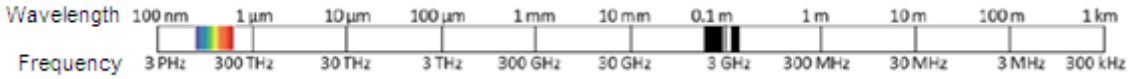

Fig 4. Wavelength and frequency range of Wi-Fi signals

3.4. Microprocessor Unit NodeMcu ESP8266

NodeMCU ESP8266 development board V3-CH340 Chip LoLin is a development board that contains an ESP8266 WiFi module with NodeMCU firmware installed on it. Since it was developed using the ESP8266 SDK, it supports GPIO, PWM, IIC, 1-Wire and ADC connections without the need for an extra microcontroller. It is affordable and breadboard compatible. This product can be used alone. Additionally, it does not require an arduino-like development board [16].

Fig 5. NodeMCU ESP8266 module

3.5. PHP

PHP is a general-purpose scripting language designed to create dynamic web pages. PHP codes are placed in HTML and interpreted with the PHP interpreter on the server to create the desired document. PHP is supported by many modern web servers and operating systems [17]. The PHP part that manages the server consists of two files. These are defined with the names "sendLocation.php" and "getLocation.php". With the sendLocation.php file, it saves the location information from the android program that sends data to the database. With the getLocation.php file, it sends the data in the database as output when a request comes to the android program that provides data tracking.

3.6. Telegram

Telegram is a multi-platform, secure instant messaging service. Telegram clients are available for both mobile (Android, iOS) and desktop systems (Windows, Linux). Thanks to location sharing and channels (bots), data sharing and matching with servers in various parts of the world can be done very quickly.

3.7. App Invertor

App Inventor is a free web application created by Google and later developed by the Massachusetts Institute of Technology (MIT). It allows beginners to easily create Android applications. It can be applied easily, especially thanks to its puzzle-like structure and drag-and-drop mechanism.

4. SYSTEM IMPLEMENTATION

4.1. Location Tracking

The location tracking design consists of two modules. One of the modules takes the coordinate data from the person to be monitored and updates the database on the server at regular intervals.

4.1.1. Send Location

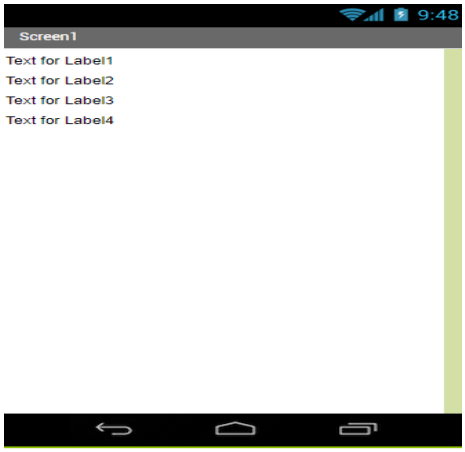

Fig 6. Main screen of the program

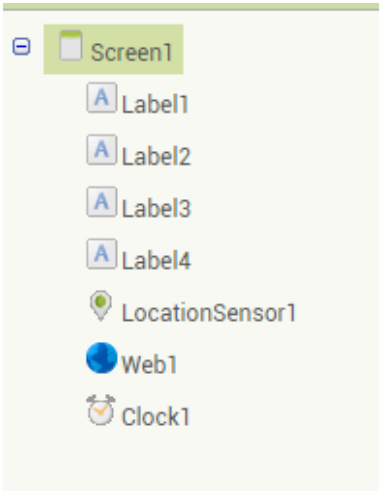

Fig 7. Components for creating the main screen of the program

As seen in Fig 7, the data sending module uses four labels, the phone's location sensor, a web module to send data to the server, and a clock module to perform this operation at regular intervals.

