

Assistive Domotics for the elderly

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Abstract - This paper reviews the opportunities to leverage the benefits of technology evolution to the elderly, so that they can live comfortably and securely. Active research is being carried out to extend the benefits of information and communication technologies that enable them to live independently and promote a sense of overall well-being. IoT advancement in recent years has helped to bring the cost of hardware significantly down and hence making it more accessible for the common man. This has also given opportunity to think about innovative use-cases for different generations of people. This paper is an attempt to explore the use of IoT for elderly people but nevertheless some use-cases can be of relevance for other generations as well. There are a lot of technologies available, which can be tied together thoughtfully to make the life of elderly comfortable and safe. The technologies which are available include Wi-Fi, Bluetooth, 4G Cellular, Cloud-native software, natural language processing, low cost controllers, and sensors, to mention a few.

Key Words: Internet of Things, Artificial Intelligence, Automation, Smart Home, Home Automation, Actuators, Sensors, Assistive Technology.

1. INTRODUCTION

Elderly people are an important and growing segment in the world population and the statistics show that the percentage of older people is continuously growing due to many reasons. Life expectancy of people is increasing leading to the situation where elderly population is increasing. The current social life style, modern medicine, and easy access to medical care have increased life expectancy [12]. The main reason for the same being the declining birth rates and the reduction of women fertility [13]. A United Nations report estimated that the life expectancy was 65 years in 1950, and 78 years in 2010 and it will continue to rise to 83 years in 2045 [14]. On the other hand, it was reported that 35% of people aged 65+ in 2011 had some type of disability [13]. Due to this, they require assistance to meet some important personal needs.

At the same time there is another demographic change happening where the younger generation has to move to the places away from their homes in search of a job, leaving behind their old parents alone. While elderly have to manage to stay alone amid their health conditions, on

the other hand the young generation is worried about their elderly parents staying alone at far-off places. Can we find the solution to this problem by extending the benefits of advancement in IoT space? The answer is yes, as technology evolution has made IoT a lucrative option to explore in all phases of life.

There are a lot of issues encountered by the elderly in their day-to-day life. For instance, they need regular medical check-ups to make sure they are in good health. This is a challenge for them both physically and financially. They also find it difficult to remember things such as locking of doors, or find it difficult to detect a gas leak. All these things can lead to serious hazards to their health. Even the minor tasks of switching on/off the appliances becomes difficult for them as they could be mobility-challenged. In general, their capability to manage daily activities is reduced due to their weak physical systems.

2. PROPOSED DESIGN

The end user, who is elderly in this case, could use their mobile phone to control the appliances. There are following key use cases:

1] Controlling Appliances: As elderly people are weak and cannot always roam around the home to switch on/off the various appliances example light, fan etc., so the proposed home automation system provides the control of all home appliances through the Mobile application. They can switch on/off the appliances from anywhere in the house or even from some distant location as needed.

2] Monitoring Health Parameters: As key body vitals for elderly keep fluctuating, it is important that key body parameters are monitored by them and also available to be monitored remotely by the remote doctor. The key parameters monitored in this project are Temperature and Pulse Rate but many more parameters can also be integrated.

3] Safety: As memory loss is one of the key conditions associated with old age, elderly might leave the gas stove knob turned on without igniting the stove or they might leave the main door open, leading to several safety issues. This home automation system realizes a monitoring system for:

1. Gas leak detection by means of using Gas Sensor

2. Door open indication by means of using Magnetic Reed Sensor
3. Rain detection by using a rain sensor.

Many more similar sensors like PIR etc, can be used to detect the presence of a person at a door. All such sensors provide useful environmental information through Mobile applications and make the elderly take actions based on information.

4] Security: In event of any emergency, the provision of alarm is given through the mobile app. The emergency alarm can be mounted either outside the home door or in the security room of a society, so that elderly can raise an alarm in case of any emergency or help.

