Smart Mirror using Raspberry Pi

K.P. Vijayakumar[1], Yash Tandon[2], Vennam Prahasith[3]
[1]Assistant Professor, [2,3]UG Student, Department of CSE, SRM IST, Chennai
[1]vijayakk2@srmist.edu.in, [2]yashtandon_mukesh@srmuniv.edu.in,
[3]vennamprahasith_vennam@srmuniv.edu.in

Abstract

A Smart mirror is an electronic device that can be a daily use device. The proposed system describes the design and implementation of a speech-controlled and interactive mirror known as "Smart Mirror". The proposed system has two key features: facial recognition which increases the security of the mirror and also increases personalization within the mirror with the help of user profiling. Second, speech recognition which makes communicating with the mirror easier. The proposed system applies Local Binary patter histogram facial recognition. The system uses a microcontroller called 'Raspberry Pi' which integrates all the modules such as news, weather, date, time, sports updates etc. Experiment results shows that the proposed system outperforms all existing systems to achieve a success rate of 91.2%.

Keywords: Raspberry Pi, Speech recognition, Facial recognition, Python, Smart, Mirror.

1. Introduction

A smart mirror uses a two way reflective mirror as a basic panel to display data. 'Raspberry Pi' is the microcontroller that is being used in the system being proposed. The major concepts involved in the system is Local binary pattern histogram which is an Artificial Intelligence algorithm. LBPH is a simple and efficient text description operator which labels the pixels of an image by thresholds the neighborhood of each pixel and which produce the result as a binary number. Artificial Intelligence is a computer system that has the ability to do human like tasks such as speech recognition, facial recognition and also make decisions. The smart mirror being proposed will help the user, navigate through user's day better by showing the necessary information on the mirror. The smart mirror will be able to save significant amount of time by doing multiple task which the user demand it to do. The mirror will be able to display all the information that user need to plan his/her entire day, it will include important information such as notifications, reminders, weather updates, news briefing for the day.

The objective of this paper is to devise a device namely smart mirror which has the ability to function as a regular mirror as well as an interactive mirror and display various types of content such as date, news, weather, time all at the same time. The user can interact with the mirror with great ease using voice commands. Smart Mirror includes multiple functionalities such as collection and display of real time data, information updates, speech and facial recognition through Mic, LCD display and webcam respectively.

The motivation behind invention of the proposed system is, most of users wish to be efficient, accomplish task and manage their schedules easily in everyday lives. The household mirror is often taken for granted in our daily routine, but really it is one of the products that stand to gain the most functionality out of a tech upgrade. Mirrors are a focal point of our attention almost every single day, and yet rarely physically touch them. Therefore, the proposed system is devised using Raspberry Pi stays hidden behind the mirror and controls the data being displayed on the mirror. With just a glance at the mirror user can look at various notifications, temperature, current events and much more. These mirrors are programmed in such a way that they function as an artificial intelligence and hold the power to control house appliances such as lights, TV, fan, fridge etc. by voice input through speech recognition. The Raspberry Pi is connected to LCD screen via HDMI port and also has Wi-Fi and

Bluetooth interfaces built in. Over this LCD screen a two-way reflective mirror is placed, this mirror acts as a reflective surface that enables to display on the monitor and to be visible on the mirror.
The rest of the paper is organized as follows, Literature survey is presented in section 2. The proposed model is described in section 3. Results and discussions are presented in section 4. Section 5 concludes the paper and discusses future work of the system.

2. Literature Survey

The design of smart mirror using Raspberry Pi [1]. This mirror looks similar to any normal mirror, though there are significant differences between a regular mirror and this mirror. This mirror can display weather, time, current temperature, and a web application for college. The smart mirror is implemented and designed with the help of raspberry pi. There are other major components, which include an LED monitor that is covered by a two way mirror. The raspberry pi is able to actively connect to the World Wide Web and can retrieve data upon the user's request. This product is able to retrieve weather based on the current location of the user.

Internet of Things, there has been significant development in these areas due to multiple reasons [2]. The biggest reason being, the continuous development of new smart devices such as smart lights, smart TV, smart fridges. This paper describes how a Raspberry Pi device can be used to enhance such mirrors to make them a smart mirror with intelligence and security. The final aim is to create an efficient and affordable intelligent smart mirror system. This mirror will have the capability to work not only as a regular mirror but also as an interactive mirror which can display information such as temperature, time, and trending events. The mirror also provides security across the entire system.
The design of smart mirror using Raspberry Pi [3]. This mirror can seem like any conventional mirror, but in reality, it is quite unconventional. The mirror has the ability to display multiple information, such as time, date, and temperature. This mirror uses raspberry pi, which enables the mirror to be smart. The mirror has facial recognition as well as speech recognition. The user can interact with the mirror using speech. The security of the mirror is improved with the help of facial recognition. This mirror, however, does not support user profiling.

