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IOT BASED DOOR ALERT SYSTEM FOR PEOPLE WITH HEARING IMPAIRMENT

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ABSTRACT

Persons with hearing impairment face many challenges every day in their life and the biggest challenge they face is communication. They face difficulties in getting and giving information, exchanging ideas, sharing their feelings in a group or even in a one-to-one contact. There are many devices and systems that are available to assist deaf and hearing impaired people to improve their communication and to adapt to the environment and society more effectively. The paper deals with designing and implementation of low cost device for people with hearing impairment who live alone and independent to get notified when the door-bell rings. The system consists of Raspberry Pi, Raspberry Pi camera, Vibrator, Server motor, ADC board, LED board, WIFI module and Bluetooth module. The evolution of technology has reached to an extreme horizon that makes the life for an ordinary human being easier. In such scenarios, the technological stream of Internet of Things(IoT) plays a major role to help the individuals in various ways. The latest evolution of Internet of Things is Raspberry Pi model B 3 which is utilized to its extent to serve the human race with all the embedded features in it. The Raspberry Pi is a low cost, low power embedded controller which consists of features like WiFi, Ethernet connection port, in-built Bluetooth, manageable USB ports and changeable OS specifications. The complete system consists of transmitter and receiver. The transmitter section includes Raspberry Pi, Raspberry Pi camera, switch, WiFi and Bluetooth. The receiver section includes wearable vibrator which provides alert to the hearing impaired person. The system upon receiving alertness through vibrator, person checks the mobile phone and is able to determine the details of the person arrived. The software used for this work is python, PHP/ MySql and android app. The employed device consists of a well built and configured OS on its latest version of Raspbian. The Raspbian OS and other configurations are specified on own terms as the device is expected to work. The Raspberry Pi board is connected to the devices and components such as Raspberry Pi Camera(PiCam), the display, Ethernet for internet access and the server motor. The programming languages like Python and Kernel are used to configure Linux commands in this work

1. INTRODUCTION

Hearing is one of the six senses in human body. Hearing loss causes lots of chaos in a home and a society. In regions like India, the rise in population leads to major difficulties as the people strive from many problematic situations that tend a human being to break into one's security or privacy. In such cases, the people with natural defects are seemed to be victims in most of the scenario. So an alerting system is essential for everyone to protect their privacy.

Prior to the modern age, people with hearing loss had to rely on others for their safety and connectivity to the rest of the world. As technology has rapidly evolved in the beginning of the 20th century, devices to help people with hearing loss to live more independent lives has been developed.

Today there are assistive listening devices, hearing aids, FM systems, infrared systems, captioning and amplification devices that help people communicate with others. With these available systems they are able to hear the sounds of everyday life and enjoy the entertainment. Otherwise they will have a difficult time of it due to hearing loss. Similar to such aiding devices the PiCam is also a device that renders its technological connections with lot of IoT devices that assists the hearing impaired person to know about the visitors and the trespasser inside their resident zone.

The alerting devices are less commonly known but perhaps the more important ones. Some devices are for everyday use while others are for emergency situations that will help people stay connected and safe. They have at least a visual, a vibrotactile or an auditory signal



International Journal of Engineering Researches and Management Studies

Alert systems are simply signalers that are intended to notify different events, such as the phone ringing, the doorbell, a baby's cry, motion, weather alerts or smoke alarms. Deaf people are unaware of the visitor to the home and also the old age people have difficulties in walking or moving to go and see who the visitor is. So it will be of great help for those people to have an alert about the visitor to home.

The proposed system designs an alerting system that will help the hearing impaired and old age people to know about the visitor. The system consists of two modules: a transmitter and a receiver. The transmitter is a device that is installed at the door. The transmitter consists of Raspberry Pi, Raspberry Pi camera, switch or doorbell, WiFi and Bluetooth. The receiver is a wearable device that includes Raspberry Pi, Bluetooth, WiFi and LED to display the image, notify through message and vibrator to alert. The date and time along with the visitor image is sent to the server for retrieving information later. The whole device works in a way co-ordinating the functions of all the components through several communicating medium such as signals, WIFI and Bluetooth. The major advantage of this system is that it reduces the visitor's waiting time and also help in the security of the deaf people.

2. LITERATURE REVIEW

Aamir Hussain proposed a system on healthcare and emergency care for the elderly and disabled person. This work uses a wireless sensor network as the core component of healthcare system. In this paper, three aspects have been discussed like manipulating context from a mobile device in people-centric environment, Emergency response based on context information, Modeling mobile context sources as services.

