INTERACTIVE PERSONAL ASSISTANT WITH HOME AUTOMATION AND FACE RECOGNITION USING RASPBERRY PI

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Abstract – *The key objective of this paper is to build a Virtual Assistant which can perform home automation. The assistant can not only help with home automation but also help in answering any questions interrogated by the user. In this current swift environment with technologies growing rapidly around us, we do not have time to agonize about our home, so automating it would be great as it would save a lot of time for the users. This system can be built in such a way that the user can control every electronic household by his voice by staying stationary in one place. Here we are not only talking about normal users but also considering the conditions of the old individuals or the disabled who cannot perform their basic tasks efficiently. Considering this paper is not only about home automation it also helps the user to keep up with the current world. The personal assistant can inform the user about the news, current weather, provide information about something, etc. This assistant cannot be used by anyone as it uses user authentication. Face recognition is used for user authentication. It is developed using the OpenCV library which uses computer vision for face recognition. OpenCV is developed in many languages but here we are using Python for developing the face recognition module. The user can register his face which will be in a stored database. A trainer is used to train these faces in the database and finally when the camera detects a face which will compare it with the list of faces in the database. So only the authenticated individuals can use the personal assistant. The incorporation of face recognition works in a similar way of a security system. Hence making the user's home safe and secure from theft and intruders. The whole system is developed using the Python programming language. Python provides a ton of libraries that can be used to make programming more simpler and efficient.*

*Key Words***: Virtual assistant , Face Recognition , OpenCV , Home Automation , Raspberry Pi , Speech To Text , Text To Speech.**

1. INTRODUCTION

In this day and age automation is everything. With automation, even a hard task can be made easier to perform as it reduces human effort, labour and also reduces time consumption to a high extent.[1] A Raspberry Pi is a low cost, small-sized computer that can be used for developing various applications. This paper is of a personal assistant that can respond to user commands accordingly. This paper represents a flexible way to control devices. The user will be able to provide voice commands for controlling devices such as "Turn the light on" or "Turn on the AC", etc. This system will be able to control electronic and electromechanical devices by the user command. The speech recognition (Google Speech Recognition API) library of python comes into great use as the input from the user will be recognized through a microphone and this input will be converted into text which can be understood by the program. The personal assistant will be awake all the time waiting for the user's command.

2. LITERATURE SURVEY

In the paper presented by Mrs. Madhuram.M et.al [1], proposed an IP (Internet Protocol) camera which was mainly developed for real time video surveillance system. The Face recognition module was developed using OpenCV (Open Computer Vision) and Python using algorithms. The System first detects the user's face and stores it in a database. The database of images are trained using a specific algorithm and a recognition module is then used to recognize the user's face.

In the paper presented by Chen-Yen Peng et.al [2], proposed a system for home automation using Google home voice recognition. The user gives commands to the voice recognition module of the Google Home and the commands are transferred to a Raspberry Pi using a Bluetooth module to control the various devices. They have also incorporated machine learning to understand the user's pattern of controlling the devices.

In the paper presented by Juan Celis et.al [3], proposed an Acoustic and Language module for the people living in Notre

de Santander region. They have used a Raspberry Pi which gets user's commands as its input from an android application. The commands from the android device is transmitted to the Raspberry Pi using Internet Of Things (IoT). Then the raspberry pi will process the voice commands and will control the lighting inside a house. Additionaly they have also included various sensors for the measurement of temperature, pressure and humidity which communicates with the raspberry pi.

In the paper presented by B. Vamshi et.al [4], proposed a system for voice controlled home automation using Arduino. The voice control is implemented using a V3 voice recognition module which recognizes the user's commands. To secure the system the user have to use a voice password for authentication. The commands given by the user is transmitted to the Arduino through a RF (Radio Frequency) module. A RF receiver is connected to Raspberry Pi to decode the commands of the user. Then the system will control the specified home appliance. Some sensors are also used for temperature and motion detection.

In the paper presented by Ana Marie. D Celebre et.al [5], Siri proxy server was implemented on Raspberry Pi. A proxy server is a server that doesn't directly communicates with the client instead uses a proxy. Siri proxy was developed so as to create custom handlers to the original Siri. In this paper they are trying to implement Home automation as a function to the Siri proxy server. For this they have developed a plug-in for Siri proxy server so as to set custom commands for home automation. This system has been tested and verified by performing various speech recognition tests and has been successful over 90% of the times tested.

2.1 EXISTING SYSTEMS

In the current world, majority of the houses have the usual circuitry which contains wires, switches , MCBs, etc which are connected to the electrical appliances like fans, lights, ACs, etc. This paper is built to reduce the human effort by automating these tasks. In turn the user can save a lot of time and utilize it in an useful way. Here we are not only focused on home automation but also help the user to get to know about the world around him. This is done by the personal assistant, which keeps the user up to date about the world. The assistant will also help on other things such as entertainment, news, jokes, calculations, information, etc. Another thing that we look into is about the security systems in the houses or buildings. They are just the usual alarms

which are just simple, here we introduce the face recognition module which will authenticate the users based on their faces.