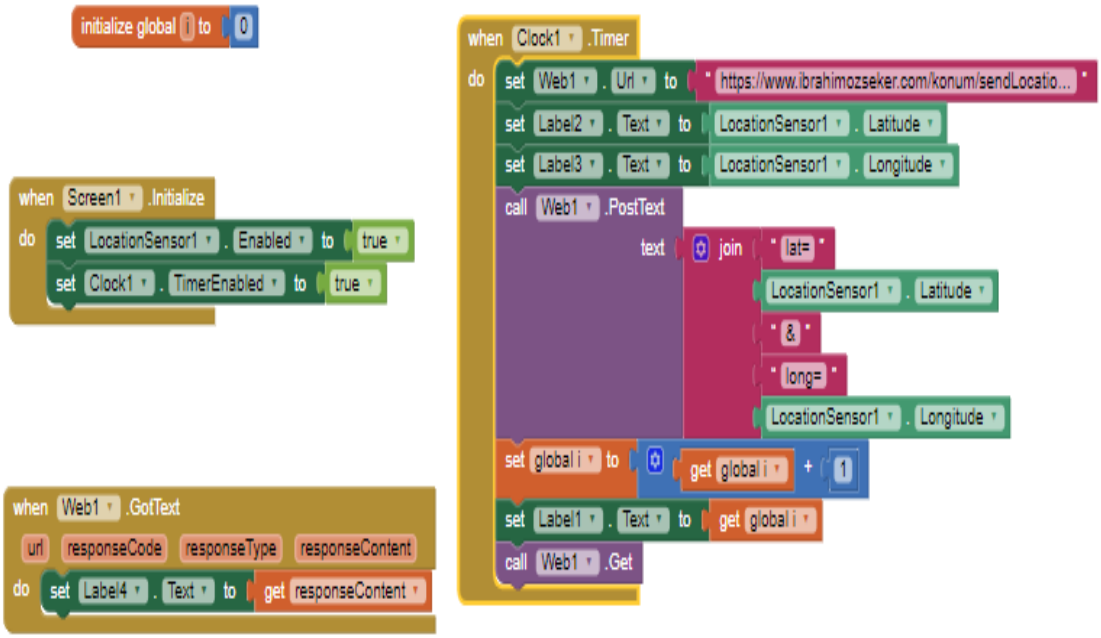

Fig 8. Block diagram used for the program to send location

As seen in Fig 8, when the program first runs, the position sensor and clock module are activated. In order for the clock module's processing time to operate accurately and stably, the database on the server is updated every second by taking coordinate data from the position sensor. Meanwhile, data from the database, which is also shown on the labels on the main screen, is printed on the screen.

4.1.2. Positioning

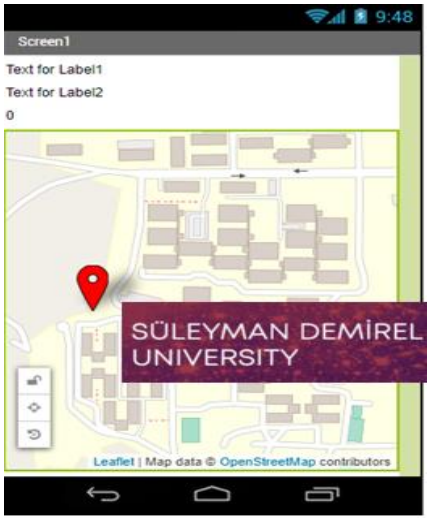

Fig 9. Main screen display with monitoring

Three tags were used in the program used for monitoring. The map module from these tags was used to show exact time location. Apart from this, clock and web modules have also been activated.

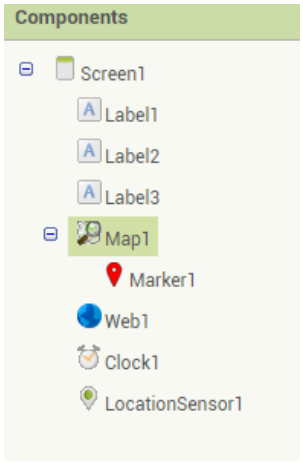

Fig 10. Components used for positioning

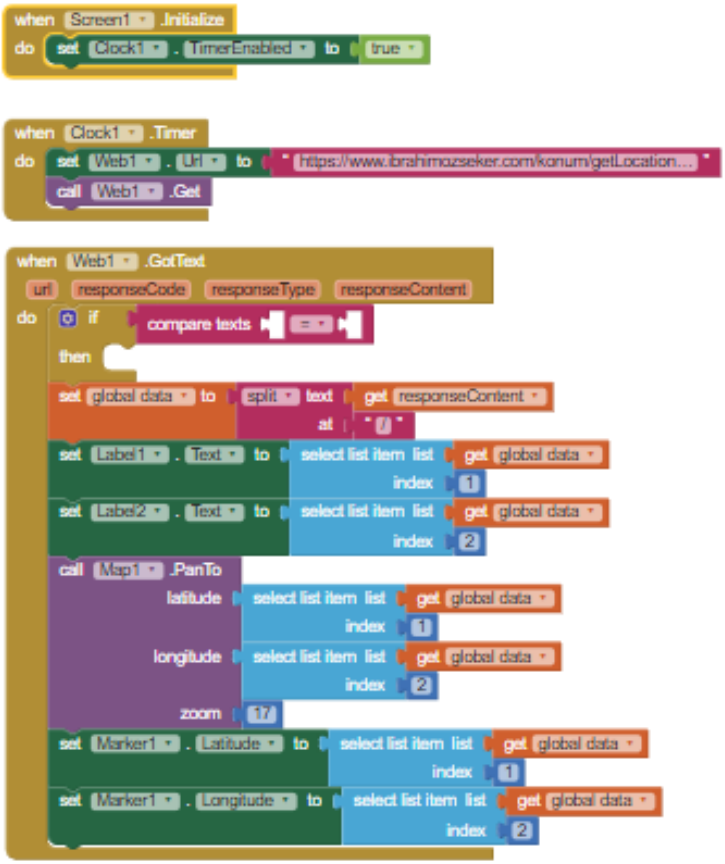

Fig 11. Block diagram used to position the program

When the program first runs, the clock module is activated and the update time is set to one second. Location information is received from the server every second. When this process is completed successfully, the location point on the map is updated according to the latest data and the process is completed.