The Smart Mirror based on traditional household mirror [4] belongs to home automation system to meet consumers' needs towards intelligent life. It provides occupants with a series of intelligent experiences such as home appliance control, information acquisition, environmental monitoring, entertainment and remote operation. The intelligent home control platform - The Smart Mirror is designed to solve the problem of smart home communication and information integration in the family. Based on the development of Raspberry Pie, unidirectional mirror and the infrared frame and other hardware devices, the smart mirror, as a mirror display screen, offers a kind of safer, more comfortable, more conveniently, more swift and open intelligent, information-based living space to household in the intellectual district.

Facial recognition [5] with a single sample per person is a massive and very challenging problem in computer vision. To address this issue, this paper puts forward a alternative solution combining transfer learning and sample expansion in feature space. It is a difficult task to predict facial differences such as the lighting conditions, the posture of the user, change in look such as glasses, beard, etc. Due to the inadequate amount of training samples. We intended to increase the accuracy of facial recognition even with a few numbers of samples. It also trains softmax classifiers with expanded face features. In comparison to existing expanding sample methods in the image field, the proposed method of expanding the samples in the feature domain is one of a kind and is also simple to implement.

From the study of existing systems, it is identified that, a device was created [1] which has limited abilities such as display time, weather and temperature. The mirror could display the map and architecture of the university and could display placement information. In [2], the addition to this device was that of facial expression detection which could recognize changes to the facial muscle.

This device also had authentication which would allow only recognized users to use the device the security detail used was facial recognition. In [3], the main objective of the project was to establish automation and create a truly smart home. It was designed to solve the problem of integrating the smart home and establishing coherence among all the devices in the house. In [4], the main focus of the project was the security to the device. It had all the similar capabilities to the other orders but had advanced multi factor authentication. It was use the 'Raspberry Pi' microcontroller. In [5], system devised with facial recognition. It increases accuracy of the software by enabling feature expansion. It is able to do so by training samples to predict different variants of the face such as different.

Therefore, the proposed system is devised which has the ability to function as a regular mirror as well as an interactive mirror and display various types of content such as date, news, weather, time all at the same time. The user can interact with the mirror with great ease using voice commands. Smart Mirror includes multiple functionalities such as collection and display of real time data, information updates, speech and facial recognition through Mic, LCD display and webcam respectively.

3. Proposed System

The major purpose of this project is to simplify the daily life for us even more than it is at the moment. The mirror can give different type of information just at a glance without having to spend much time to search for a specific detail or information. The mirror will also be a benefit in the health point of view, with the phones emitting large amounts of blue light the smart mirror will be a major improvement as the mirror coating will reduce the amount of blue light emitted. We can also say that the amount of strain that is caused by looking at a small screen is much more than the amount of strain looking at the mirror. Security enhancements are made with the help of facial recognition. It is easier to converse with the system with the help of voice commands.

