Senior Design Project 499A Report
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AI Smart Mirror

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AI Smart Mirror
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Paper Review 3 Name of the Paper Conference Name Location (Scopus-indexed)	Md Salekur Rahaman Smart Mirror Using Raspberry Pi for Human Monitoring and Intrusion Detection 2019 1st International Conference on Advances in Information Technology (ICAIT) Chikmagalur, India
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***Abstract*—In recent years, the smart home and advanced gadgets have been a common topic. Because of the rise of powerful smart gadgets, the development of these fields is increasing. Smart mirrors are a recent addition to the smart home family that has recently received much interest from people. In this work, we developed an artificial intelligence-based smart mirror to minimize people's workload and to make life easier. We build a smart mirror that includes artificial intelligence. This paper describes how we can use low-cost hardware like Raspberry Pi to make a smart home. Using some default modules, this mirror can display various features that we use daily, as clock, live news, weather, and many more. It can not only detect its user but also can detect an intruder and alert the house owner. Hence, it contributes to the house's safety. Users can also control the magic mirror and update information on the Android application.**

***Keywords*—smart mirror, artificial intelligence, face recognition, object detection**

I. Introduction

Artificial intelligence is an environment where the system can think like a human being. By thinking it reduces our daily work and makes our life easier. The smart characteristics of present devices are due to the help of Artificial Intelligence [1]. So, we developed a smart mirror that works with AI using low-cost hardware, such as Raspberry Pi [2]. It has many features which will help us to detect and doing many household works. So for the home automation system, it will be the next big thing. It will detect the user and give the command. The mirror will work according to the command and will do many tasks. So automatically it will reduce our work. The most important part is there are already so many smart mirrors in the market. Still, there is no smart mirror in the market that will do face detection, object detection, and human activity recognition and work as home security. We can use it for our entertainment purpose and can also use it as a home security system. So we are enhancing the power of the existing smart mirror in the market.

In [2], A. C. Njaka et al. used Raspberry Pi to build a smart mirror system that employs biometric authentication with multi-factor facial and voice authentication to ensure a higher level of security. They employ a one-way acrylic mirror over a display monitor, a Raspberry Pi device, and a microphone. Next, an intelligent mirror software was created using the Python programming language, containing numerous modules. For voice recognition, they use the Voice API. They also employed the Amazon Alexa speech service, and for facial recognition, they used the Open CV library. This mirror can display multiple media items like films, photographs, and audio files, show the weather, and recognize face and voice. They showed high accuracy with the registered user for voice recognition. But they could have also added the accuracy for face recognition.

In [3], the authors have created a home automation system with a smart mirror. They used a Raspberry Pi micro-controller to create face recognition, voice recognition, speech conversion, infrared wake-up, touch control. In hardware, they used an IR frame to control the touch system, a mirror that reflected their display screen, speaker, camera for face and voice detection, and the raspberry pi, which controlled all the system. For software, they used python language to achieve infrared sensor control of face recognition, Raspberry Pi micro-controller, magic mirror framework, and API for the Google service. So finally, they created a smart mirror as an innovative home control platform that helps them control the home by commanding and maintaining the home security system.

In [1], the authors design a smart mirror with Raspberry Pi 3, a Pi camera module, a two-way mirror, a display, and some AI libraries to detect objects and perform any action based on the detection. At first, the authors described smart mirrors and some basic features like weather info, clock, calendar, and voice assistant module. After that, they explained where and how their model would work and described the problem they faced. Finally, they tested the smart mirrors by detecting objects with OpenCV Yolo library and were satisfied but did not report any accuracy results. It was an AI work where they wanted to minimize human work to save effort by detecting objects but did not show any auto-complete work of humans by setting

automatic commands.

In [4], The authors designed a system 'OLIVIA' which can be integrated into any home to make a smart home. The system can interact with users and also connect the owner of the home virtually. As hardware, they have used a Raspberry Pi 3, web camera for face detection, USB microphone with inbuilt sound and speakers. They have used the Eigenface algorithm for face detection and various libraries like Speech recognition, gTTS to generate an mp3 file from spoken text using Google Text-to-Speech (TTS) API. Finally, they ran the system successfully with a web camera and through the face detection recognition algorithm but did not show any accuracy of the proposed system.

