IoT based Interactive Smart Mirror

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***Abstract*—Recent Advancement in Internet of Things (IoT) technology has seen many application mainly related with automation. Modernizing home appliances have become a trend but the only thing that has not been modernized is mirror. The Mirror being the most used objects in the house but there's been no advancement in its design and application. Our project focuses on modernizing the mirror by enhancing its functionality at the same time make it more interactive and useful in saving our precious time. A mirror's function is to display reflection of anything that comes in front of it. We present the idea of Smart Mirror which displays real-time information like mobile notifications, email notifications, Calendar, Live weather updates, reminders, and so on. In addition to this Amazon's Alexa services have been used so that mirror takes voice commands from user. Available Smart Mirror lacks privacy of data and makes use of PIR sensor to recognize a human being also that Smart Mirror can only be used by a single user only i.e. it is built only for one user. Our Smart Mirror can be used by any number of users but since multiple users will use same mirror then the privacy of their data becomes significant so we programmed the mirror keeping the privacy of individuals in mind, to ensure privacy we have used face recognition technique so that each user would see their specific personal information on the mirror. Now Imagine a mirror could read you a news or play a song of your choice. This is made possible with the use of Amazon's Alexa services which provide a rich voice experience to the user so the user can ask Alexa to read news for him. Everything is going to be displayed on mirror therefore a high quality dual-way mirror has been used so that simultaneously reflections and information can be seen on the mirror.**

***Keywords*—Internet of Things, Amazon's Alexa services, Real-time information, Mobile notifications, Privacy of data, Human detection, PIR sensor.**

I. INTRODUCTION

Recently with the developments of smart devices and IT technologies, studies to construct the smart space are being conducted. This leads to saving more space for personal use. This is made possible with the use of sensors, controller boards, and advancements in IoT fields [1]. This gave us an idea of customizing and developing home space in an interactive way. The function of a mirror is very limited it only displays whatever comes in front of it. So we thought to make it more useful and at the same time interactive. We propose a smart interactive mirror which makes use of Internet of Things technology and a raspberry pi controller board. Raspberry pi has many versions so in order to get the right version to support our system we chose the raspberry pi version 3 b+ model because it provides support for its predecessors. The raspberry pi is an excellent controlling board which works on a 1.2GHz 64-bit Quad-core ARMv8 CPU with features like 802.11n wireless LAN and Bluetooth 4.1.Raspberry pi is fast since it consist of 1GB RAM. The Smart Mirror displays the real-time information on the screen so a HDMI supported controller was the choice and raspberry pi has it along with the support for 3.5mm audio jack [2]. The previous Smart Mirror was meant for the use of a single user restricting to only one user also to recognize a user a PIR sensor was used [3]. Our Smart Mirror can be used by any number of users so completely eliminating the restriction of single user. Passive Infrared Radiation (PIR) sensor detects the change in infrared radiation of warm blooded moving object in its detection range. So it can detect any living body as human being. A cat can also be recognized as a human. So this is the big loophole in privacy of the user's data. In order to recognize a human being most of a user we made use of facial recognition using local binary pattern histogram. There were different algorithms for face recognition but linear binary pattern histogram is better than any of those methods [4]. Each user can access their data by just looking at the mirror, the camera captures image of user continuously and compares it with the stored data of sampled images and if it matches then that user's information will be displayed on the mirror. This way privacy of information is achieved. The system makes use of different API's. An API specifies how software components should interact. Additionally, APIs are used when programming graphical user interface (GUI) components. A good API makes it easier to develop a program by providing all the building blocks [5]. The use of API increases the speed of processing and hence helps in providing real-time information to appear instantly on the mirror.

II. IMPLEMENTATION

Before implementation of project, we gathered all the necessary resources and components essential for the development of the same. The project development steps are as follows:

As per the problem statement, recognizing different users properly and displaying their individual information was the most important task of all. After researching various face recognition techniques as per the requirement of the project we found three

different face recognition techniques namely, Fisherface Recognizer, Eigenface Recognizer, and Local Binary Patterns Histograms Face Recognizer.

