

Development of Voice Control for Smart Home Automation for Physically Disabled People

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Abstract : Innovations in technology mostly emerge from the needs of human society. The 21st century is the era of prompt advancement in digital technology. Most of this technology is focused on proficiently monitoring and controlling different activities. Homes of the 21st century will become more and more self controlled and automated due to the comfort it provides, especially when employed in a private home. A home automation system is a means that allow users to control electric appliances of varying kind. Many existing, well-established home automation systems are based on wired communication. This does not pose a problem until the system is planned well in advance and installed during the physical construction of the building.

Index Terms– IoT, smartphone, Alexa, sensor.

I. INTRODUCTION

The Internet of Things is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers and the ability to transfer data over a network without requiring human – to – human or human – to – computer interaction.

The definition of the Internet of Things[1] has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", covering devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers.[2]

The so-called "smart homes", also referred to as "connected homes" are fast becoming an interesting and growing global phenomenon. Automation forms a large part of smart homes. Connected programmable devices utilize "a network to control home functions for a better quality of life" and more convenience. These devices use wireless technology such as Wi-Fi (IEEE 802.11), Bluetooth (IEEE 802.15.1), Radio Frequency Identification (RFID), ZigBee, IPv6 Low-Power Wireless Personal Area Network (6LoWPAN), and more. [5]

Smart home residents are able to control lighting, control their HVAC (heating, ventilation, and air conditioning), lock and unlock doors, turn on the coffee make while they are in bed or sitting on a couch. The technology that is used by these systems falls under the category of Internet of Things (IoT). A smart home is able to notify the residents when a washing machine has finished washing clothes, when a roast is cooked and ready to eat, show the residents the contents of their refrigerator remotely, and perform many more tasks that residents have to manually perform. The cost of a smart home is generally high but as always; costs go down over time due to a number of reasons such as economies of scale or competition among vendors.[4]

The programmable devices are controlled using smart phones because of their capability to communicate wirelessly. Users download and install applications that are designed to send commands to the programmable devices wirelessly. Smart home residents are also able to send commands via computers. Augmented reality has also been used to allow users to control smart devices. Being able to control home devices using smart technology could be a tremendous benefit to people with physical disabilities and the older persons. Most of the smart home devices are not designed with people with disabilities and limited range of movement in mind. We can agree that "disabled persons face many problems in their daily life both inside and outside of the home especially while staying alone at home". [2]

In this paper, we present a system that uses a digital assistant such as Amazon Alexa to capture voice commands from a person with disabilities spoken in a much more natural way to control ordinary electrical appliances to turn them on or off. The digital assistant, in the case, Amazon Alexa, can communicate with a smart electrical power strip or smart mini power socket via Wi-Fi to turn the electrical appliances plugged into them on or off. The person with a disability simply asks Alexa to turn an appliance on or off by simply saying "Alexa turn on the microwave", for example.

The limitations of the smart home programmable devices can be overcome by designing systems that make use of the ability to send commands to these systems using voice if the disabled person can speak to communicate with the system. Additionally, smart phones could be used by a person with disabilities to control the appliances plugged into a smart plug. The paper focuses on using Amazon Alexa to turn the appliances on and off.

II. RELATED WORK

The concept of a network of smart devices was discussed as early as 1982, with a modified Coke machine at Carnegie Mellon University becoming the first internet-connected appliance, able to report its inventory and whether newly loaded drinks were cold. Mark Weiser's seminal 1991 paper on ubiquitous computing, "The Computer of the 21st Century", as well as academic venues such as UbiComp and PerCom produced the contemporary vision of IOT. In 1994 Reza Raji described the concept in Spectrums [moving] small packets of data to a large set of nodes, so as to integrate and automate everything from home appliances to entire factories. Between 1993 and 1996 several companies proposed solutions like Microsoft's at Work or Novell's NEST. However, only in 1999 did the field start gathering momentum. Bill Joy envisioned Device to Device (D2D) communication as part of his "Six Webs" framework, presented at the World Economic Forum at Davos in 1999.