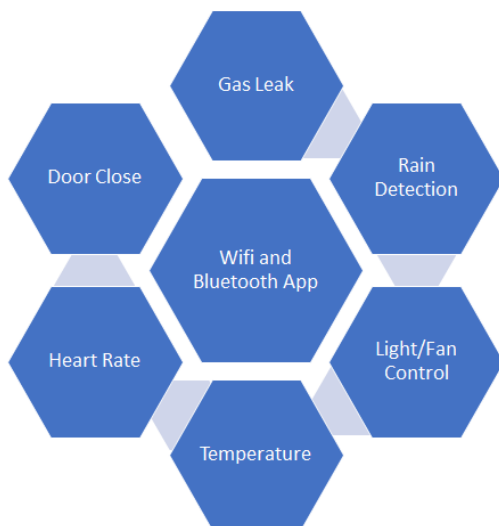


Fig -1: Features Implemented

3. IMPLEMENTATION

In order to demonstrate two different communication technologies and the associated capabilities, the project is realized with two different controllers and mobile applications.

BLUETOOTH BASED HOME AUTOMATION :

This implementation uses the Arduino UNO as the main controller unit which is interfaced with HC05 Bluetooth module for communication with mobile phones. As Bluetooth provides P2P connectivity over only a limited range over wireless, the usage of Bluetooth based application is intended to be within the house premises. Figure 2 depicts the block diagram for the implementation using Bluetooth.

Arduino UNO R3 : Arduino Uno is a microcontroller board based on the ATmega328P with a small enough form

factor and easily available in the market. It offers the flexibility of 14 digital input/output pins along with 6 analog inputs, a 16 MHz oscillator, a USB port, a power jack, an ICSP header and a hard reset button. It has the necessary components needed for the microcontroller. It can be connected to a computer with a USB cable or powered with an AC-to-DC adapter or can be used with a battery.

HC-05 Bluetooth Module : It is designed for establishing a short-range wireless data communication between two microcontrollers or systems. The module is capable of working on Bluetooth 2.0 communication protocol and it can only act as a slave device. It is the cheapest method for wireless data transmission and is more flexible compared to the other methods. It even can transmit files at speed up to 2.1Mb/s. It uses frequency hopping spread spectrum technique (FHSS) to avoid interference with other devices and to have full duplex transmission. The device has been designed to work on the frequency range from 2.402 GHz to 2.480GHz.

Smoke and Air Quality Sensor MQ135 : It is used in air quality control equipment and is suitable for detecting or measuring NH₃, NO_x, Alcohol, Benzene, smoke, CO₂ etc. It has a wide detecting scope along with fast response and high sensitivity. It is stable and has a long life. It operates at a voltage of +5V. It can be used either as a digital sensor or an analog sensor.

Rain Sensor Module : Raindrop Sensor is a component used for sensing rain, based on presence of water. It is made up of two modules, a rain board that detects the rain and a control module, which reads and compares the analog value and then converts it to a digital value. It has a digital switching output and an analog voltage output. It uses a potentiometer to adjust the sensitivity. Its advantages include anti-oxidation, anti-conductivity and a long use time.

Reed Magnetic Sensor : A reed switch is a sensor that closes the circuit in the presence of a magnetic field. Reed sensors can be used in many applications where contactless on/off is required. However, reed switches are a little fragile to use directly, hence the sensor module can make it easier to handle and mount the sensor in different applications. The Reed Switch Sensor Module consists of a Reed Switch, resistors, capacitor, potentiometer, comparator LM393 IC, Power, and status LED in an integrated circuit. It has a digital switching output. It is small, cheap and easily available.

MIT App Inventor platform : The application platform used to develop the mobile application. MIT App Inventor is a web-based IDE (application integrated development

environment), originally designed and provided by Google. But now it is maintained by the Massachusetts Institute of Technology. It uses a GUI (graphical user interface) which allows users to easily drag and drop visual objects, to create an application that can run on android devices.

