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*Research Article*

# Smart Home System for Making Easier the Living of The Elderly

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ABSTRACT

In this study, it has been researched how smart home technologies, which enable people to lead a more comfortable and safer life, can provide the life of elderly and needy people, and which smart home scenarios can be used to provide convenience to these people in the Smart Home project developed. With this project, we aim to make the elderly, and someone need for care living in our society live an easier and more comfortable life. Our most important goal is to develop a smart home system that will improve the quality of life of these people. While making this determination, both the demands of elderly and needy people in this direction and the smart home scenarios used in the previously developed smart home systems were based on. We think that this system we developed will be effective in increasing the welfare level of the society. At the same time, many people living far away from their families will be able to be constantly informed of them by using this system. This system can be developed in the future and turned into a state application. Many elderly and bedridden patients can be controlled remotely in any situation and can be interfered to them quickly. In addition, one of the biggest advantages of the project is that it can be controlled remotely through both the mobile application and the website we designed.



## 1. Introduction

According to the survey conducted by TSI (Turkish Statistical Institute) in 2014, 8% of our country's population consist of older than 65 years old. The same research shows that 17.3% of the elderly population live alone [1]. This study is aimed at facilitating the lives of the elderly who live alone or those who are constantly wondering about their family elders. Thanks to this study, the person whose elders lives alone, elders will be able to keep the situations constantly under control. In case of any problem, the person controlling the system is automatically informed.

In the smart home system, which was previously developed by a number of academicians at Umea University (Sweden); it was concluded that information processing should be realized by integrating with daily objects in a smart home environment. It is concluded that this requirement brings along the use of the objects and changes that are used daily depending on the user's relationship with them. It has been determined that the acquired information is also useful for recognizing the activities and status of the user. In this study, ZigBee communication protocol based on wireless sensor network of 42 daily objects (containing 81 status changes of 8 sensor types) in a smart home environment is included. The system is made with a realistic installation and background sounds are also included. The perception module showed promising results with a rate of 91.2 % in terms of overall system sensitivity and 98.8% in tracking the changes in the status of everyday objects. In the home environment, the signal strength measurement for compliance with reliable data communication was found above 10 dB, which was the acceptable limit, and it was found to be 97.5% in 8 different places in the home environment. Finally, the indoor transmission and reception range is 33m beyond one wall and 19m beyond multiple walls [2].

Regarding smart home systems, a number of academicians at Surrey University (UK) have developed a mobile controlled smart home system. This study

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describes the control and remote monitoring of home devices for the design and implementation of smart home applications via the mobile data messaging services and the Internet. The existing smart home appliances have been found to be accessible with their own remote controls within the limited coverage range of the personal network connection, usually 100m Radius. With the development of the Internet and mobile devices, it was concluded that the scope of access of smart home devices will be almost unlimited, convenience will increase, and favourable conditions will be provided for potential developments in smart home technologies [3].

Another study involves a smart home system developed using cloud computing. This work supports the Cloud Computing and Smart Home Electricity Management System. With the Internet, it has been determined that power consumption data can be collected online and power supplies of connected electrical devices can be operated. In addition, it is understood that every tool and load (resistance) connected to the system can generate the reports that are daily, monthly and annual cost and kilo-watt usage reports per hour [4].

In another study, it was found that smart home systems are not only aimed at the comfort of people, as it is generally known, but also in the house where people live, they have the features to protect people in case of any threat to life and property safety. In addition, in this study, the structured determination of the infrastructure in accordance with these systems has been made during the construction of houses for how to work in any emergency and the successful operation of these scenarios [5].

In another study by a group of academics, smart home systems developed for people with disabilities were mentioned using wireless networks. In this study, an alert system to facilitate the lives of hearing-impaired people, a gas leakage system and an automatic door control system that will facilitate the life of a disabled person, especially visually impaired people [6].