Our goal is to create a smart mirror that integrates Artificial Intelligence. Mirror will verify user identities using their face and voice detection. It can detect an intruder and alert the homeowner. We can also use it for the entertaining purpose to play music and videos, watch the weather forecast, news, calendars. We can utilize it in homes to give commands to other devices as needed, and we can use it from anywhere using our Android application.

The following is the paper's section II provides a high-level overview of the system. Section II-C delves into the specifics of the system's design and implementation. Section III describes the experimental work, and section IV provides a conclusion. Lastly, section IV-B presents our future plan for 499B.

II. Proposed System

We developed a smart mirror to make human life easier with some artificial intelligence libraries. As a hardware and software combined project we used both software and hardware tools. The following paragraphs describe notable hardware and software tools and how the system will work in smart mirror.

A. Hardware Components

1) Raspberry Pi: Raspberry Pi is one of the world's mini-computer that allows us to do such intelligent things in our daily lives. It is a low-cost, credit card-sized system that can do almost all things of the computer system. We used the Raspberry Pi 4 model B (RPI4) that has 2GB LPDDR4-3200 SDRAM RAM and 1.5GHz CPU speed, has been shown in Fig. 1. For the central storage of this board, we used a micro SD card which capacity is 32GB.

2) Pi Camera: The Pi Camera module is a small camera used to capture images and videos through the Raspberry Pi. We used a Pi camera, as demonstrated in Fig. 2, which has a maximum resolution of 720p. This camera module used the 15-pin connector of the Raspberry Pi board.

3) Others: Also, we used a microphone to receive voice input from users using USB to the audio sound card. And a mini speaker for external sound output.

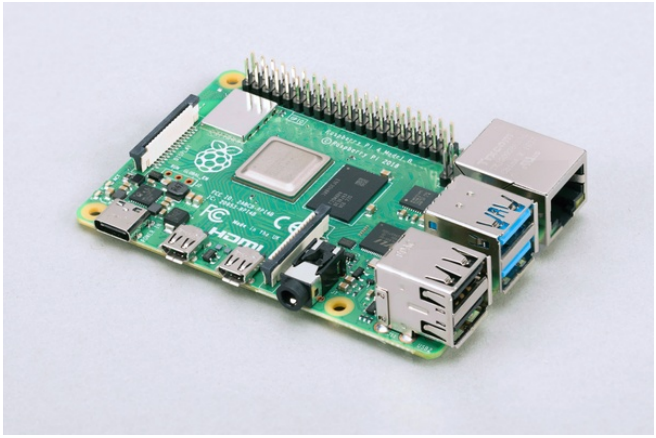

Fig. 1. Raspberry Pi 4B

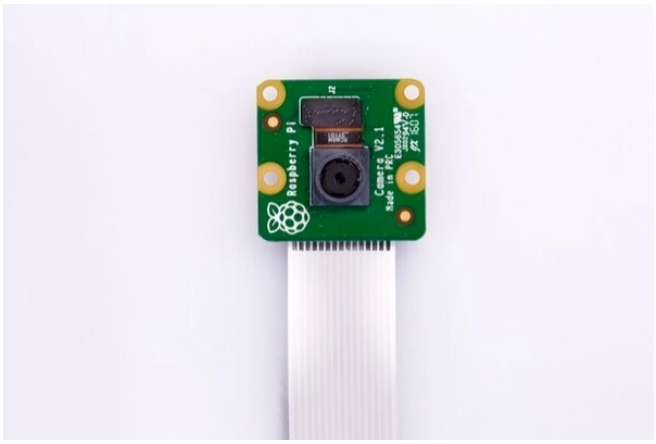

Fig. 2. Pi Camera Module

B. Software Components

1) Visual Studio Code: Visual Studio Code is a development platform that supports almost all languages as it has an extension store where users can install necessary extensions for their language. One of the significant development environments of the smart mirror system is NodeJs which is also debug using Visual Studio Code.

2) Android Studio: Android Studio is an application development platform for the Android OS powered by IntelliJ and Developed by Google LLC. We used Android Studio to develop our remote app, which can control AI Smart Mirror from anywhere remotely.

C. Methodology

An AI smart mirror can detect authorized faces as an intelligent device, and it works according to its authorized user. So the flow of the system is briefly described below,

1) Mirror Building: We used a computer monitor as the smart mirror main display, which can be used as a mirror, and a smart display that can show the smart mirror contents or features.

2) Installing framework: We installed Debian OS on a micro SD card and the OS on the Raspberry Pi board to run the smart mirror. And then, we installed the MagicMirror framework, which gives the environments and layout for the smart mirror. Michael Teeuw develops the MagicMirror framework.

