Smart Personal Assistant for Visually Impaired People

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***Abstract*- The present personal assistants are incapable of providing adequate assistance to visually impaired people. There's a need to develop a smart personal assistant that is equally assistive for them. Small computing devices has really replaced those big computers required for doing some large and smart computations. These mini computers are portable, can support lots of sensors, can connect to internet, can provide cloud support too and many more services. Implementing extra intelligence to the system and will dramatically hide/reduce human computer interaction(HCI).**

In this project we are going to explore automation capabilities and planning capabilities of the agent and micro-controller. It highlighted the requirements on external data and knowledge sources. Hence, introducing a smart personal assistant that is smart in a way that it provides audible assistance. Smart personal assistant (smart agent) can be used as an interface to the digital world to make the consumption of this information timely and efficient for the user's specific tasks.

Goal of the project is to design personal assistant that understands the semantics of the task, is able to identify the task correctly and make appropriate decision without much HCI. It will be designed using cloud technologies and artificial intelligence. Agent will be integrated with online web-services to harvest various web services and help the user to manage his or her tasks.

***Index Terms*- Voice Automated System, Cloud Services, Artificial Intelligence, Internet of Things, Microcontroller, Virtual assistant.**

I. INTRODUCTION

According to the World Health Organization (WHO), 285 million people are estimated to be visually impaired worldwide, 39 million are blind and 246 have low vision. Whatever the cause may be, it greatly affects the life of such people. As mobile devices are increasing rapidly they provide a best way to solve the problem to some extent. To satisfy the need of VI community, it is necessary to develop device with smart algorithm to extract information from surroundings. In this work, we propose system that provides security solutions for the blind. With > 90% accuracy, the proposed system aims to assist blind people in real-time household security and common appliance operation tasks. Also, in this context, the current research proposes a solution for indoor navigation of visually impaired and blind people. It is simply composed of a voice commanded personal assistant that interacts with the cloud system. Here photos from cameras, located on the door, are captured and analyzed using algorithms. The person can command the system to open the door or not and if not then also alert someone. In this paper we have tried to solve problems of VI people by analyzing their problems and by providing one simple solution to most of their needs.

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paper we have tried to solve problems of VI people by analyzing their problems and by providing one simple solution to most of their needs.

II. MOTIVATION

The life of a visually challenged person is not easy. There are various parts of everyday life which seems easily doable for a normal person but doesn't seem so normal for a visually challenged, say, recognizing people, switching ON/OFF appliances, reading time, or even as simple as opening the door. Hence, they feel avoided from the society in doing even small things. Security for them is also a big concern for them because if a person can't see, then how is he supposed to protect himself.

India is ranked second in the world in visually impairment index. Also, according to Times of India dated 18 June 2017, the cases of house burglaries in the national capital New Delhi has risen from 4800 to 6200 cases per year. It's really hard for us to imagine our loved ones, who have visual challenged, to get caught in such incidents of theft or burglaries. Hence a product like this can help reduce this risk to a huge extent. This acts like a security measure for the needy by providing facilities at their fingertips.

To provide daily life justice for these people is the basic goal of this project. Hence using the technologies already existing and customizing it specifically for the very needy is the way this project helps. Proliferation of artificial intelligence and web services running on these devices has led to specialized applications.

Introducing a smart personal assistant that is smart in a way that it provides audible assistance. The data is fed to a Raspberry Pi that process it on cloud to give the required output that is audible to visually impaired people by the means of audio outputs. The system is capable to processing the input received from the sensors, identify the input and give the appropriate output.

III. LITERATURE SURVEY

The recent development of intelligent voice assistant mainly focuses on addressing the problems of intelligent conversations and interactions. In the first paper [1], they have proposed to automate home using Apple's Siri. Apple's personal voice assistant is used in order to control home appliances like window, door, lights, etc. However, this system works only with mobile application and requires Siri for interaction with the modules. As we know that Apple is a close-source project, it becomes uneconomical and limited to only Apple devices which themselves are costly. A solution for a more efficient, economic, scalable and portable speech recognition tool is Amazon's Alexa. Amazon Alexa comes with SDK which can easily be ported to microcontrollers, smartphones and other mobile devices. Alexa also has the ability to respond to the commands of the user using NLP. For more portability, versatility and cost efficiency in the system, Raspberry Pi is recommended. It has a small size and using it smart home devices can easily be controlled via its GPIO ports. The best part is Amazon provides SDK to port Alexa on Pi making the Pi fully voice enabled personal assistant. We can add our customized intelligence i.e. skill sets to the systems using Lambda Functions.