Gopinath Shanmuga Sundaram attempted to build a standalone device on low cost that transmits data using the Raspberry Pi with Bluetooth and has a resistive touch screen display which provides a user interface. Exceptions are found using error handling techniques and are retransmitted till the acknowledgement is received.

Chao-Huang Wei and Shin-An Chen developed a networked digital video door phone system by engaging a novel power line communication chip and replaced the conventional ones. Door Phone can identify a visitor or a simple voice interlocation. It transfer audio visual information and additionally enhances the entrance guarding functions.

Mahdi Safaa A designed a handheld device for detecting obstacle using ultrasonic sensor and to generate a voice alert for blind and vibration alert for deaf people by keeping finger on the button at the top of the device. The device is suitable and easy for blind & deaf with 40-150m range. It can also be used in three dimensions.

HuiPing Huang presented a solution for establishing low power consumption remote home security alarm system. It is developed by applying Wireless Sensor Network (WSN) and Global System for Mobiles (GSM) technology is presented. It detects a theft, leaking of raw gas and fire and send alarm message remotely. This system has many advantages. Some of them are reliability, easy usage, complement wireless, low power consumption and the system also has practical value in other fields.

The design and implementation of a low cost, low power consumption and GSM/GPRS based wireless home security system is presented by Yanbo Zhao and Zhaohui Ye. This system include three kinds of wireless security sensor nodes that are door security nodes, infrared security nodes and fire alarm nodes with easy installing nodes. It has a friendly user interface which includes a LCD and a capacitive sensor keyboard.

Ming Xu developed a WSN system to construct smart home systems. A monitoring system is built by taking advantage of the GPRS network and Zigbee technology to support multi-hop communications.

Jayashri Bangali and Arvind Shaligram suggested two methods for home security system. The first system uses web camera. Whenever the camera detects a motion in front of the lens, it gives security alert in terms of sound and a mail is delivered to the owner whereas the second method sends SMS which uses GSM/GPRS Module (sim548c) and Atmega644p microcontroller, sensors, relays and buzzers. The web camera based security system is very easy, user friendly and the software has many features.



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K. L. Koay used dog-inspired visual communicational signals to design a robot in the intention of communication. This Robot leads participants to the microwave door and front door sound source. Head movements and gaze directions are important for communicating the robot's intention using visual communication signals.

3. EXISTING SYSTEM

The current system uses a WSN which is Wireless Sensor Network to construct smart home systems. A monitoring system is built by using GPRS network and Zigbee technology that supports multi-hop communications. The physical range of Zigbee is from 10 to 20 meters (approx.).

Zigbee networks are extendable using routers. It allows many nodes to interconnect with each other to build a wider area network. The system is supported by a well secured network as it involves the privacy of the people in home to which the developed system is installed. The existing system is not reliable for large area coverage and security

Limitations of Existing System

- Zigbee based systems are designed for wireless networking among sensors and is more preferred for devices which are smaller in size and consume less energy.
- Zigbee has low transmission rate and it covers smaller distance. Coverage: 10 meters.
- It requires knowledge of the system for the owner to operate zigbee compliant devices.
- Replacement cost will be high when any problem occurs in zigbee compliant home appliances.
- It is not secure like WIFI based secured system.

4. PROPOSED SYSTEM

The proposed systems in this paper enable the utilization of the various components emerged in the Internet of Things field and it is a low cost, reliable and efficient system. The entire system is articulated with the revolutionary systems that make the life of the people more easier and comfortable.

It consists of two modules.

- A transmitter installed at the door.
- The receiver, a wearable device.

The transmitter installed at the door consists of the Raspberry Pi board connected to camera and server. The captured image is sent through WiFi to the receiver side of the system.

The receiver side consist of a mobile application and a display connected WiFi to which the main Raspberry Pi board is networked.

Advantages of Proposed System

- Raspberry Pi is a low cost, reliable and efficient embedded controller
- For efficient programming, python language is used which is very simple and occupies less memory space.
- This system uses IOT concepts and also it is user friendly since it requires no assistance.
- The whole system is very compact and requires low power for its operation.
- The camera is a tiny 5 megapixel camera mounted on a small circuit board. It is similar to the camera used in mobile phones. It has a fixed focus lens.

5. IMPLEMENTATION

Architectural Design

This paper proposes a low cost, reliable and efficient system to alert the deaf or hearing impaired person consisting of two modules- a transmitter installed at the door and another is the receiver, a wearable device.