The concept of the Internet of Things first became popular in 1999, through the Auto-ID Center at MIT and related market-analysis publications. Radio-frequency identification (RFID) was seen by Kevin Ashton (one of the founders of the original Auto-ID Center) as a prerequisite for the Internet of Things at that point. If all objects and people in daily life were equipped with identifiers, computers could manage and inventory them. Besides using RFID, the tagging of things may be achieved through such technologies as near field communication, barcodes, QR codes and digital watermarking.[2]

One of the first consequences of implementing the Internet of Things by equipping all objects in the world with minuscule identifying devices or machine-readable identifiers would be to transform daily life. For instance, instant and ceaseless inventory control would become ubiquitous. A person's ability to interact with objects could be altered remotely based on immediate or present needs, in accordance with existing end-user agreements. For example, such technology could grant motion-picture publishers much more control over end-user private devices by remotely enforcing copyright restrictions and digital restrictions management, so the ability of a customer who bought a Blue-ray disc to watch the movie becomes dependent on so-called "copyright holder's" decision, similar to Circuit City's failed DIVX. [4]

As of 2014, the vision of the Internet of Things has evolved due to a convergence of multiple technologies, ranging from wireless communication to the Internet and from embedded systems to micro-electromechanical systems (MEMS). This means that the traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of Things (IoT).

Smart home automation system is increasingly used due to the wide manufacturer brands and various available technologies. From a social point of view, residents are admitted to smart homes for comfort, luxury, improving quality of live, and for providing security against intrusion and burglars. Secondly, home automation is achieved using a single controller, monitoring and the controlling many interconnected appliances such as lights, power plugs, HVAC system, humidity and temperature sensors, gas, smoke and fire detectors, audio, video and home theater as well as security and emergency systems.

The 3 pin socket is provided to connect to the geezer. Time can be set for turning on the geezer using android. The processor will turn on the geezer automatically, 15 minutes before the set time. On time of the geezer will depend on the environmental temperature. Required lights and fans are turned on/off and controlled wirelessly through android. If the lights or any electrical appliances are left on in hurry can be seen and turned off remotely through simply typing the IP address of the web server.

Smart homes are cheap, low-power, cost effective, efficient, and realize the automation of a variety of domestic appliances using user-friendly interface as remote control or any other handheld devices. Elderly, handicapped patients, and people with disabilities who have problems with locomotion difficulty can benefit from this smart home to totally operate, with high performance, all appliances and devices from anywhere in the house. When a resident is living alone, the ubiquitous access becomes very important.[2]

Many embedded systems have substantially different designs according to their functions and utilities. In this project design, structured modular design concept is adopted and the system is mainly composed of a single microprocessor, CPU fan, LED lamp, relay, 3 pin socket, GPRS module and internet.

The microprocessor located at the centre of the block diagram forms the control unit of the entire project. Embedded within the microcontroller is a program that helps the microcontroller to take action based on the inputs provided.

Raspberry Pi microprocessor is 32 bit architecture, it has 40 I/O pin. It has 11 I/O ports, 512MB RAM, 700MHz Broadcom BCM2835 CPU, 4 USB Ports, HDMI Port, Micro SD Card Slot. [5]

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature and $\pm 3/4^\circ\text{C}$ over a full -55 to $+150^\circ\text{C}$ temperature range.[5]

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits) or where several circuits must be controlled by one signal.[3]

The introduction of digital assistants such as Amazon Echo has made interacting and controlling appliances much easier using voice commands and even the device and appliance manufacturers have designed devices that can interact with digital assistants thus making it easier to control. Our system takes advantage of smart plugs that are Wi-fi enabled and Alexa enabled.

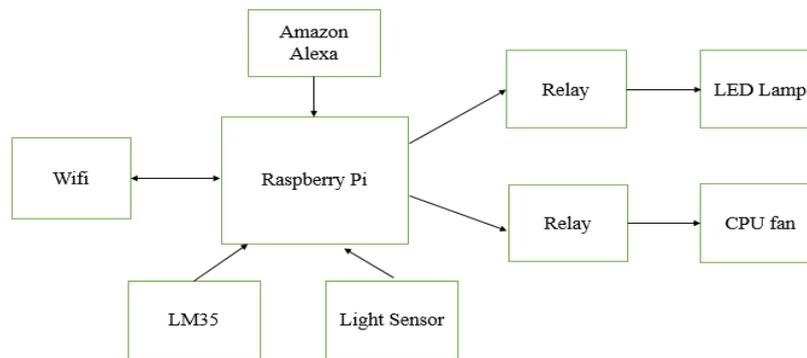


Fig. 1 System Architecture

Consider Fig. 1 for our system architecture where input is given by voice command to Alexa or from sensors and it is processed and output signal is sent to relay.