In the second paper [2], they have proposed to automate home using Raspberry Pi and android application. However, the usage of static commands on Raspberry Pi doesn't appear to be useful for visually impaired people as they cannot put commands on Raspberry Pi themselves. Also, this method limits the functionality of the system to only few operations.

The problem in the previous paper was that the system only uses Siri. Siri is limited only to iOS devices which are not affordable to most of the common public. The problem in the second paper is that user has to explicitly give commands using their phone. In both cases, the user has to engage himself with the phone in order to issue commands. But with the use of Amazon Alexa, these problems can be easily handled.

IV. SYSTEM OVERVIEW

Figure 1 shows how the whole voice enabled system will work. The skills like magic answer, door, lights etc. are controlled using Alexa. These skills run on cloud and react on user's command. Home appliances are controlled by Node MCU GPIO pins through internet and voice commands.

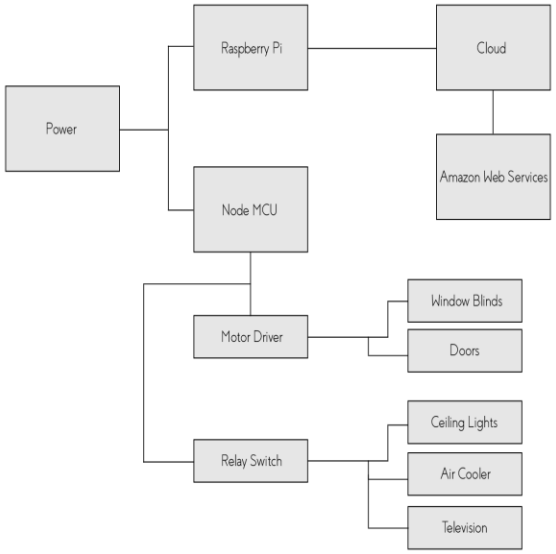


Figure -1: Overall System Diagram

V. HARDWARE DESIGN

A. Raspberry Pi

The Raspberry Pi is used as an interface between the user and Alexa. Pi routes the user's voice commands, received through its input ports, to the Alexa voice service. Pi is the medium for interaction between Alexa and the user. The user gives the command using the headset provided. This headset is connected to Pi through Bluetooth. Alexa is activated on the voice command "Alexa". The Alexa's SDK script is automated in the Pi as soon as the Pi boots up, Alexa service is started automatically. Camera module is attached to the Pi for image recognition.

Figure -2: Raspberry Pi with Camera Module and Headset

B. ESP Wi-Fi Module

NodeMCU is a microcontroller with ESP8266 Wi-Fi module built for mainly home automation purposes. Like Pi, it also has GPIO pins in which the user can add many appliances. NodeMCU is connected to internet via its Wi-Fi module, so that it can respond to the requests/commands from Alexa.

Lights and servo motors is attached to the NodeMCU's GPIO ports via a 4-channel relay. Upon receiving the request from Alexa, the respective GPIO pin is triggered to the requested state by the user. This is shown in Figure 3.

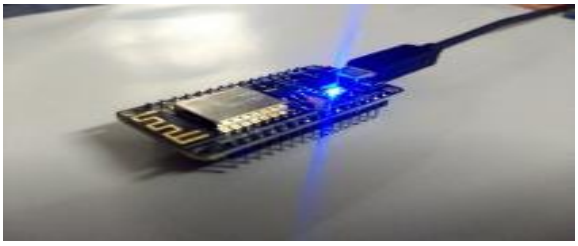


Figure -3: NodeMCU

VI. SOFTWARE DESIGN

A block diagram of the code is shown below in Figure 4. If the user says a command, Alexa will determine if that command is written in the code or not. When there is a corresponding command within the code, Alexa will immediately go to the server of the IFTTT then it will go to the NodeMCU. The NodeMCU will now be able to enable or disable the GPIO pins to control appliances.