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When the visitor presses the doorbell which acts the camera snap. Ping switch initiates the camera, Raspberry Pi Camera which is mounted on the door captures the image and transfers it to the wearable device through Bluetooth that is inbuilt in the Raspberry Pi board. Architectural design is shown in the figure.

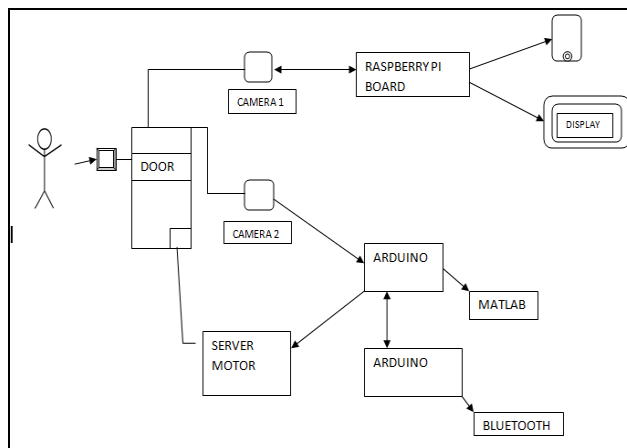


Figure.1 Architecture Diagram

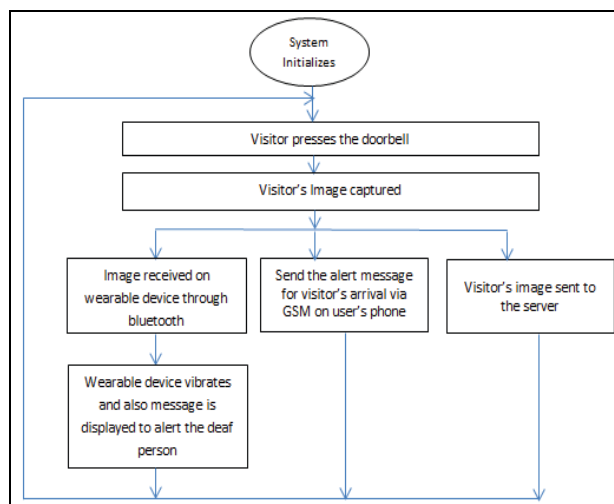


Figure.2 Flow Chart

After sending the image to the wearable device which consists of a LCD screen that displays the image of visitor, the GSM Modem sends a message to the cell phone of the visitor that there is a visitor at the door to the owner. The database is also created which is sent to the server.

In door system, the camera is plugged directly into the CSI connector on Raspberry Pi board. Switch is connected with the GPIO Pin of Raspberry Pi. The transmitter of Bluetooth is connected with the receiver of Raspberry Pi and vice versa to transfer the visitor's image on wearable device.

In wearable device, the LCD is connected with the Raspberry Pi to display the message. The vibrator is connected with the GPIO Pin of Raspberry Pi as output. The transmitter of Bluetooth is connected with the receiver of Pi and vice versa to receive the image through Bluetooth.

When the visitor presses the doorbell, Raspberry Pi Camera captures the image and transfers it to the wearable device through Bluetooth. After receiving the image on wearable device, the device vibrates to alert the person about the visitor's arrival and also displays the message on screen. The message is also sent to the owner about the visitor's arrival.



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A. System Requirements

Hardware and Software Requirements

The hardware requirements are mentioned below.

- Raspberry Pi 3 development board
- Raspberry Pi camera
- Vibrator motor
- Servo Motor
- Arduino UNO

The software requirements are mentioned below

- NOOBS Operating System
- Python
- MATLAB

B. Hardware Description

Raspberry pi 3 Development Board

A Raspberry Pi is a credit card-sized computer. It is originally designed for education and inspired by the 1981 BBC Micro. The Raspberry Pi is slower than a laptop or desktop but still it is a complete Linux computer that provides all the expected abilities at a low-power consumption level.

The Raspberry Pi is an open hardware. An primary chip called Broadcom Soc(System on a Chip), which runs on many of the main components of the board like CPU, graphics, memory, the USB controller, etc is used.