The proposed system includes three modules, namely speech recognition, facial recognition and weather and notifications. The first module, speech recognition module is shown in figure 1, is the foundation of the system further interaction with the smart mirror. In order to communicate with the device the mirror must first be able to understand data and information being sent. For the scope of this project, we have used Amazon/Google API for the world knowledge process of the project. Apart from just basic communication the speech recognition module also helps us differentiate between each person to fit the user/customers personal requirements. For the implementation of this module we have written a code in python and requires raspberry pi to be integrated to function with the smart mirror.
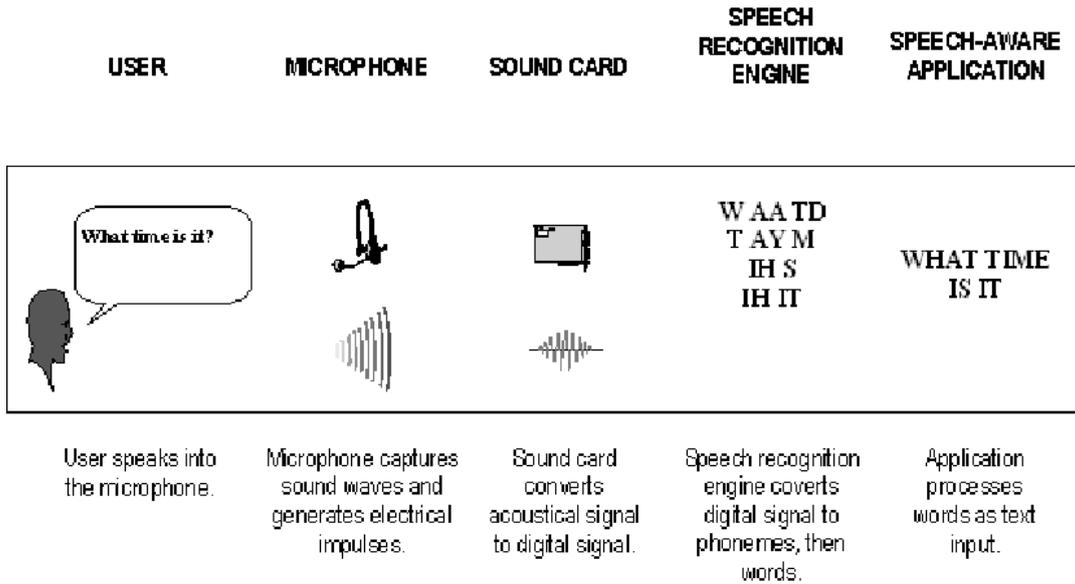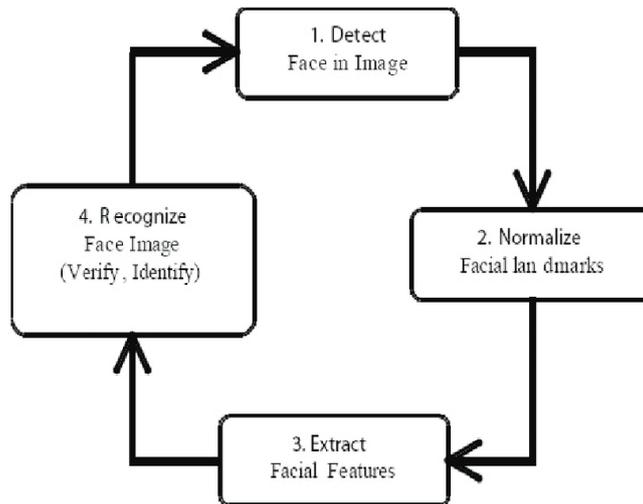
USER   MICROPHONE   SOUND CARD   SPEECH RECOGNITION ENGINE   SPEECH-AWARE APPLICATION

What time is it?

W AA TD
T AY M
IH S
IH IT

WHAT TIME
IS IT

| User speaks into the microphone. | Microphone captures sound waves and generates electrical impulses. | Sound card converts acoustical signal to digital signal. | Speech recognition engine coverts digital signal to phonemes, then words. | Application processes words as text input. |

FIGURE 1. Speech recognition

1. Detect
Face in Image

4. Recognize
Face Image
(Verify, Identify)

2. Normalize
Facial lan dmarks

3. Extract
Facial Features

FIGURE 2. Facial recognition

Second module, Facial recognition as shown in figure 2 can have multiple utilities including security, personalization etc. The smart mirror is integrated with facial recognition for both security as well and personalization. The data must be fed into the mirror's data base for the first time like any other smart mirror after which the data will be saved in the mirror for future use. Data goes through a series of steps during this cycle.

Last module, weather and Notifications, the main features and attraction points of the smart mirror are is notifications and display, with the help of the mirrors surface we can do multiple things which include the following, (i) Represent the data clearly, (ii) Represent and showcase the weather data for today, tomorrow and day after tomorrow, (iii) Designed to work with MMM Weather-now and uses weather now API, (iv) You can personalize it to fit your needs, if you are into business and stocks you can make it display stocks data with alpha advantage API, (v) There are multiple sports leagues that you can follow and display on the smart mirror like football, cricket etc., and (vi) User can make the mirror display news so that you can go through daily news at a glance. User can play YouTube videos on the minor to catch up with your daily activities in a glance. These are few of the many