The Local Binary Patterns Histograms Face Recognizer was the best of all techniques because unlike other techniques we compare the central pixel value with the neighboring pixel. The users were successfully identified as shown in **Figure 1.**

Now after choosing the face recognition techniques the next step was to choose a camera in order to capture an image, for this purpose we had several options at the desk like raspberry's own camera module and several other camera modules. But raspberry camera module had a problem which was it had a native resolution of just five megapixel and fixed focus lens and other problem was it did not have a built in microphone so after searching several other options we found PS3's camera module which had a built in microphone and its image capturing quality was better than raspberry pi's camera module.

For the hardware part that is controller we chose raspberry pi as per the applications of the project and to achieve a high performance and reliable internet connectivity over other controller boards. The **Figure 2** shows the hardware connections.

Raspberry Pi 3 is capable of running an operating system like Linux, Windows core IoT. We are using model B raspberry pi. This Model B board contains 512MB SDRAM and requires 700mA. All models feature a Broadcom system on chip (SoC), which includes an ARM compatible central processing unit (CPU) and an on chip graphics processing unit (GPU, a Video Core IV).CPU speed ranges from 700 MHz to 1.2 GHz for the Pi 3 and on board memory range from 256 MB to 1 GB RAM. Most boards have between one and four USB slots, HDMI and composite video output, and a 3.5 mm phone jack for audio.

After choosing controller board and camera module we head towards programming the raspberry pi. Since raspberry pi supports python, OpenCV and java languages so the face recognition programming was done in OpenCV.

After completing the programming we had to put it on mirror for this purpose first we selected a dual way mirror which is basically a mirror over which you can see reflection as well as the text behind it since we are displaying text on the screen an led monitor was required.**Figure 3 shows the various text on screen.Figure 4** shows a dual way mirror on the led screen.

Configuring all the parts with each other the final assembly was made. All the parts have been configured in a wooden case.