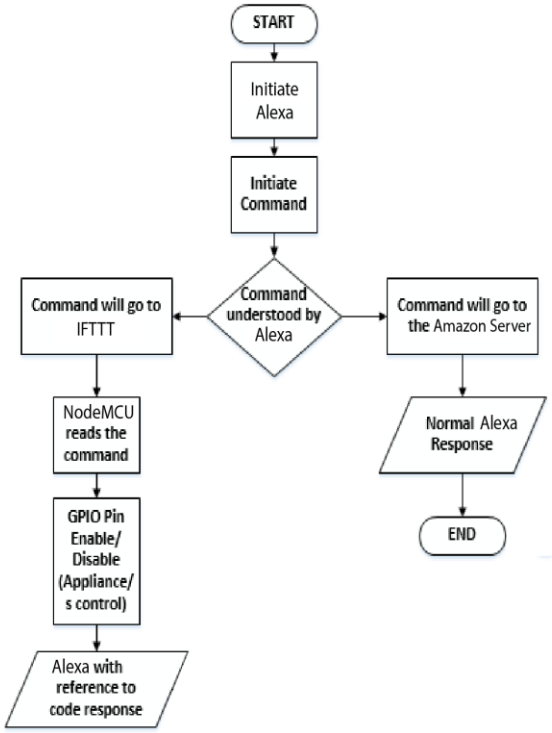


Figure -4: Code Block Diagram

A. Speech Recognition

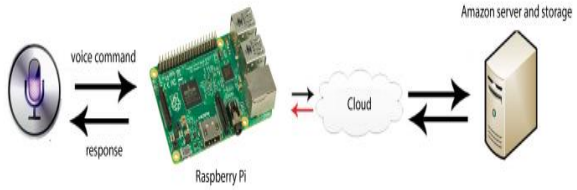


Figure -5: Speech Recognition

The system's speech recognition operation is shown in Figure 5. The user gives the command using the headset provided. This headset is connected to Pi through Bluetooth. Pi routes the user's voice commands, received through its input ports, to the Amazon's cloud server. Hence Alexa is activated on the voice command "Alexa". The Alexa's SDK script is automated in the Pi as soon as the Pi boots up, Alexa service is started automatically. In similar fashion, the other commands like "Switch ON/OFF lights", "Who is at the door", etc. commands are processed.

B. Lambda function

When the guest at the door presses the button, it triggers the GPIO pins that is responsible to run a code, present in the microcontroller. This code activates the camera module and captures the picture of the person at the door. This captured image, renamed as "sample.jpg" is sent to the S3 bucket from the microcontroller and saved. Simultaneously, the Lambda function is triggered which then fetches the image from the S3 bucket and performs image recognition and saves the obtained results on the database DynamoDB.

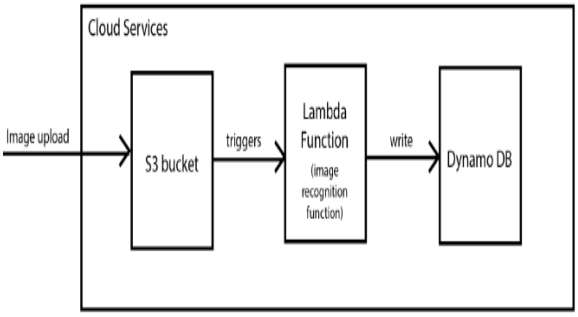


Figure -6: Uploader Function

C. Skills – Magic Answers

Alexa provides capabilities, or skills, that enable customers to create a more personalized experience. These skills make Alexa smarter as they increase its capabilities for doing diverse tasks. One of the customized skill named "Magic Answers" is discussed. When the user, i.e. visually impaired person, utters "Who is at the door?", the automated voice assistant, Alexa here, requests the REST API to fetch results from DynamoDB. The DynamoDB responds to Alexa through REST API which in turns gives the vocal response to the user through speakers or some other device.