The Raspberry Pi was designed to use in Linux operating system. Raspberry pi 3 development board is shown in the figure 4.1. There are two most popular options for raspberry pi. They are:

- Raspbian, which is based on the Debian operating system
- Pidora, which is based on the Fedora operating system

Several generations of Raspberry Pi's have been developed. The first generation was Raspberry Pi 1 Model B released in February 2012. It is simple and inexpensive model "Model A". In 2014, the foundation released a board with an improved design in Raspberry Pi 1 Model B+. These boards are approximately credit-card sized and represent the standard mainline form-factor. A year later improved A+ and B+ models were released. A cut down "compute module" was released in April 2014. A Raspberry Pi Zero with reduced input/output (I/O) and general-purpose input/output (GPIO) capabilities was designed in smaller size and released in November 2015. The Raspberry Pi 2 which added more RAM was released in February 2015. Raspberry Pi 3 Model B released in February 2016 is bundled with on-board Wi-Fi, Bluetooth and USB Boot capabilities. As of January 2017, Raspberry Pi 3 Model B is the newest mainline Raspberry Pi.

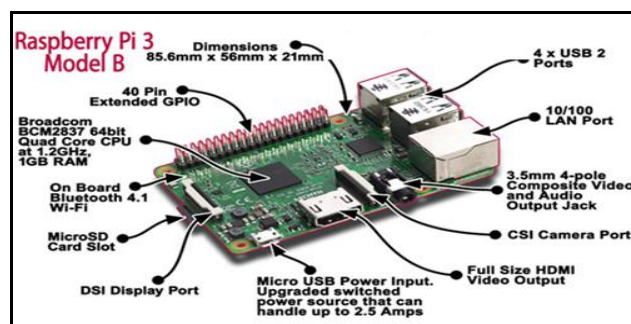


Figure. 3 Raspberry pi Camera

The Raspberry Pi camera module is used to take a high-definition video, as well as photographs. There are lots of examples of people using it for time-lapse, slow-motion and other video cleverness.



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The camera module has a five megapixel fixed-focus camera which supports 1080p30, 720p60 and VGA90 video modes, as well as stills capture. It is attached to the CSI via a 15cm ribbon cable.

The camera is a tiny 5 megapixel camera mounted on a small circuit board. It is similar to the camera used in mobile phones. It has affixed focus lens. Architecture of raspberry pi camera was shown in the figure 4.

The small size will be an advantage if used in a small space, or a slight disadvantage as it will be difficult to hold still. The main advantage of this camera over a USB webcam is that it is able to make use of the graphics processing capability of the Broadcom CPU. This will bypass the USB interface and is much better than to use a normal processor.

The Raspberry Pi camera module can take full HD 1080p photo and video and is controlled programmatically.

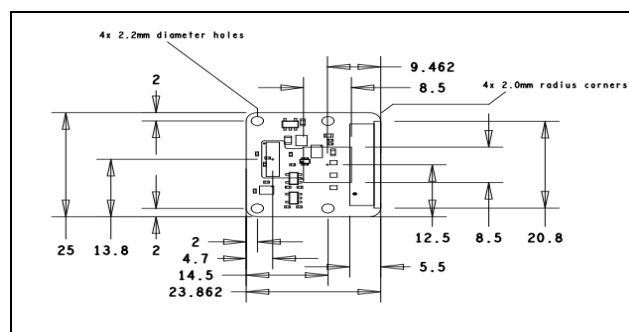


Figure.4 Architecture of Raspberry Pi Camera

Arduino UNO

Arduino/Genuino UNO is an ATmega328P based microcontroller board. It has 14 digital input/output Pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It has everything that supports the microcontroller; simply it can be connected to a computer with a USB cable or can power it with an AC-to-DC adapter or battery to get started. Arduino UNO board is shown in the figure 4.3

"UNO" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of Arduino Software (IDE) are the reference versions of Arduino. Now, many new releases have been evolved. The UNO board is the first in a series of USB Arduino boards. It also acts as the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