3) Basic Modules Setup: The smart mirror has some basic features for our daily life, implemented from the MagicMirror framework.

- Digital Clock: It is a clock that displays the current time from the real-time location of the users. It showed on the top left of the mirror, although users can change its location.
- Live Weather: It is an informational module that displays the current weather from the current location in real-time. It showed on the top right corner of the mirror.
- Weather Forecast: It is a weather informational module that displays upcoming day's weather based on the current location.
- Dynamic Calendar: It is a real-time synchronizable calendar provided by google calendar according to logged-in users. For these features, users need to log in with their corresponding Google account.
- Live News: It is a module that displays live news based on user location.

4) Google Assistant Setup: As an advanced feature, the smart mirror has the google assistant module also. We implemented it from the Google cloud console API. Go0ogle assistant can receive voices from the users through the microphone and respond in three categories: information, playing videos, and playing Spotify music.

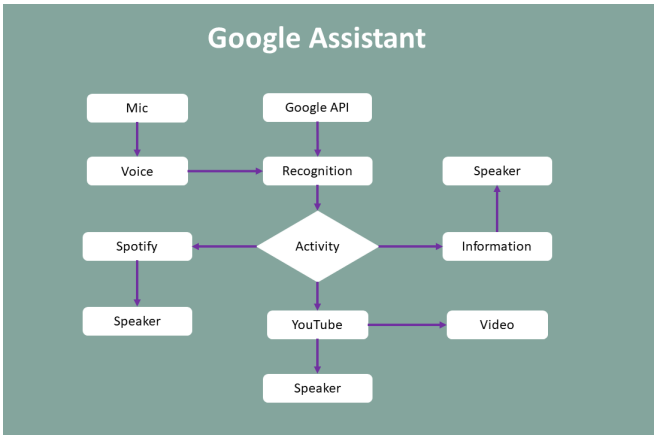

Fig. 3. Google Assistant Flowchart

In Fig. 3, we can see that we receive voice through the mic and send it to Google API after recognition by Google. Next, after detecting the command, it works like playing the YouTube video, Spotify music, and talk with user to give information. Voices are played on speaker, and videos will be played on smart mirror display.

5) Face Recognition Setup: The proposed smart mirror will detect and recognize the real users by the face recognition feature. At first face, the recognition library creates a model with registered user images. And then, using the OpenCV library mirror will see whether any human is coming in front of the mirror or not. If OpenCV detects any human face, then it sends the image to the Face Recognition library. If it recognizes the face, then display a welcome message with his name and his profile picture into the mirror from the firebase cloud database.

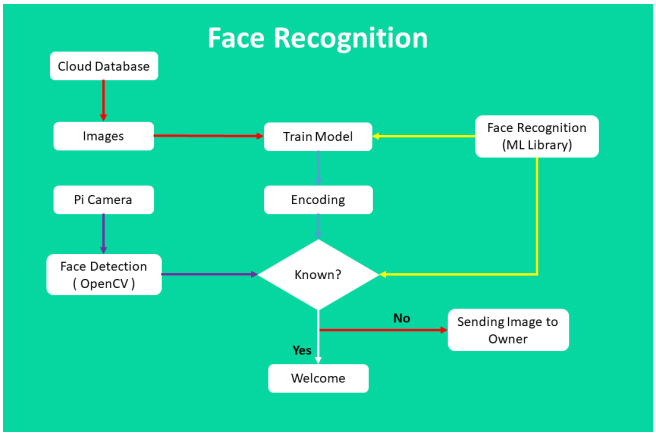

Fig. 4. Face Recognition Flowchart

According to Fig. 4, the Pi camera takes live images from the environment and sends them to OpenCV and Face Recognition library to recognize the user. If the face is identified, then the mirror will work for the user. Otherwise, it will send the detected image to the mirror owner through email.

6) Database Setup: We used the firebase database to keep user data like name, email, profile image, and images for train face recognition. We use the Node.js environment, which is supported by Google firebase.

7) Android Development: To develop a remote Android app, we implemented ssh library on Android studio. After that, we connect the smart mirror through the IP address and password of the mirror. And then, we send commands through ssh to control the smart mirror and its features.

III. Result and Discussion

We implemented pre-build the library and API from OpenCV, Google, and Face Recognition, so results of these libraries are given on their website for accuracy. In our intelligent mirror system, they worked properly without any system error.