3. PROPOSED SYSTEM & SYSTEM ARCHITECTURE

The proposed system is designed in a way such that the user can control almost all the electrical appliances by their voice. The user's input is captured by the microphone which is then converted to text format using the Speech To Text synthesizer and this command is then processed and will look for the relevant output. The user can thus control all the appliances in his home. This paper is designed using the raspberry pi which is a mini computer which can perform the usual tasks performed by a PC (Personal Computer). The user can query the personal assistant about anything that happens around the world. The assistant can perform some basic calculations, get the news, tell the weather, etc. The face recognition used in this paper is for security purposes. It will help in authorizing the user to use the home automation system and also to interact with the assistant. This mainly protects the user from intruders and other threats which can occur to the user.

3.1 WORKFLOW OF THE SYSTEM

The proposed system's work flow starts with the user registration using the face recognition module. The face recognition module will capture the user's face and then store in a remote database. Then the trainer is used to train all the images which are stored in the database, so that when the user wants to use the assistant, the recognizer will detect the face using the trained data. After the user is authenticated the user can query the assistant about anything using his voice command. The user's command is converted to text which is understood by the machine using a STT (Speech To Text) synthesizer. The user can ask the assistant to turn ON / OFF a certain electronic device. Then the assistant will match the user's phrase to the particular module and will perform the specified task on the devices. These electronic devices are connected to the Raspberry using the GPIO pins which can be further connected to other devices using the help of relays. This is the workflow of the proposed system(Fig -2). The system architecture is shown in Fig -1.
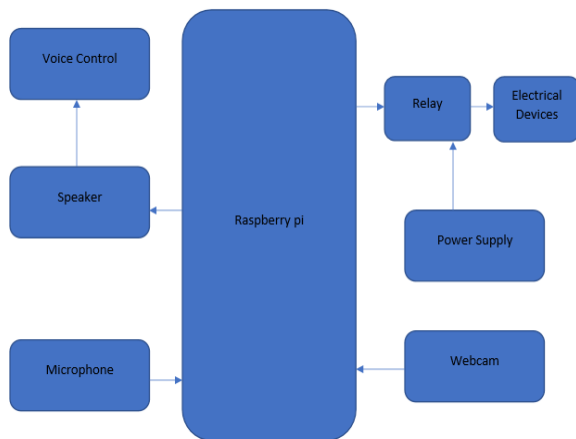
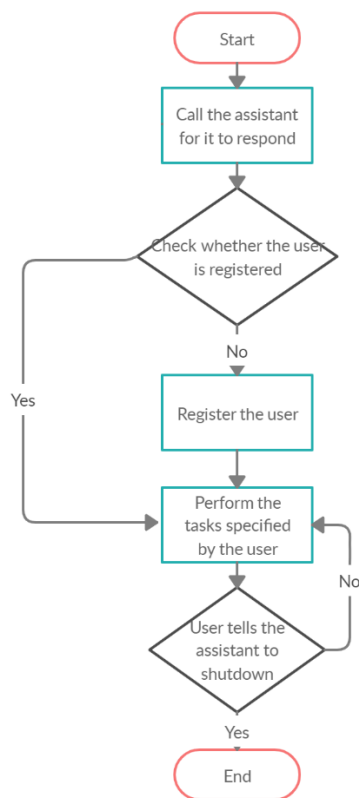**Fig -1:** System Architecture

Fig -2: System Workflow

4. IMPLEMENTATION

4.1 HARDWARES USED

4.1.1 Raspberry Pi : The Raspberry Pi is a small card-sized computer that was initially developed in the UK by the Raspberry Pi foundation. It has an ARM-compatible CPU and an on-chip GPU. There are many models released to date with RAM size varying from 256MB to 4GB. From model 2B

they have incorporated USB and Ethernet ports to the Raspberry Pi. It has the GPIO pins to which relays can be connected. For video they have provided two micro HDMI ports which can be further connected to a monitor or television. An SD card slot is used for installing the OS onto the Raspberry Pi. And finally it also has a Type-C port for power.

4.1.2 Microphone : The principle used in microphones is that when waves of sound strike the diaphragm of the microphone, it oscillates which leads to a change in the interval between the two plates which are placed in parallel. When the distance between the capacitor is increased (or) decreased, then the capacitance decreases (or) increases and then changes in the current. These changes in current are proportional to the sound waves which were given as the input. These currents are allowed to flow to the resistor, which is connected in series and output is collected parallel to the resistor. In this paper we are using a USB microphone so that it can be directly connected to the USB port of the Raspberry Pi. It has an inbuilt amplifier, so doesn't need any external preamplifier circuit. This does the Analog to Digital conversion of the user's commands.