personalization that user can do with your smart mirror. Figure 3 is the main home screen of the smart mirror, which is currently displaying the weather in Chennai, the current time in India and the trending news at the current moment.
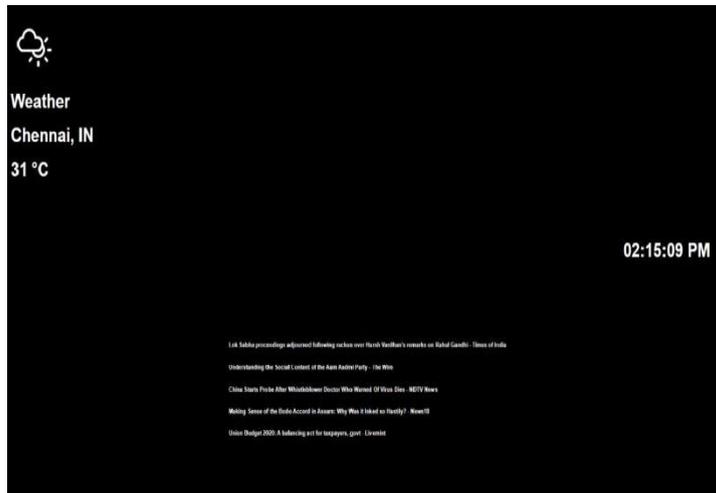

FIGURE 3. Home screen of the mirror displaying weather, news and time

4. Result and Discussions

1. Simulation Setup

The basic requirement is the Raspberry pi, With Raspberry pi we will be able to run multiple programmes and custom modules that we can display on the on the mirror. So the bare minimum needs are the raspberry pi, a monitor and custom codes for each modules. The block diagram shown in figure.5 consists of five main modules, Smart Mirror CPU (raspberry pi microcontroller), LCD screen and a two way acrylic sheet. The modules of the smart mirror include all the capabilities of the mirror which include calendar updates, multimedia services, traffic updates, news alarms and more. The raspberry pi is the CPU of the device which handles the data and convert's it into necessary signals which enable the device to function coherently as a whole.
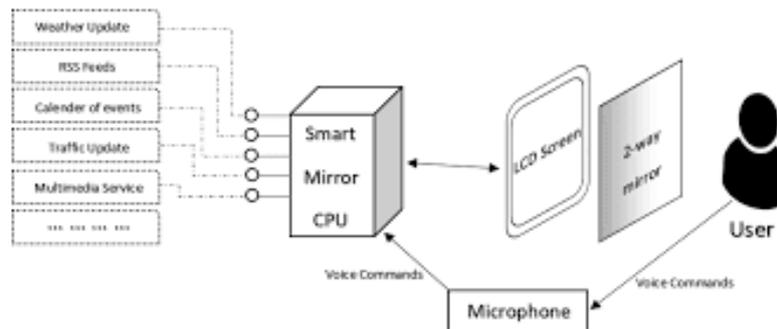

FIGURE 5. Block diagram of the proposed system

The LCD screen allows all the information to be displayed in a graphical format and is placed behind the two way acrylic sheet. There will also be Microphone, Speaker and camera present which will enable communication between the user and the device. The raspberry pi will be hidden behind the acrylic sheet which will display any multimedia information. The mirror must also be connected to a main power supply outlet, the necessary wires which will be used will also be hidden behind the acrylic sheet. Other components such as the camera and the mic will be placed on to top and the side

respectively. All these components will be enclosed within a frame which will give the mirror a solid shape and cohesiveness as a single until and a finished product.

The performance of the proposed system such as (i) speech recognition, and (ii) facial recognition are assessed by using an evaluation metric called accuracy as shown in Figure 6 and Figure 7. In these Figures, x axis denotes number of times the experiment is conducted and y axis denotes the accuracy of performance of the proposed system (that is, true detection). The speech recognition of proposed system is experimented for various number of trails (10, 20, 30 and 40) as shown in Figure 6 and the observations are recorded. In these trails, the system has provided 100%, 90%, 90%, 93% of true detection respectively.
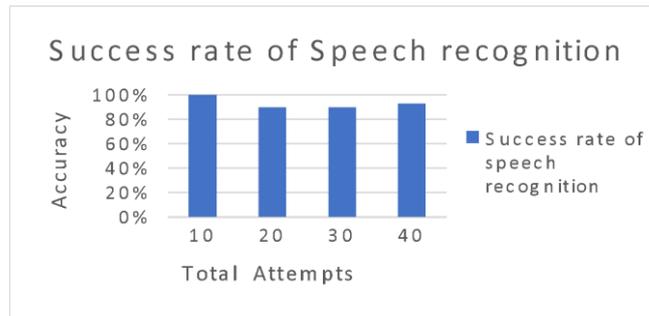