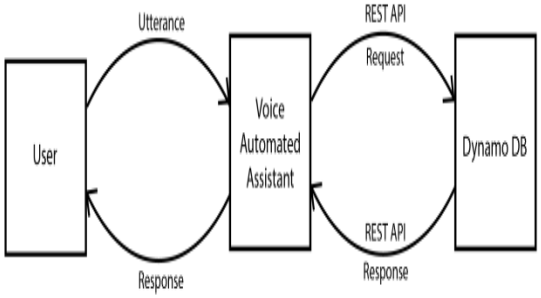


Figure -7: Alexa Skills – Magic Answer

D. Alexa and IoT

Alexa provides capabilities to connect to IoT devices. Here, NodeMCU is connected to Alexa voice service. The user can issue commands directly through Alexa to control the IoT device that is NodeMCU. NodeMCU has on board ESP8266 WiFi module that helps to connect it to internet. Also, it has several GPIO pins that can be used to connect to various appliances like servo, lights, relay etc. IFTTT is a free web-based service to create chains of simple conditional statements, called applets. An applet is triggered by Alexa's command. Then this applet sends the value to adafruit.io. Adafruit.io is a broker between IFTTT and ESP. There is a digital switch in adafruit.io which turns ON/OFF depending upon the values sent by the IFTTT. Now, using MQTT protocol, there is exchange of information between adafruit.io and the NodeMCU module. The code running on the NodeMCU detects the change and modify the state of GPIO accordingly.

User utters "Alexa trigger, turn ON the light". This change is detected by IFTTT which then updates the value 0 in adafruit.io broker. The broker sends the value to NodeMCU module through MQTT. As NodeMCU is of negative logic, 0 turns the pin ON and vice versa.

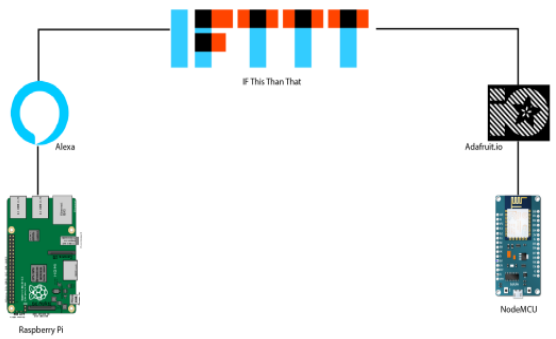
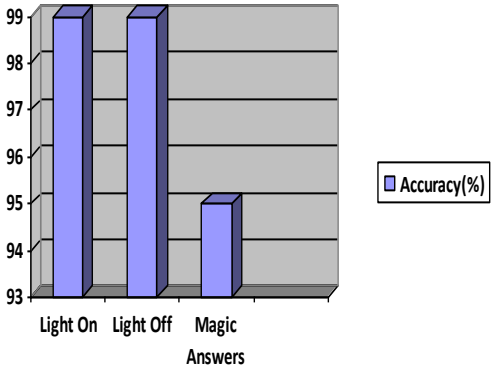
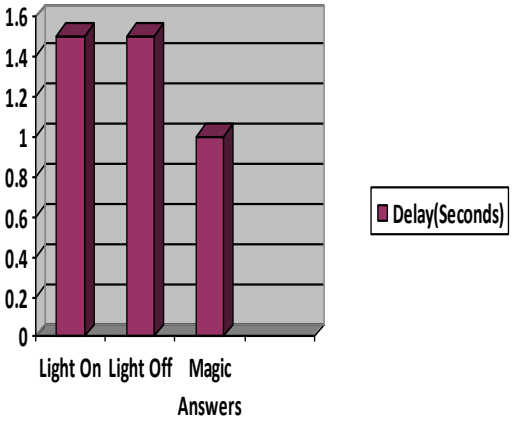


Figure -8: IoT working with Alexa

VII. RESULTS



The accuracy of the various commands issued to the system is shown in the graph.



The delay of the various commands issued to the system is shown in the graph.

These results are shown from virtual emulator which works on the same way as real device.

This figure shows, as soon as the camera takes snapshot of person, the image is stored in online storage

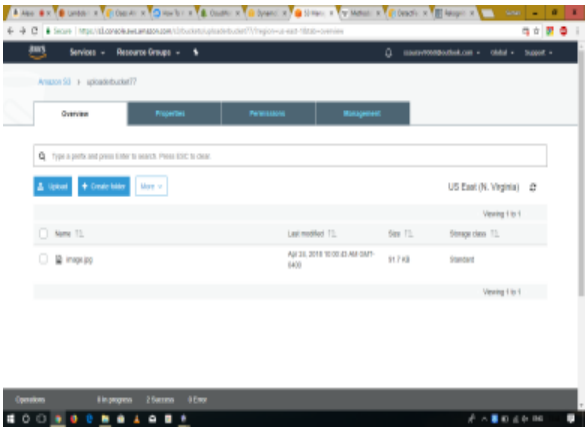


Figure -9: Image Upload

This figure shows the name returned by the image recognition function after recognizing image.