4.1.3 Speakers : Here the speakers are used as an output. When the user wants to ask the personal about something or when the user calls the personal assistant then it will respond through the speakers. Any speakers can be used, in this paper the speaker with an AUX cable is used to connected to the Raspberry Pi.

4.1.4 Web Camera : The webcam is used for the purpose of face recognition. It can be connected to the Raspberry Pi using the USB slot provided. It can be configured using the raspberry pi configuration tools using specific commands on the terminal.

4.2 MODULES USED

4.2.1 Face Recognition

We are using Python as the programming language in this paper, it has a library which is OpenCV (Open Computer Vision library). It contains a number of programming functions largely focused on real-time face recognition. There are 3 different phases in Face Recognition which are Detecting the face, Training the Recognizer and Recognition of the Face. When a face comes in the region of the camera's vision the detector will detect the face and it will save the face of the user in the remote database in JPG format. To

train these images an algorithm is used which is known as Haar cascade algorithm.

Haar cascade algorithm uses a feature known as haar feature which divides the camera's detection region into many rectangular regions and adds up all the intensities of the pixels in each region and calculates the difference between them. An algorithm is used to select the best features in an image and then trains the classifiers known as Adaboost. This algorithm uses linear combination of the weighted samples and then constructs a strong classifier. The linear combination of the weighted samples are performed by a number of simple classifiers known as decision stumps (weak learners). So these weak learners make decisions which are combined into a weighted average. At each stage of the classification these decisions are trained using a technique known as boosting. Hence the weighted average of the decisions helps train the classifier to high accuracy.

In the end the recognizer (or) the recognition module will extract the features of the face of the user and will compare it to the elements of the trained data and the top match is found. After recognizing the face the user will be able to communicate with the assistant.
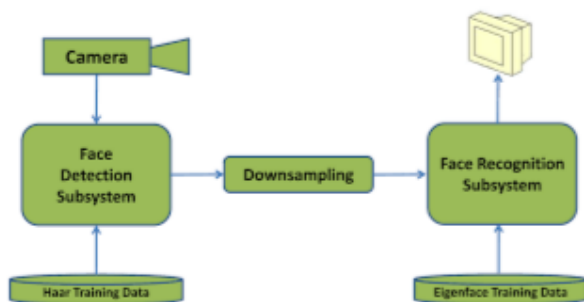

Fig -3: Workflow of Face recognition module

4.2.2 Home Automation

Raspberry pi has the GPIO pins to which the relays can be connected. A relay is an electrical switch which consist of a number of input terminals and contact terminals. The input terminal can be used for a single or multiple control signals. The raspberry pi works on 3V DC but the LED's and other electrical devices works on AC, so the relay is used.

The relay is connected to the power supply and the ground of the raspberry pi. The other channels of the relay can be connected to the specific GPIO ports of the raspberry pi. The electricals can now be connected to the relays and the specific ports of the raspberry pi can be set to HIGH or LOW to turn on/off the electrical device.

4.2.3 Speech Recognition

This module will let the user interact with the personal assistant. The speech recognition can be divided into two parts which is Speech To Text (STT) and Text To Speech (TTS). STT is a speech synthesizer which converts the user's command to a text format. TTS is also a synthesizer but converts text format to speech which can be provided as an output to a speaker. This speech recognition module can be implemented with other modules such as home automation so that the electrical devices can be controlled by the user's input. As mentioned earlier the personal assistant can also have casual interaction with the user. Certain modules can be included to the personal assistant such as News, Wikipedia, Weather, etc. So when the user asks the personal assistant for news, it can call the specific module and speak out the news for the user. These modules can be implemented using APIs (Application Programming Interfaces) where the APIs can provide the information from its database and this information can be used by the personal assistant to respond to the user's questions.

5. CONCLUSION

This paper makes up the most important and essential features in this modern world. It includes voice controlled home automation which can be a benefit for the adulthood and the physically disabled people by staying stationary in a single place. The face recognition can be used for security purposes which provides a safe and secure home. There are plenty other modules included in the Personal Assistant which can help the users by providing information to the user about news, time, weather, calculation, set reminders, file management, email management, etc.

6. FUTURE SCOPE

Here in this paper we can authenticate users using face recognition but in the future we can even build voice recognition for more security. Voice recognition here refers to storing a user's voice and identifying the particular user by their voice. Instead of calling out the light to switch on, sensors can be attached with the raspberry pi so that it can detect the motion of the user and turn on the lights based on it. A smart door can also be developed by implementing voice and video calls with the person standing outside. This helps the user to be more secure from strangers and other insecurities.

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