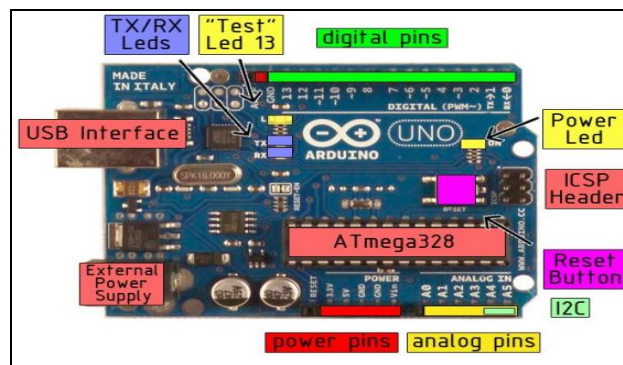


Figure.5 Arduino Uno Board

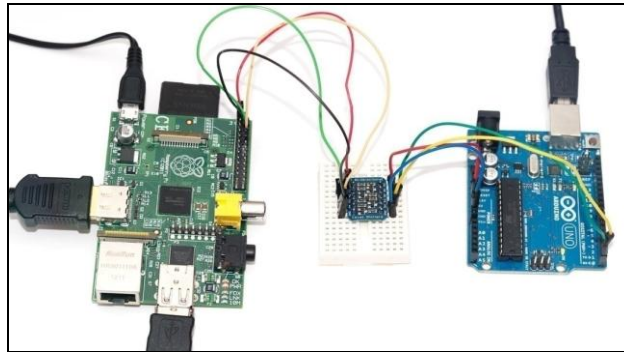


Figure.6 Arduino and Raspberry Pi power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power comes either from an AC-to-DC adapter (wall-wart) or battery. The adapter is connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery are inserted in the Gnd and Vin Pin headers of the POWER connector. The board operates on an external supply of 6 to 20 volts. The board will be unstable if supplied with less than 7V. Still the 5V Pin supplies less than five volts and makes the board unstable. The voltage regulator gets overheated when the board is supplied with more than 12V which leads to damage of the board. The recommended range is 7 to 12 volts. The power Pins are as follows:

- **VIN:** This pin is used to supply voltage for the board or if supplied through power jack, it helps in access. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source).
- **5V:** The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- **3V3:** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND:** Ground Pins.

Memory

The Atmega328 has a 32 KB flash memory for storing code (of which 0, 5 KB is used for the boot loader). It has also 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

Each of the 14 digital Pins on the Uno can be used as an input or output, using PinMode(), digitalWrite(), and digitalRead() functions. These pins are operated at 5 volts. Each Pin provides or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 ohms.

In addition, some Pins have specialized functions:

- **Serial:** 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These Pins are connected to the corresponding Pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts:** 2 and 3. These Pins are configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM:** 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- **SPI:** 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These Pins support SPI communication, though it is provided by the underlying hardware, it is not currently included in the Arduino language.
- **LED:** 13. There is a built-in LED connected to digital Pin 13. When the Pin has HIGH value, the LED glows, when the Pin is LOW, it's off.

Features of Arduino

Some of the key features of arduino are:

- Arduino boards can read analog or digital input signals from different sensors and can turn it into an output like activating a motor, turning LED on/off, connect to the cloud and many others.



International Journal of Engineering Researches and Management Studies

- It controls the board functions by sending a set of instructions to the microcontroller in the board through Arduino IDE. IDE is referred to as uploading software.
- Unlike the preceding programmable circuit boards, Arduino works without an extra Piece of hardware to load a new code onto the board. A simple USB cable is used.
- Moreover, a simplified version of C++ is used by the Arduino IDE which makes it easier to learn the program.
- Finally, Arduino is provided with a standard form factor which breaks the functions of the micro-controller into more accessible package

C. Wearable Vibrator

The Precision Micro drives 304-002 Pico Vibe 4mm vibrating motors are based on a coreless motor design, with precious metal commutation circuitry and a toroidal neodymium magnet. Rated at 3V nominal, it is designed for alerting functions in handheld applications powered by either dual cell alkaline primary / nickel based rechargeable batteries, or single cell lithium primary / lithium rechargeable batteries.

The vibrator is fixed to a hand strap to notify the user about the visitor or guest entering the house by receiving signal from the Raspberry Pi main board through WIFI. The signal can be transmitted through Bluetooth also but the project is preferred to choose the transfer through WIFI as it is faster and coverage of the WIFI network is large. The wearable vibrator is shown in the figure 4.4

One of the main advantage of the WIFI transmission is the security that is been carved by most of the home security technologies. By using WIFI Home Network, the system is protected from unauthorized users to connect to the network.



Figure.7 Wearable Vibrator

D. Servo Motor

Servo motors are applied in remote controlled toy cars for controlling the direction of motion. It is the very commonly used motor to move the tray of a CD or DVD player. The main advantage upon using a servo is that it provides angular precision. It only rotates as much it wants and then stops and waits for next signal to take further action. This is not like an ordinary electrical motor that starts rotating as and when the power is applied to it and the rotation continues until the power is switched off. It does not have the ability to control the rotational progress of electrical motor, but it is able to control the speed of rotation and can turn it ON and OFF. Servo motor is a special type motor that automatically operates up to a certain limit for a given command with the assist of error-sensing feedback which corrects the performance. Servo motor and its parts are shown in the figure 4.5