FIGURE 6. Speech recognition success rate

The facial recognition of proposed system is experimented for various number of trails (10, 20, 30, 40) as shown in Figure 7 and the observations are recorded. In these trails, the system has provided 90%, 85%, 87%, 90% of true detection respectively.
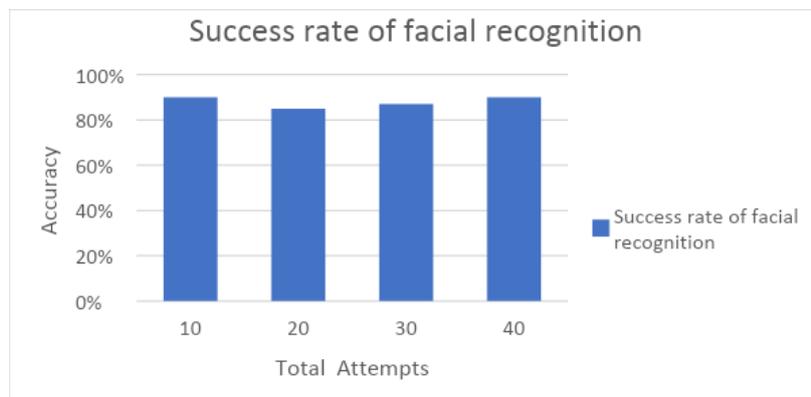

FIGURE 7. Facial recognition success rate

The performance of the proposed system is also compared with the accuracy of existing systems as given in Table 1. When compared to the other existing systems, the proposed system's accuracy rate is higher.

	Accruacy	
	Facial Recognition	Speech Recognition
Proposed system- Smart Mirror	90%	100%
Smart mirror digital magazine	Not Available	Not Available
Smart mirror design powered by raspberry pi	88%	Not Available
Single sample facial recognition	99.2%	Not Available

TABLE 1. Comparison of proposed system vs existing systems

Home Screen : - This is the main page of the mirror where, Weather, time, date and currently trending news as shown in Figure 8. The page can also be personalized according to the users interests.
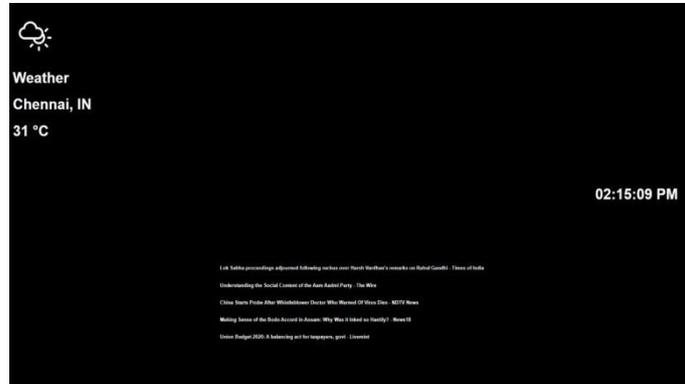

FIGURE 8. Home Screen

Football news:- This is the page which is displaying current football scores. If the user asks the mirror about current football scores, a separate page will open with the news as shown in Figure 9.

FIGURE 9. Foot ball news

News:- This is the page which is displaying current and trending news. If the user asks the mirror about news, a separate page as shown below will open and display the news as shown in Figure 10.
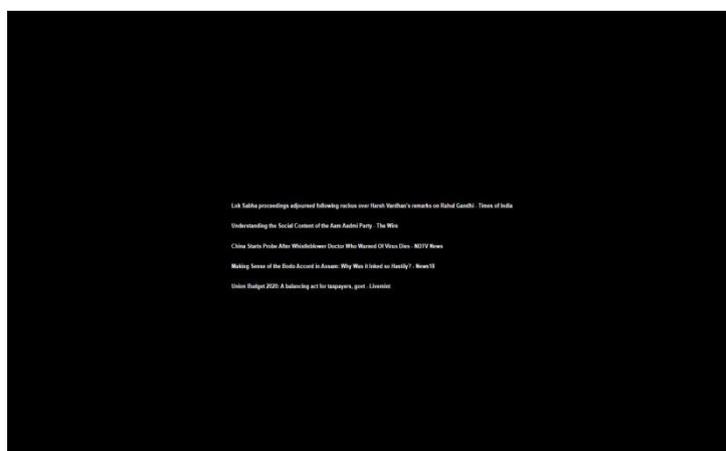
FIGURE 10. Current and Trending News

Weather: - This is the page which is displaying current weather of any area. If the user asks the mirror about weather of a city, a separate page as shown below will open and display the weather as shown in Figure 11.

FIGURE 11. Weather

5. Conclusion

The proposed system provide us insight to a new way of communication and interaction with an artificial intelligence system. The speech recognition and facial recognition of the proposed system achieve 100 % and 90% respectively in terms of accuracy. A system which is compact and efficient and uses new technology for making home truly smart. In future, it is planned to shrink the size of the smart mirror to improve portability.

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