Arduino IDE: The Arduino IDE (Integrated Development Environment) is a cross-platform software that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also with other vendor development boards. It employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

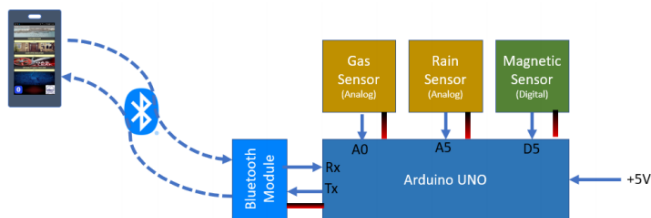


Fig -2: Block diagram for bluetooth implementation

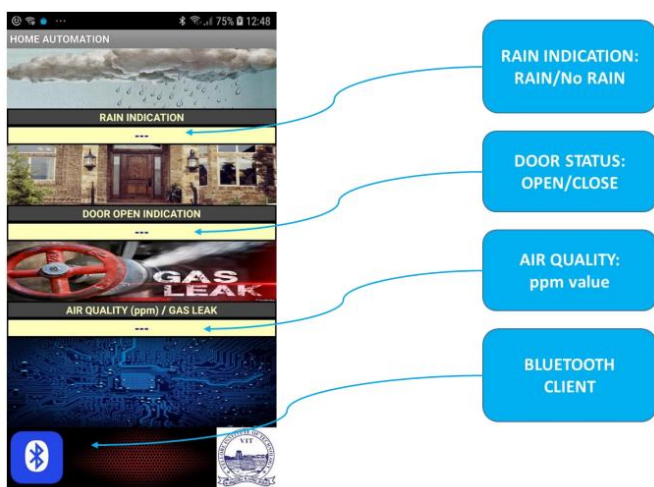


Fig -3: Smartphone Application

Wi-Fi BASED HOME AUTOMATION :

Wemos D1 R1 controller module based on ESP8266 chip is used to realize the Wi-Fi based home automation system. This controller has the in-built Wi-Fi module and can easily connect to any Wi-Fi network with easy programming. The Wi-Fi provides access beyond the boundaries of home premises as it connects to Mobile applications through the web-server in cloud, which can be accessed from anywhere in the world. This controller module is used in conjunction with a cloud-based Web server provided by Blynk.

Wi-Fi ESP8266 Development Board WEMOS D1: WEMOS D1 is a WI-FI development board based on ESP8266 12E. Its hardware is built resembling an Arduino UNO. The D1 board can be configured to work on Arduino IDE using the board manager. Different versions of D1 boards are available in the market R1, R2, MINI. The ESP12 chip has only one analog pin, on board there is only A0 and the other analog pins are dummy. It has a larger flash memory compared to an Arduino Uno and consists of 11 digital I/O pins and 1 analogue pin. It can be connected using a Micro-B type USB cable.

DS18B20 Temperature Sensor : DS18B20 is a digital temperature sensor with 1-Wire support from Maxim IC. It reports degrees in Celsius with 9 to 12-bit precision, from -55 to 125 (+/-0.5). Each sensor has a unique 64-Bit Serial number written into it which allows for a large number of sensors to be used on one just data bus.

BPM Sensor : Pulse Sensor is an easy to use, plug-and-play heart-rate sensor for Arduino and likes. It can be used to get live heart-rate data. It's noticeably faster and easier to get reliable pulse readings, achieved by adding amplification and noise cancellation circuitry to the hardware. Pulse Sensor Amped can work with either a 3V or 5V Arduino.

Buzzer : A buzzer is an audio signalling device, which can be mechanical, electromechanical, or piezoelectric. Buzzers are typically used for alarm devices, timers and confirmation of user input such as a keystroke or mouse click.

Relay Driver : The Single Channel Relay Module is an easy to use board which can be used to control high voltage, high current load appliances such as fans, lights, television, air conditioners etc. It is designed to interface with microcontroller boards such as Arduino, Raspberry Pi etc. The relay terminal is being implemented using a screw terminal. It also provides the LED to indicate the status of relay.