We worked on some basic and advanced features of intelligent mirrors. There is an output result image for these features.

In Fig. 5, we can see on the top left there is a digital clock that displays the current time. Then on the top right

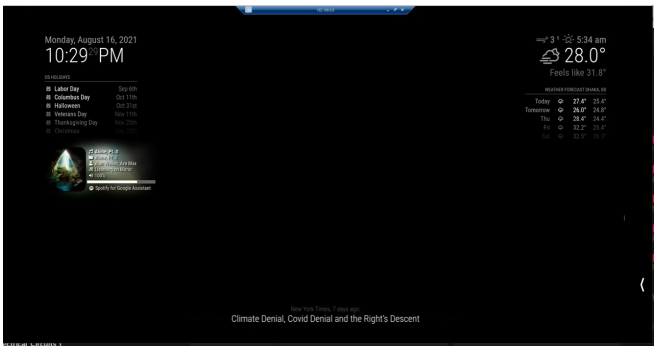

Fig. 5. Mirror with Basic Features

mirror is displaying current weather. Then on the top left, under the digital clock, there is a dynamic calendar. Then on the top right, under current weather, there is a weather forecast for upcoming days. And finally, the live news displaying on the bottom of the smart mirror.

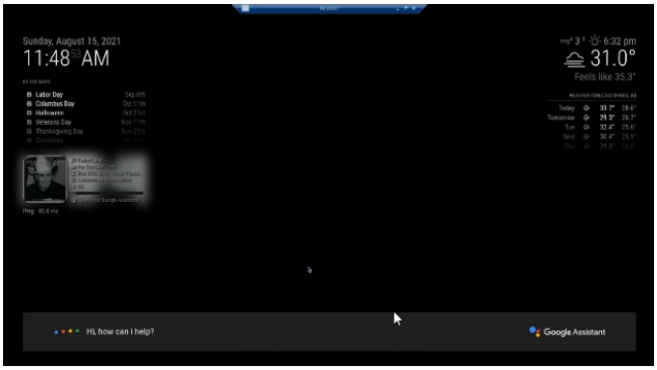

Fig. 6. Mirror with Google Assistant

According to Fig. 6, the bottom of the smart mirror shows that google assistant is listening voice of the user from the microphone. To active google assistant, users need to use the keyword ”Jarvis”.

Fig. 7. Mirror with Face Recognition

In Fig. 7, on the right side of the smart mirror, we can see the face recognition feature displaying the detected user image and the name.

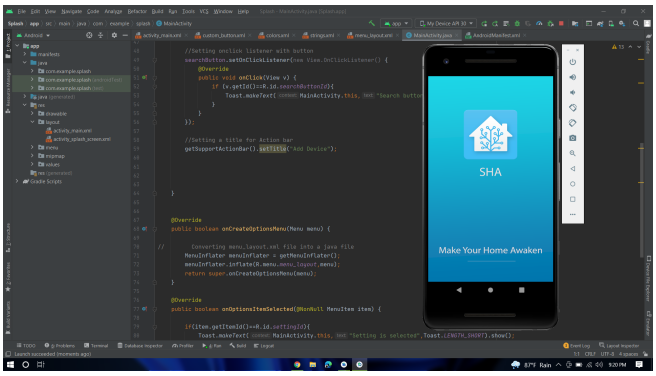

Fig. 8. Android Home Screen

In Fig. 8, we can see that we developed an Android app to control smart mirrors from the android device.

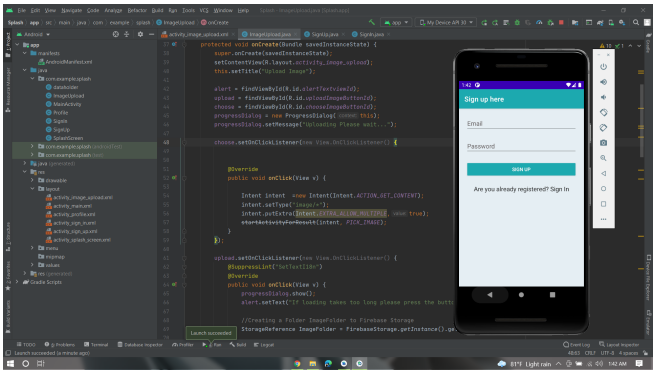

Fig. 9. Android Register User

In Fig. 9, we can see that users need to register with their basic information in our system through the android app.