As a result of this research, it has been determined that smart home systems increase human efficiency and saving energy. If we talk about the smart home systems scenarios included in this research;, by sensing the sunset with the light sensor closing the curtains and opening the garden and door entrance and the lights in the house optionally, activating the alarm when detecting the fire with the smoke sensor, turn down television and music system when the phone rings [7].

Within the aim of this study, a smart home application that will facilitate the lives of elderly and disabled people at home has been realized. Scenarios such as keyless entry to the house, automatic entrance to the garage by car, fire / gas leak warning, flood warning, automatic lighting, burglar alarm, earthquake condition, air conditioning are handled within the smart home. In addition, the Raspberry Pi 3 module with a 64-bit, 1.2 GHz quad core ARM Cortex-A53 processor and various sensors and hardware materials were used in the study. By developing a prototype house and a web interface for the scenario tests of the smart home application, all the scenarios and equipment are successfully tested on [8].

In addition, we use some of the scenarios that are mentioned, in our study. It has been researched how smart home technologies, which enable people to lead a more comfortable and safer life, can provide the life of elderly and needy people, and which smart home scenarios can be used to provide convenience to these people in the Smart Home project developed. With this project, we aim to make the elderly, and someone need for care living in our society live an easier and more comfortable life. Our most important goal is to develop a smart home system that will improve the quality of life of these people.

## 2. The design of project

There are many applications in the smart home system in our project that will facilitate the lives of the elderly and their relatives. For example; thanks to the motion sensor placed in the smart home, if the person stays in bed for longer than normal hospitalization duration, the notification is sent to the relatives automatically. The elderly or sick person can use the panic button when faced with any emergency. Thus, notification is sent to the relatives directly. At the same time, enlightening turns on automatically after a certain hour, especially for the elderly who are bedridden and difficult to move. Again, with the sound sensor we placed, the smart home system can be listened to remotely by the person who controls it. Also, if a sound is detected above the threshold value at home, the person who controls the system is automatically notified. In addition, with the heart rate sensor we placed at home, the elderly person at home will be able to measure their pulse whenever they want. If this pulse value is above the specified threshold value, the person controlling the system is automatically notified.

With this project, we aim to make the elderly, and someone need for care living in our society live an easier and more comfortable life. Our most important goal is to develop a smart home system that will improve the quality of life of these people.

One of the biggest benefits of smart home technology is saving. Another important advantage is the security part. With the security functions to be selected in the system, it can be warned against various dangers such as theft, gas leakage, fire, flooding in the home, whether it is or not, and it is also possible to prevent these dangers before they occur. In addition, with the smart home technology, the comfort area of the person is increased by performing works such as closing all the curtains, adjusting the temperature of the water and the house, turning off the lights [9].

Many old people find it difficult to adapt to today's technologies. For example; it may be more comfortable for them to adjust the temperature remotely [10]. In addition, we can access a lot of information about the house remotely with the sensors placed in the smart home system. For example; the instant temperature of the house can be learned with the LM35 temperature sensor we place.

Thanks to this system, the lights are automatically on and off after a certain time. In this way, great convenience will be provided, especially for patients who are bedridden. At the same time, energy savings are provided.

By means of the motion sensor we placed, if the elderly person or people who live in the smart home stand still for a certain period of time, the person who controls this system remotely is informed via the mobile application.

The button we have placed, when the elderly or needy person presses the button, the person who controls the system is automatically notified.

Thanks to the Supersonic sound sensor to be put in the house, if a signal comes above the predetermined sound level in the house, the person who remotely controls the system is automatically notified. This level can be determined by the person controlling the house as in other sensors.

## 3. Experimental Results

We will use Arduino hardware in the smart home system we will develop. Arduino is an open source development platform using ATMEL processors. Within this development platform, there are different cards, plugins (shields) for making many different operations and Arduino IDE for programming [11].

For the smart home project that will make life easier for the elderly, we used Arduino UNO to process signals from different sensors and users. In order to reach the data of the smart home system we developed remotely; we used the sensors we will place in this home [12].