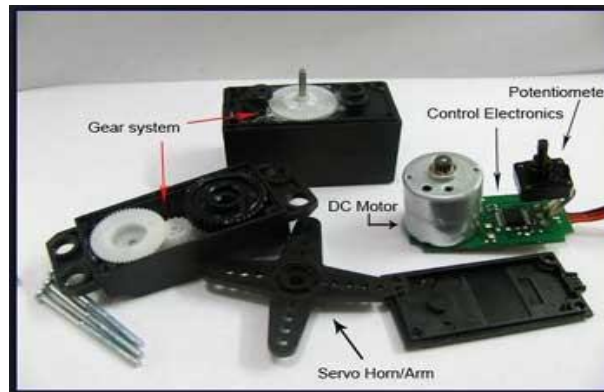


Figure 4.5 Servo Motor

Servo motor is used in this system to open the door through the activated signal from the Raspberry Pi board. The system assists the disabled person in opening and closing the door by using the signals through WIFI and Bluetooth.

E. Software Description

Noobs Operating System

New Out Of Box Software (NOOBS) is a simple operating system installation manager for the Raspberry Pi.

There are certain steps to be followed to set up a blank SD card with NOOBS:

- Initially the SD card which is 8GB or larger as FAT is needed to be formatted. See the instructions given below.
- Next the files from the NOOBS zip file have to be downloaded and extracted.
- The extracted files are copied onto the SD card that had been formatted, so that this file is at the root directory of the SD card. In some cases it may extract the files into a folder; if this is the case, copy the files from inside the folder rather than the folder itself.
- Finally on the first boot, the "RECOVERY" FAT partition is automatically resized to minimum, and the list of OS that is available to install is displayed.
- The deployed project uses 2.4.0 version of NOOBS released on 2017-04-10.

Python

A widely used high-level programming language for general-purpose programming is Python. It was created by Guido van Rossum and released in 1991. Python is an interpreted language. It has design philosophy that emphasizes code readability and syntax. This allows programmers to express concepts in fewer lines of code than compared to languages such as C++ or Java. The constructs provided by the language are intended to enable writing clear programs on both a small and large scale.

Python has features like dynamic type system and automatic memory management and also supports multiple programming paradigms, including object-oriented, imperative, functional programming, and procedural styles. It has a library which is large and has a comprehensive standard.

Python interpreters are offered for many operating systems that allow Python code to run on a wide variety of systems. Python has a reference implementation called CPython. It is an open source software and a community-based development model having nearly all of its variant implementations. A non-profit Python Software Foundation manages CPython.

Matlab

Matlab (matrix laboratory) is a fourth-generation high-level programming language and an interactive environment for numerical computation, visualization and programming. It allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with



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programs written in other languages, including C, C++, Java, Fortran and Python. An optional toolbox uses the MuPAD symbolic engine and allows access to abilities. An additional package called Simulink adds graphical multi-domain and model-based design for dynamic and embedded systems.

Some of the basic features of Matlab are as follows:

- It is a high-level language for numerical computation, visualization and application development.
- It provides an interactive environment for iterative exploration, design and problem solving.
- It has a vast library of mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, numerical integration and also solving ordinary differential equations.
- It provides built-in graphics for visualizing data and tools that are used for creating custom plots.
- MATLAB has a programming interface which provides development tools that improves the code quality maintainability and maximizing performance.
- It has tools for building applications in the company of custom graphical interfaces.
- It can provide functions for integrating MATLAB based algorithms with external applications and languages such as C, Java, .NET and Microsoft Excel.

MATLAB is a widely used computational tool in science and engineering around the fields of physics, chemistry, math and all engineering stream. It can be used in a range of applications including

- Signal Processing and Communications
- Image and Video Processing
- Control Systems
- Test and Measurement
- Computational Finance
- Computational Biology

6. CONCLUSION

As the technology renders help to the human being in all aspects and ways to make life more complete in every field and this work is a combination of technologies to make the incomplete hearing sense of many human being to the utmost to make them feel secure and complete with the use of several components and simple algorithms to easily construct a system that is affordable and easy to use them. The alerts are virtually instantaneous once a decision is made to send them, and the network built by these alert systems can be used for other purposes, such as important, but non-emergency communications. Also, electronic communications, text messages and e-mail allow for two-way communication, which can help authorities manage a developing situation with more information.

The system enhances the laying back sense of all the hearing impaired people in most accessible way and with its simplest form of alerting system

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