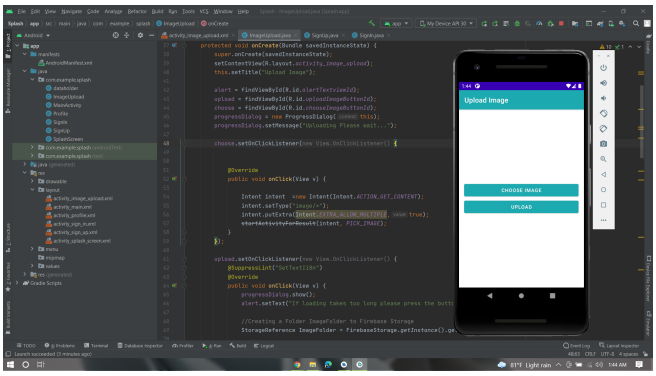

Fig. 10. Android Uploading Train Images

In Fig. 10, we can see that users need to upload their facial images on the Firebase database to train models to recognize them on the smart mirror.

In Fig. 11, we can see an option to find and connect the smart mirror with the mirror’s IP address and password.

In Fig. 12, we can see that we stored all the user’s data on the Google firebase database.

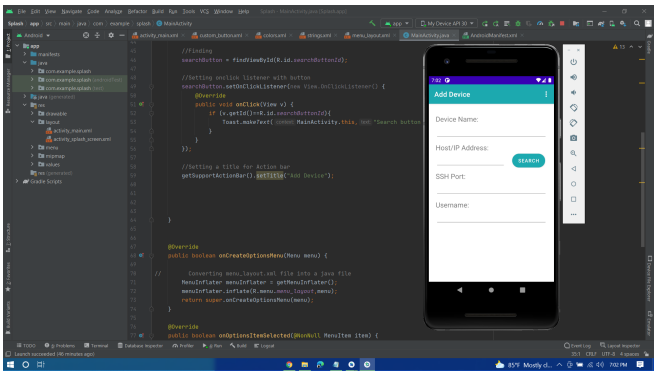

Fig. 11. Connect Mirror from Android

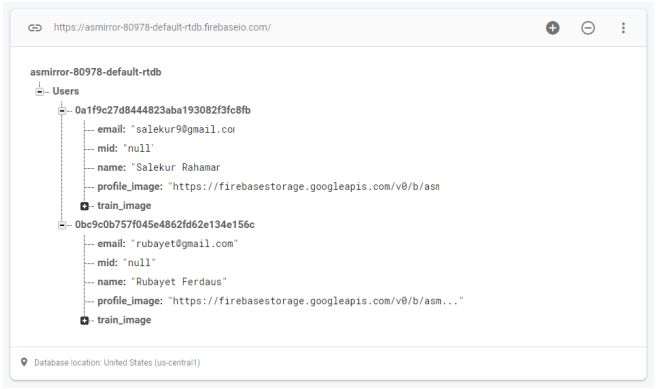

Fig. 12. Data on Firebase Database

IV. Conclusion

The proposed AI smart mirror developed for the advancement of an ordinary home. The system has the potential to perform household activities with less physical effort.

A. Summary

The smart mirror ensures the home automation service and provides high-tech security along with smart notification to the registered Android device. Also, we have developed a remote Android app. The system can be manageable anytime from anywhere with the Android app.

We have tried to keep the cost as less as possible as we use a simple Raspberry Pi and some necessary hardware's to ensure that financial cost could not be a barrier to use the system. The smart mirror gives the user comfort so that the user can handle everything with less stress. So that the smart mirror is expected to be the best-suited solution for residential buildings nowadays.

B. Future Plan

The system will be extended with much more features to reach the next step in user satisfaction. The feature of the smart mirror will not be limited to home monitoring only. Our target is also to detect any unwanted object in front of the mirror. The smart mirror will notify users if any undesirable thing is coming up in front of the mirror.

The mirror can detect whether the user is angry, shy, or disgust that means user face mood detection will be part of our future work. We will also work on user pose detection, which means if the user is dancing or performing yoga, the system will play music itself accordingly.

We also want to set command according to detection, for example, if there any intruder appears in the mirror the system will send a short message to the mirror owner automatically also on condition that any unwanted accident occurs, the mirror will capture a short video and then send it to the owner.

Dynamic calendar sync with a google account will also be implemented. Finally, we want to develop our Android app according to the functionalities mentioned above.

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