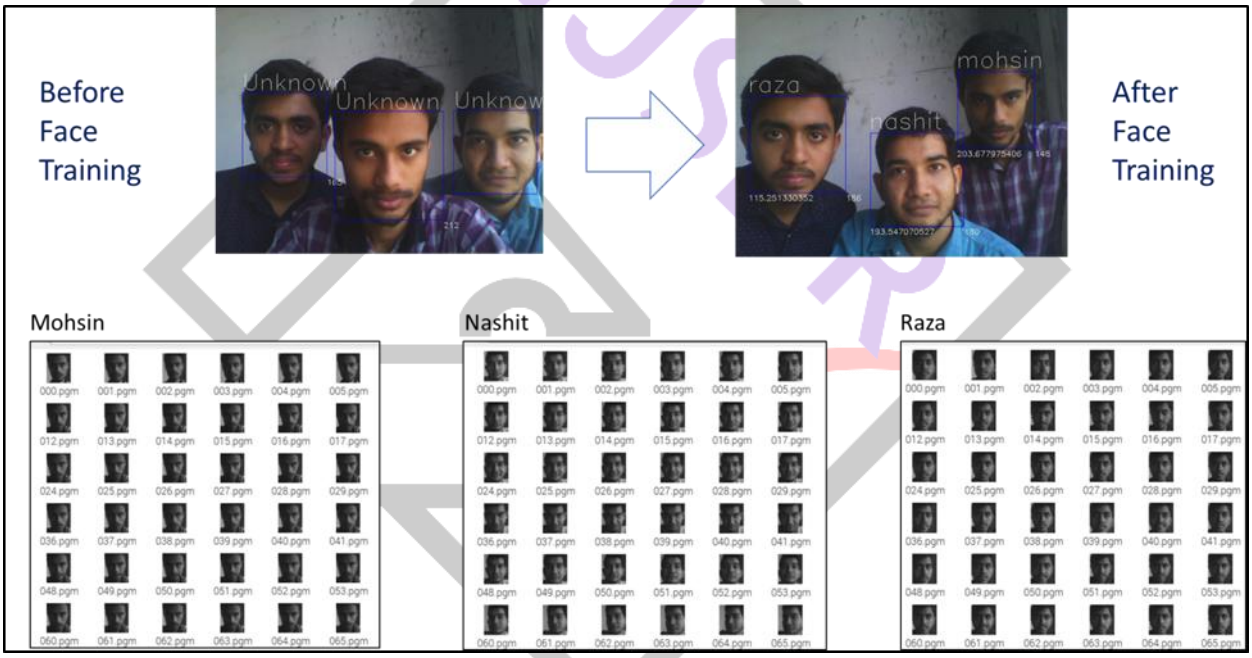

Fig. 1

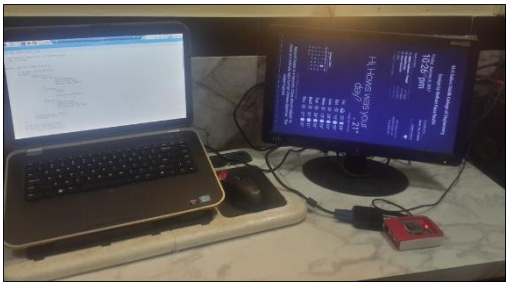

Fig. 2

Fig. 3

Fig. 4

III. RESULTS AND DISCUSSION

We developed Facial Recognition system in Smart Mirror using Local Binary Pattern Face Recognition algorithm to provide privacy to user. To test how this algorithm behaves in real life, we conducted some test as discuss below.

In first test scenario, we captured and trained user image through the distance of 1 foot, 2 foot and 2.5 foot respectively and tested the accuracy. The accuracy is tested by conducting 10 recognition in a row. The result is shown in table 1 below.

Table 1

Sr.no	Users	Recognition Interval (in ms)	Accuracy Percentage		
			1ft	2ft	2.5ft
1	User1	800	60	70	40
2	User2	750	70	70	50
3	User3	850	60	60	40

In second case scenario, we capture and train the image of user with same distance but we added an external flash light with camera. The result of this scenario is shown in table 2 below.

Table 2

Sr.no	Users	Recognition Interval (in ms)	Accuracy Percentage		
			1ft	2ft	2.5ft
1	User1	600	80 %	90 %	60 %
2	User2	550	80 %	90 %	50 %
3	User3	600	70 %	80 %	50 %

As from the result, we observed that recognition accuracy is increased to a great extent by using external flash with camera. This is because with external light source it is easy for the camera to take quality image with more details and low noise.

IV. CONCLUSION

We intend to keep researching user-adaptive services and systems by keeping on the evaluation to learn how much convenience the user will experience and how well the user will use when using this individually customized automatic system. When we started working on the system, it was figured that interface would allow any direct interaction with using the mirror. This would result in home automation shelf security which is accomplished using speech recognition. What was even more significant was the fact that the mirror should be usable as a normal mirror reflecting the person, and thus it should not be fully filled with unwanted information. Only the outer corners should be used for content display, leaving enough room to see the person. In this work honest efforts have been made to develop a system that is not only smart but also interactive with varied functionalities to carry out tasks with high precision and efficiency. The basic mirror that we know was changed to a new interactive system. With the help of amazon's Alexa voice services (AVS) the system became voice enabled and opened the door for users to communicate through voice so anyone can use it. So a physically challenged user can also use it. User's privacy security has been major problem throughout the process but this was solved by using face recognition technique. Now the user no longer have to worry about the security of his information. The real time notification was the key to the project.

The following **Figure 5** shows the final output of the proposed project work.

Fig.5

V. Future Work

The Alexa voice service can be modified in such a way that one can ask it to send a message or call to anyone (whose name is in the contact list). The message will be shown on the mirror so one can see what message is being sent. The user have to feed the contact information of peoples in the database along with their names and other important details.

The smart mirror can be used in industries where the workers can directly be instructed about their work. This can be done by uploading data on the cloud and integrating it with the smart mirror so whenever a worker comes in front of it the mirror recognizes it and shows the schedule for that particular day. For industries this could be a game changing tool because it saves time and this leads to enhancement in productivity. The Smart Mirror brings smartness in the corporation along with the productivity.

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