4.1.3. MySQL Database

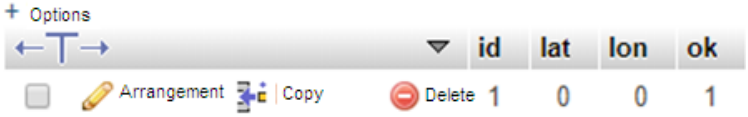

Fig 12. Table used for communication between programs

4. 2. Proposed In-Home Tracking System

4.2.1. Setting Up Telegram

A channel has been created on Telegram for broadcasting. A bot with web access was created in this channel, allowing it to broadcast to the user via Telegram.

4.2.2. Operation of the System

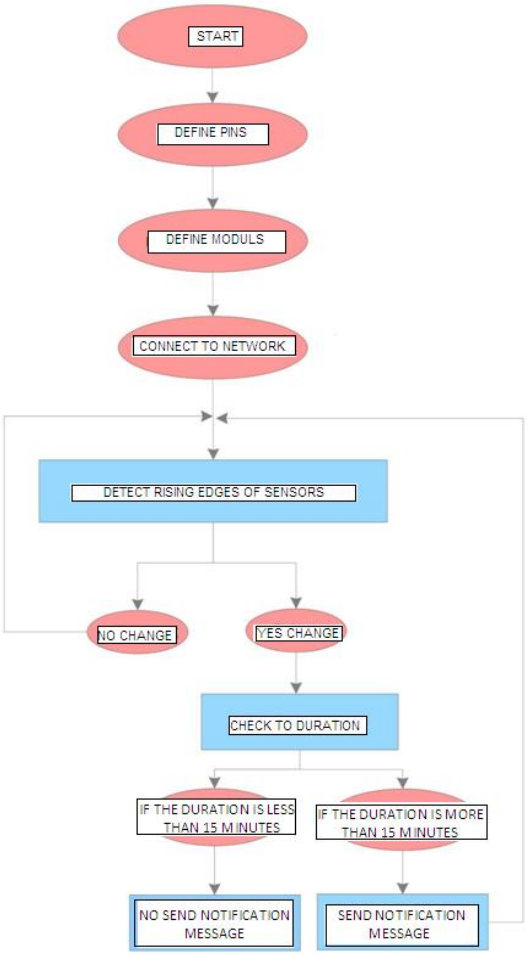

Fig 13. Operating block diagram of the system

When the program first runs, it connects to the Wi-Fi network and assigns itself an IP. Digital data from PIR sensors is read in a fixed loop, and while the digital data is being read, the rising edge is captured and the message of the active room is sent as a notification to the channel via the telegram bot. At the same time, a period of inactivity is started. If the time has already started, it is checked during the cycle whether it is less than the previously determined time. If the time has exceeded the specified time, the bot will send a message via the telegram channel notifying you of this.

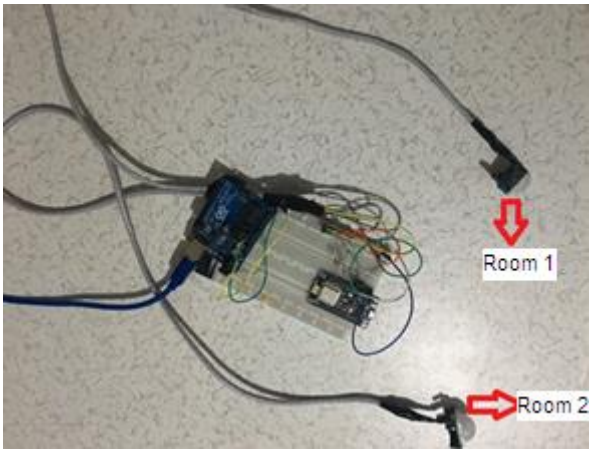

Fig 14. Completed in-home tracking system

In the design shown in Fig 14, when PIR sensors detect movement, they send notifications to telegram with their given names. While “Room 1” represents the bathroom/toilet, “Room 2” represents the outer door. When the time set in Room 1 (15 minutes) passes, the "there may be an emergency situation" notification is displayed; in Room 2, when you exit the outside door, the notification "leaving the house has been made" appears.