### *3.1.1. LDR Lightening Sensor*

It is a kind of optical sensor that can adjust the resistance value inversely correlated it according to the intensity of the light in the environment. By using this sensor, the resistance value can fall between 5-10 Ω in a fully bright area, that is, when sunlight is falling on it. While the resistance value shows a very high values such as 200 MΩ in a completely dark environment that is with little or no light falling on it, the resistance value decreases nonlinearly as the light falling on it increases. Therefore, increasing the light intensity causes the resistance value to decrease, and decreasing the light intensity causes the resistance value to increase [13]. Depending on the resistance value displayed, lighting in the house can be automatically turned on and off after a certain time. This sensor saves energy for the smart home user. We have used the light sensor to turn the lights on and off automatically after a certain time. In addition, thanks to this sensor, we can instantly access information whether the light is on or not. We can turn the light on and off remotely via mobile application or website.

### *3.1.2. Heat/Temperature/Humidity Sensor*

It is a cost effective and high-quality temperature sensor. It is analog output. It can measure between -55 and 150 degrees. It has a sensitivity of 10mV / degree [13]. Thanks to this sensor, the instant temperature of the smart home can be directly learned through our mobile application or our website. Also, if the temperature of the house rises above the specified threshold, the person who controls the system is automatically notified via the mobile application.

### *3.1.3. Supersonic Sound Sensor*

With this sensor, we can listen to every sound in the home and if a sound signal is detected above the predetermined sound threshold, notification is automatically sent through the mobile application. The person controlling the system can listen to the smart home environment via the website or mobile application. The sound sensor board is a card that has a microphone and outputs digitally according to the ambient sound level. There is a potentiometer on the card where you can continuously read a sudden and loud sound or ambient noise as a clap or a horn. In this way, you can get the sound output without the ambient noise. It can be used with many microcontroller systems, especially Arduino.

### *3.1.4. Motion Sensor*

With this sensor, the user's movements can be monitored by the person controlling the system and if the resident of the smart home stay still for a certain period of time, the notification is automatically sent via the mobile application. In addition, the person controlling the system can access the data when the smart home user act last time via the mobile application we designed. In addition, the maximum time to stay still can be determined from the settings section of the mobile application and website. To mention the technical features of the sensor; PIR are sensors used in our system to detect live movement occurring in an environment [13].

### *3.1.5. Pulse Sensor*

With the help of this sensor, the person who lives in the smart home can be measured the pulse at any time. The three most recently measured values are stored in the system database. If the measured value is above the determined threshold value, the person who controls the system is automatically notified via the mobile application. In addition, the person controlling the system can see the last three measured heart rates of the smart home user through the mobile application or website.

Thanks to the panic button that we place in the house other than the sensors we will use, when the elderly or

person in need of care encounters any problems, they can ask for help from the person who remotely controls the smart home system by pressing this button. When the button is pressed, notification is sent to the person who controls the system instantly via mobile application. Also, 4 Pin Push Button is used in our project.

We will use the Android operating system for remote control using the smart home system we will develop. Android is an open source operating system designed for mobile devices.

With the Android application we developed, we can control our smart home system remotely. We used Android Studio as the application development platform. Through the sensors, we can access the information that is coming to the server over Raspberry Pi directly from our android application. For example, with our temperature sensor, we can directly learn the temperature of the house using the smart home system using our Android application. We will be able to reach the information that the lights in the house whether are on by using the application. In case of any adversity, we automatically receive a notification to our phone where our application is installed.

The biggest reason we use Raspberry Pi in our project is to use the Johnny-Five library. Because this library contains many code blocks that we can use in the project [14]. The code blocks in this library were written in Node.js. Since we can run Node.js on Raspberry Pi, we decided to use this hardware [15].