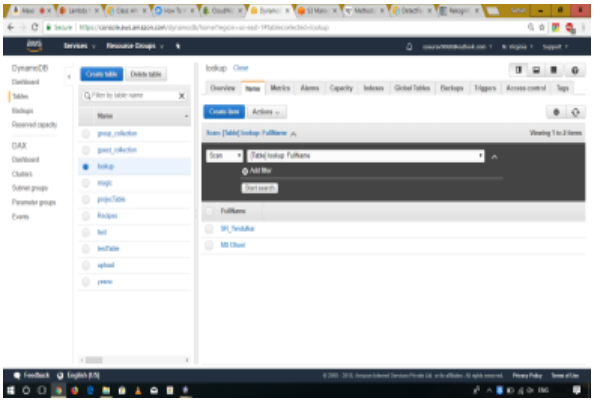


Figure -10: Name Table

This figure shows the features returned by the image recognition function after feature detection.

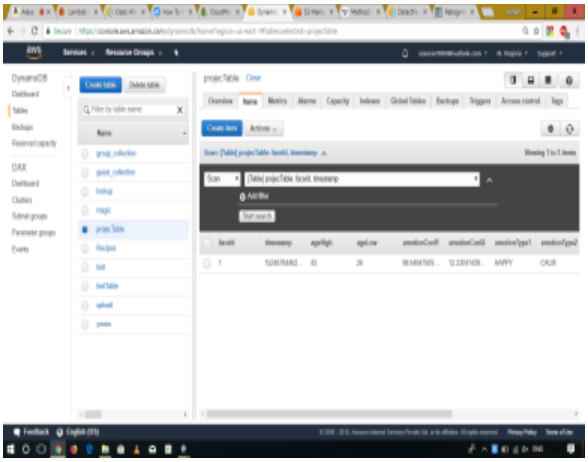


Figure -11: Feature Table

This figure shows how voice assistant respond on launch of application by Sample Utterance: “Open magic answer”.

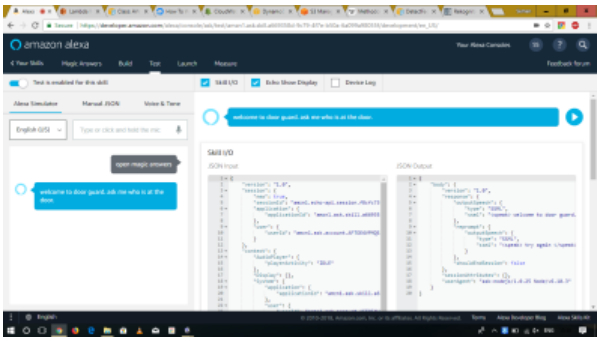


Figure -12: Open App

This figure shows how voice assistant responds on Sample Utterance: “Who is at the door”.

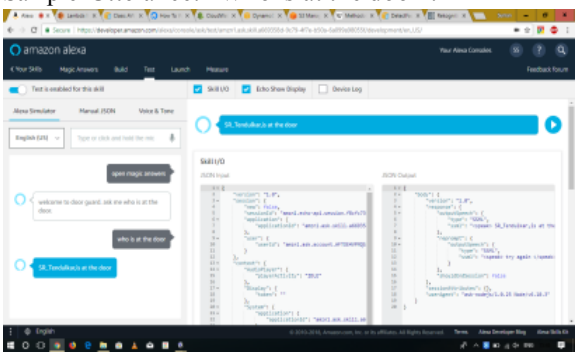


Figure -13: Name

This figure shows how voice assistant responds on Sample Utterance: “How old is he”.

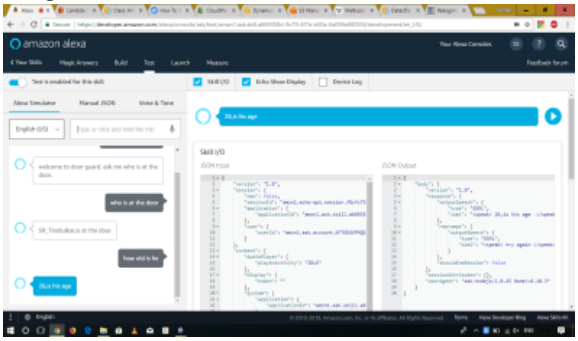


Figure -14: Age

This figure shows how voice assistant respond on Sample Utterance: “What is his gender”.