5. CONCLUSIONS

The aim of this study is to facilitate the follow-up of elderly individuals experiencing health problems. For this reason, the target audience of the project is considered to be older individuals living alone and disabled people. In this design, PIR sensors are planned to be placed in every room in a house, allowing complete individual tracking. With the help of these sensors, it is possible to track the elderly person by learning which rooms he stays in and for what periods of time. Their messages will come from the mobile application and if they are away from home, the patient's relatives will be able to follow up from the mobile application. This aims to prevent unwanted accidents.

Thanks to the use of this design, it is aimed to increase the quality of life of the users with ease and low costs. Considering the changing country conditions, individualism and loneliness are seen as the biggest problems of people in the future, especially lonely older people. Thanks to this technology, people's quality of life increases, the patient's range of motion increases, it provides real-time monitoring and increases the chance of early intervention. Despite the continuous studies and developing technology in this field, we have not reached a level where all the requirements are met. For this system to work error-free, high data transfer rate, reliable communication, and multiple and mobile receivers are needed.

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REFERENCES

[1]. Gogate, U., Bakal, J. (2018). Healthcare monitoring system based on wireless sensor network for cardiac patients. Biomedical and Pharmacology Journal, vol. 11, no. 3.pp. 1681–1688.
[2]. Rotariu, C., Costin, H., Andruseac, G., Ciobotariu, R., Adochiei, F. (2011). An integrated system for wireless monitoring of chronic patients and elderly people. In 15th International Conference on System Theory, Control and Computing, pp. 1–4.
[3]. Sundara, B., Sarvepalli, K. C., Davuluri, S. H. (2013). GSM Based patient monitoring system in NICU. IJRET Int. J. Res. Eng. Technolgy, vol. 2, no. 07., pp. 120-123
[4]. Chenhui, Z., Huilong, D., Xudong, L. (2008). An integration approach of healthcare information system. International Conference of BioMedical Engineering and Informatics (BMEI 2008), pp.606-609.
[5]. Sanli, M. (2009). Mobile patient tracking system. Master's Thesis, Kocaeli University Institute of Science and Technology.

[6]. Yilmaz, A., Guven, A. (2017). Wireless patient monitoring system. Electronic Letters on Science and Engineering, 13(1), pp. 16-30.
[7]. Derelioglu, B. (2007). GPS and GPRS based wide area network application. Master's Thesis Gazi University Institute of Science and Technology.
[8]. Karaali, C., Yıldırım, O. (1996). Global positioning system (GPS). Pamukkale University Faculty of Engineering Journal of Engineering Sciences, Issue: 2, pp.103-108.
[9]. Aziz, K., Tarapiah, S., Ismail, S. H., Atalla, S. (2016). Smart real-time healthcare monitoring and tracking system using GSM/GPS technologies. Proceedings of the 2016 3rd MEC International Conference on Big Data and Smart City (ICBDSC), pp. 1–7.
[10]. Greene, S., Thapliyal, H., Carpenter, D. (2016). IoT-based fall detection for smart home environments. IEEE International Symposium on Nanoelectronic and Information Systems, pp. 23-28.
[11]. Luo, X., Liu, T., Liu, J., Guo, X., Wang, G. (2012). Design and implementation of a distributed fall detection system based on wireless sensor networks. EURASIP Journal on Wireless Communications and Networking, (1), 1-13.
[12]. Varady, P., Benyó, Z., Benyó, B. (2002). An open architecture patient monitoring system using standard technologies. IEEE Transactions on Information Technology in Biomedicine, 6(1), 95-98.
[13]. Uddin, M. S., Alam, J. B., & Banu, S. (2017). Real time patient monitoring system based on internet of things. 4th International Conference on Advances in Electrical Engineering (ICAEE), pp. 516-521.
[14]. Yavuz, S. O., Taşbaşı, A., Evirgen, A., Kara, A. (2012). Motion detector with PIR sensor usage areas and advantages. Istanbul Aydın University Journal (İAÜD), Issue 14, pp. 7-16.
[15]. Belakbir, A., Amghar, M., El Kouhen, N. (2012). An indoor positionning system based on the fusion of location information. Colloquium in Information Science and Technology (CIST), pp. 32-37.
[16]. Malik, A., Magar, A. M., Verma, H., Singh, M., Sagar, P (2019). A detailed study of an internet of things (IoT). International Journal of Scientific & Technology Research Volume 8, Issue 12. pp. 2989-2914.
[17]. Yilmaz, S., Sazak, B.S., and Cetin, S. (2010). Design and implementation of web-based training tool for a single switch induction cooking system using PHP. Electronics and Electrical Engineering. No. 3 (99).