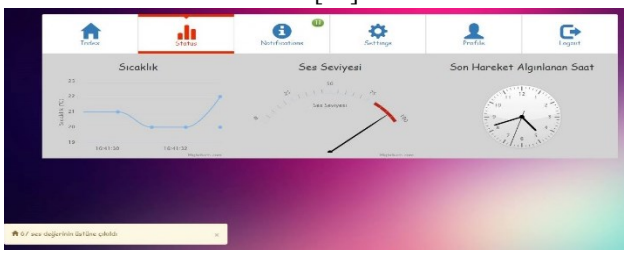


**Figure 1.** Instant information about sensors in smart home

Thanks to the mobile application we have developed, we can control the smart home system. If the sensors in the house where the system is installed make a measurement above the determined threshold values, we automatically receive a notification via our mobile application. In this way, the person who controls the system in case of any negativity can be easily informed.

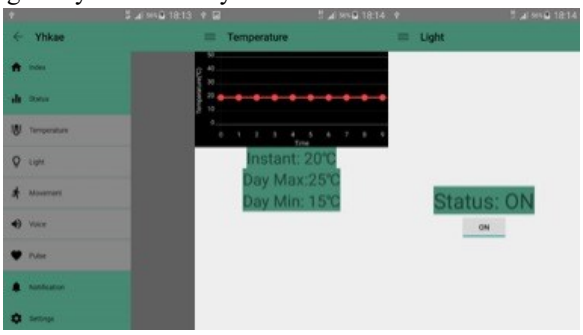


**Figure 2.** Mobile application content-1

After logging in to our mobile application, Index page is opened first. On this page, you can find information about the system we developed and information about the control of the system. Then, after clicking on the menu icon at the top of the page, the Menu section opens. When we click Status in the menu, the list of sensors in the system is opened. Here, by selecting the sensor we want, we can have information about the last measurement that sensor made at home. For example; in the Temperature section under Status, you can reach the instant measured temperature information and the minimum and maximum temperature values measured during the day. It is also included in this part of the graph of the instant temperature measured. On the Light section, we can have information about whether the lights on in the house where the system is installed. At the same time, we can turn the leds in the house on and off at any time by using the switch located here. If the sensor makes a measurement above your specified threshold value, the lights in the smart home where the system is installed automatically turn on.


**Figure 3.** Mobile application content-2

In Movement in the Status section, we can see the last move date and time of the person residing in the smart home, detected by the sensor. In addition, we can reach the time from the last detected time until the person controlling the system looks at this section. In the Voice section, we can reach the time information of the last sound detected by the sensor and the time when the sound is not detected. If we click on the Pulse section, we can reach the last three heart rate values measured by the person who resides in the smart home, with the time and date information when measured.


**Figure 4.** Mobile application

In the Notifications section of the Menu, if a value measured by the sensors in the house where the system is installed and a value above the threshold value is encountered, we can reach the notifications sent by the system. In the Profile section, we can change the user password that we login to the system. In the Settings section, we can change the threshold values of the sensors located in our smart home. Thanks to the mobile application, we can comfortably control our system through the mobile application on our phone.

## 4. Conclusions

In this study, we have mentioned a mobile application developed by us, about smart home technology by us. The system uses the information from sensors in the house such as lightening sensors, heat/temperature/humidity sensor, supersonic sound sensor, motion sensor and pulse sensor. It is aimed to share the information obtained using these sensors with the person who controls the system remotely. If the sensors sense above the determined threshold values, we automatically receive a notification via our mobile application.

Researches show that the use of smart home technologies really increases the comfort and quality of life of the society and also makes people feel safe in terms of life and property safety.

Unlike the scenarios discussed in our study, in the [8] study, different scenarios such as keyless entry to the house, automatic entrance to the garage by car, fire / gas leak warning, flood warning, burglar alarm, earthquake condition, air conditioning were handled in the smart home technology.

We think that this system we developed will be effective in increasing the welfare level of the society. At the same time, many people living far away from their families will be able to be constantly informed of them by using this system. This system can be developed in the future and turned into a state application. Many elderly and bedridden patients can be controlled remotely in any situation and can be interfered to them quickly. In addition, one of the biggest advantages of the project is that it can be controlled remotely through both the mobile application and the website we designed.

### Author's Note

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