Blynk : It is the platform designed for the Internet of Things and is used for this implementation. It can control hardware remotely, can display sensor data, can store data, visualize it and do many other things. It has three major components:

Blynk App : allows to create amazing interfaces for projects using various widgets.

Blynk Server : provides the functionality to communicate between the smartphone and hardware. One can use Blynk Cloud or a private Blynk server could be run locally. It is an Open Source platform, which can easily handle thousands of devices.

Blynk Libraries : are meant to enable communication with the server and process all the incoming and outgoing commands.

The Wi-Fi helps provide the access beyond the boundaries of home premises as it is capable of connecting to Mobile applications through the web-server in cloud which can then be accessed from anywhere around the world.

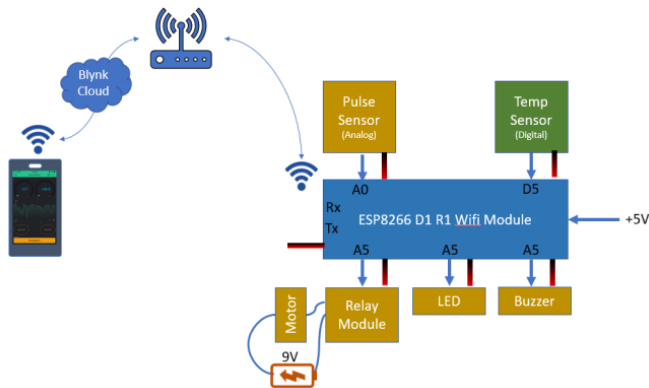


Fig -4: Block diagram for Wi-Fi implementation



Fig -5: Smartphone Application

4. CONCLUSIONS

The project was successfully designed, developed and tested and it served the intended purpose. We are able to demonstrate the use of IoT for the elderly with respect to the different use cases. This project has given us the opportunity to learn about the various types of controllers, sensors, application development platform and technologies. We faced many challenges while developing the project but were able to solve these challenges one by one by referring to the references. The objective of the project is successfully met. It could thus be concluded that IoT proves to be of great importance for the elderly, as it

helps make their lives a lot more convenient and ensures their safety at every point of time.

Even from the economic point of view, the cost of living at home with monitoring devices and intelligent appliances is less expensive and more beneficial than attending medical centres. The implementation of smart home systems with remote monitor controls and health care capabilities will definitely help reduce the expense of personal aid assistance at home [12].

Power of IoT combined with cloud-based web services can do wonders. This has the potential to take away pain out of the life of elderly and improve their quality of life by providing a convenient and safe living environment. Such an IoT ecosystem not only helps them physically but also psychological support to them, by increasing the accessibility to various services at their fingertips.

With the increasing penetration of technology into private spheres, technology must comply with the needs of a diverse user group in order to be fully successful and accepted by those for which the technology has been designed [16]. With the cost of hardware further going down and the accuracy of sensors further increasing, it will pave the way for the new era of home automation. A system or service can be usable in terms of performance measures but it could also be rejected completely. So, it is important that the design focus should not only be on efficiency, task-appropriateness, and ease-of-use. [15][11]

This project has a scope to add new capabilities and sensors to further improve the experience. Some of the possible addition to the project are:

1. Access card-based entry and exit from the main door.
2. Main door operation by Face Recognition.
3. Light operation by using proximity sensors.
4. Burglar alarm by using proximity and ultrasonic sensors.
5. Walking assistance by alerting about the obstructions by using distance sensors.
6. Automatic door or window operation based on the environmental conditions.
7. Mobile applications can be more intuitive and smarter.
8. Notifications feature in mobile applications can also help to check the sensor state change, so that appropriate actions could be taken.

9. Email alerts can also be configured for the specified people to note any adverse condition like gas leak.

Commercialization of this project is going to be very viable, due to the intended benefits and the associated costs. This project offers good ROI (Return on investment) for the customers.

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