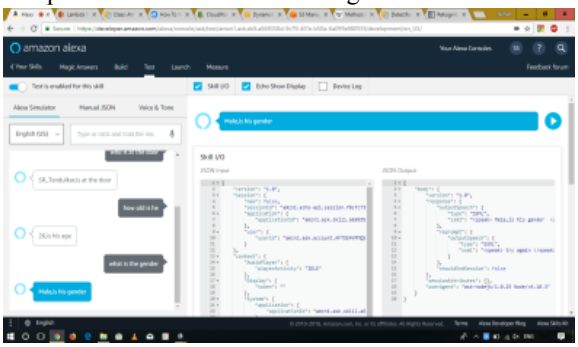
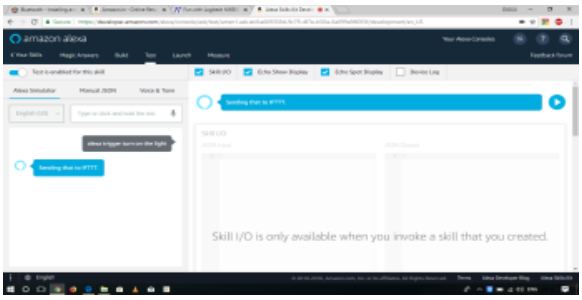
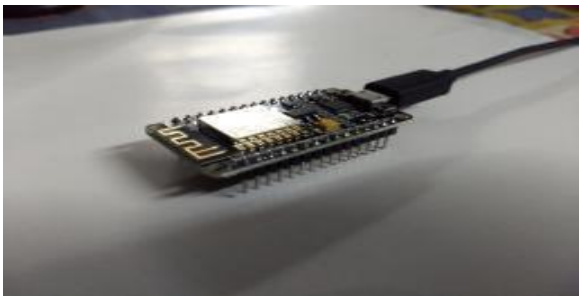


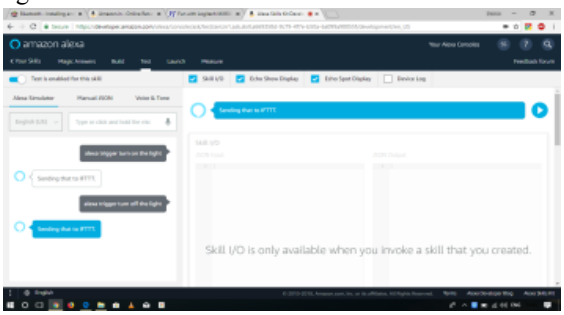
Figure -15: Gender

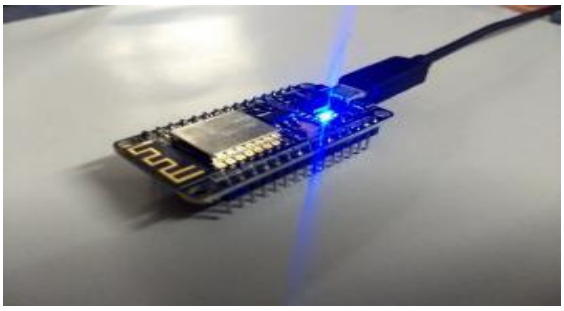
This figure shows how voice assistant respond on Sample Utterance: “Alexa trigger Turn On the lights”.





This figure shows how voice assistant respond on Sample Utterance: “Alexa trigger Turn Off the lights”





VIII. CONCLUSION AND FUTURE SCOPE

This paper presents designs for system for visually impaired and blind people. The proposed approach has a simple architecture that allows the subject to be secure at home. The systems provide security and surveillance assistance etc. Unlike other systems in

the related work, the subject needs only to wear the headset and doesn't require any particular skills to be operated. The complexity of the system resides in computer vision processing algorithm seamlessly to the user. Primary experiments show promising results as the user can feel safe using the system. The user is also alerted when an unknown intruder enters in the house. The functionalities of the watchful eye of the system are made available to the user by a simple voice command on his headset. The paper reports on a pilot study conducted to detect potholes and uneven surfaces with the aim to assist blind people in meeting their safety needs using a smart computer assistant system. With over 90% accuracy, the proposed system aims to assist blind people in real-time surveillance.

Future scope of this system can be as follows:

- To increase the number of skill sets for the visually impaired like music player, controlling phone, controlling home appliances, object recognition, text recognition, reminder, etc.
- To reduce the size of microcontroller to a size of a wearable having features like camera, mic etc.
- To include an obstacle detection system so that it provides mobility to the visually impaired even in outdoors.

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