III. METHODOLOGY

Smart home automation system is increasingly used due to the wide manufacturer brands and various available technologies. From a social point of view, residents are admitted to smart homes for comfort, luxury, improving quality of live, and for providing security against intrusion and burglars. Secondly, home automation is achieved using a single controller, monitoring and the controlling many interconnected appliances such as lights, power plugs, HVAC system, humidity and temperature sensors, gas, smoke and fire detectors, audio, video and home theatre as well as security and emergency systems.

Automation is where some work is done without any need of people taking care that work and it is done in perfection of 99%. In home automation there are some work done with the help of sensors and if any particular work is to be done it would be done after ordering to Digital Assistant i.e. Amazon Alexa. Some of sensors are light sensor, temperature sensor, fire sensor and so on. Every work needs a particular type of sensor that sends signal so that the work is done correctly.

The light sensor detects the brightness of the room and then sends the signal to turn on or off the light. Likewise, the LM35 sensor turn on or off the fan and other sensors works in the same way.

If any work is to be done without help of these sensors or control any other device then a voice command is given to Amazon Alexa to perform a particular task. The voice command is given to Alexa and then that command is compared with the skill present in Amazon cloud and that skill is sent to processing unit (Raspberry Pi) and after processing the signal is sent to a particular device as shown in Fig.2.

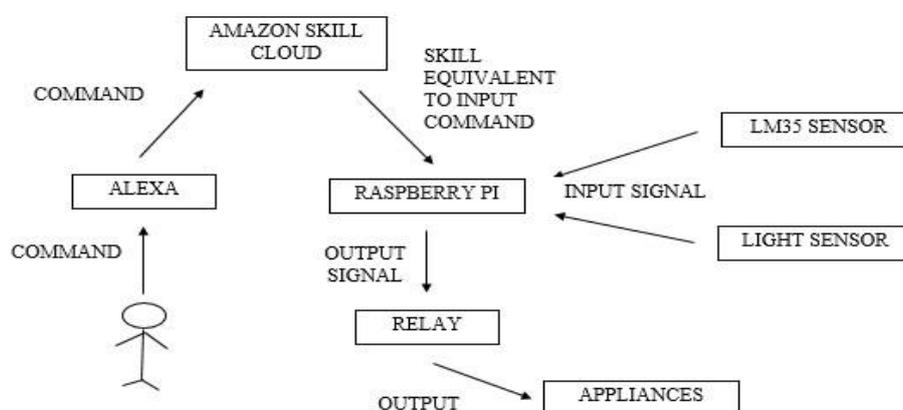


Fig 2. Steps of Implementation

Scenario 1: If voice command and is given like “ Alexa turn on fan” then this command is compared with the predefined skills in Amazon skill cloud and the correct skill is retrieved and sent to raspberrry pi where it is processed and the output is sent to the relay pin where the fan is connected.

Scenario 2: If temperature is increasing and goes above 24°C then the fan turns on automatically. The temperature above which the fan should start can be programmed.

Scenario 3: If the brightness or light surrounding becomes low or less then the light turns on automatically and if brightness increases then the light turns off.

IV. RESULTS AND DISCUSSION

The lives of physically disabled people can be made little easier by installing the smart home concept in their home and let them control the appliances. The system presented in this paper, is much simpler, easy to use, makes the interaction between a person with disabilities and the digital assistant more natural, and is much less expensive.

V. CONCLUSION AND FUTURE SCOPE

The technology has its own advantage and disadvantages. Technologies have to be used for appropriate ideas to makes life better. The digital assistants were introduced for simple and basic use like playing songs, hearing news and many more and by improvising the technology now it is made to access the appliances and work on it.

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