



# SMART MIRROR USING HAND GESTURES

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**Abstract:** Smart mirror is a device where would be able to see news, temperature, weather and can also schedule events for one month. We can interact with smart mirror using voice command, hand gesture and smart phone. Our system uses raspberry pi based processor board along with display and IoT based circuitry and temperature sensor. A camera used to capture the gestures and gives corresponding output according to the programming . The Internet of Things allows devices to communicate with each other in different and important places at the same time. One of the most important IoT applications is the smart mirror. It is a mirror that acts as a reflective surface and as an interactive screen at the same time. It provides valuable information on the display at a glance, while also acting as a conventional mirror. Smart Mirror is a mirror which allows touch-free user interaction with important information displays such as current news, time, date weather, schedule, Temperature and setting up of reminders in the form of widgets on the screen, while also providing notifications or alerts to the smart phone using an application. It uses innovative technology to achieve an interactive system, made for ease of access to basic important information and enhancing utility.

**Index Terms – Smart mirror, Face recognition, IoT, Hand gesture, Raspberry pi 3**

## I. INTRODUCTION

A smart mirror is a two-way mirror with an electronic display behind the glass. The display shows different kinds of information in the form of widgets, such as temperature ,weather, time, news updates. An app is developing to schedule, update and cancel events and also used to enrol face of users.A person who does not have enrol face with specific code using mobile application cannot use mirror.The unauthorised access results a notification on the phone which connected to the mirror.In existing system Smart Mirror is a mirror which allows touch-free user interaction with important information displays in the form of widgets on the screen, while also providing SOS calling and messaging features. It uses innovative technology to achieve an interactive system, made for ease of access to basic important information and enhancing utility. The display has mirror-like reflective properties while still displaying information in typical lighting conditions consisting of fluorescent, incandescent and LED light as fluorescent and incandescent lighting are the most common type of lighting in home and offices, which are the most likely environments for the Smart Mirror to be installed. The device should be presentable as a display piece in a home.

## II. THEORY

### 2.1 Face Recognition

A face recognition program is a software application for verifying a person and identifying him or her with a video or picture from a input source. Facial recognition can be done by the open source platform Intel called OpenCV quickly and reliably. One way from a face and an image database are the preferred facial features. The key element analysis using Fisher face algorithms, the Markov model, multilinear subspace learning using tensor representations. The PCA(Principal Component Analysis) is designed for facial recognition by the wide 1-D pixel vector in compact main elements of the space function. This is called a projection of self-space. It build a camera-based real-time face recognition system and set an algorithm by developing programming on OpenCV, Haar Cascade, Eigen face, Fisher Face, LBPH, and Python.

## 2.2 Hand Gesture Recognition

Gesture Recognition is a process in which the user performs some gestures and these gestures are to be recognized by the machine or receiver. Gesture recognition is seen as how machines or computers can begin to recognize the body language of humans. Using a low resolution web camera frames are inputted. Then, these frames are passed through different modules like pre-processing, hand detection and gesture recognition module. To reduce the noise from the video frame median filter is used. Skin color segmentation is used to segment the skin region from the frame and by using the morphology operation the imperfection can be reduced from the binary skin segmented frame. The hand is detected using the region of interest module and the fingers are counted using the finger counting algorithm.

## 2.3 Voice Command Recognition

Voice command recognition is the process that takes speech signals come from human speakers as input and process it accordingly to give output using methods like ASR(Automatic Speech Recognition). ASR has good accuracy rate in classifying manner, using relatively robust features of strong periodic energy, silence, and noise. Detection of periodicity is a major factor in estimating voicing. ASR decodes a speech signal indirectly using the sequence of spectral patterns of the speech signal. ASR systems built using Kaldi toolkit and Keras/Tensorflow tools. And also it uses MFCC (Mel Frequency Cepstral Coefficients) for identifying compact words in continuously spoken sentences and speaker identification.

## 2.4 Ultrasonic Proximity Sensor

An ultrasonic proximity sensor is connected to the Arduino microcontroller, which detects the presence of a user standing in front of the Smart Mirror and sends the signal to the microcontroller once a user is detected standing near the mirror. It uses ultrasonic sound waves to detect the presence of objects near it, and once an object enters the target radius of the sensor, it sends the distance of that particular object to the microcontroller.

## III. RELATED WORK

The aim of this paper<sup>[1]</sup> is to develop of a smart mirror and represent an ambient home environment. This system can control the house hold appliances and provides news, multimedia data that are displayed on the screen . Face recognition is used to automatically identify the user and unlock their personal profiles . If an unauthorized user comes in front of the mirror it will deny access the personal services and only provide a standard mirror. Remote control can be used to access the home appliances.

The aim of the paper<sup>[2]</sup> is to allows users to access and interact with contextual information, such as weather data, seamlessly as part of their daily routine. This paper developed SmartReflect—a software platform for developing smart mirror applications. The main features are modular, lightweight, and extensible It allows developers to sidestep the sandboxed environment created by web browsers and it supports plugins written in any programming languages. It runs on a tiny computer, such as the Raspberry Pi. Second. It is quite common for smart mirror platforms to use web browsers as the primary display method.

The aim of this paper<sup>[3]</sup> is to detecting the dynamic hand gesture. There is two type of hand gesture that are static hand gesture and dynamic hand gesture. Here, the system is designed to work with images captured through using the web camera .there is mainly 5 steps. The first one is capture our image then the second step is pre-processing this step also include median filter, skin color segmentation, morphological operation. In median filter it will be reducing the noise from the frame. In skin color segmentation it uses normalized RGB and HSV for identifying the skin pixel. In morphological operation it will reduce the imperfections. The third step is Hand detection it include region of interest and finger counting. In here shape analysis will happened. That is the image will converted to back &white. And calculate the defect. The Fourth step is Gesture recognition. In here it will check with data base and at last get the output.

This work<sup>[4]</sup> is a technology of IoT for face recognition which is combination of machine learning and the biometric techniques which holds the qualities of not only high precision but also the reliability. For automatically detecting the human's face from the databases this system can be used. This technology is used for authentication, validation, authorization and identification. Face identification is defined in three steps-face detection, feature extraction, face recognition. Camera configuration is very important to track moving persons and recognize them precisely. Facial feature points encode critical information about face shape. Precise location and facial feature points tracing are important. Each feature point is usually detected and traced by performing a local search for the better matching position. The edges are not only carrying valuable data about face but are also simple to process.

In this work<sup>[5]</sup> Automatic speech recognition (ASR) is work with the most common analysis method Mel Frequency Cepstral Coefficient (MFCC) approach. Here ASR is a task of artificial intelligence (AI) where an algorithm converts human speech to the text that was intended by the speaker. As in much of AI, it does pattern recognition (PR), to recognize a pattern (the text) that is present (although in a highly coded form) in the speech signal. As in any PR task, ASR seeks to understand an "informational" pattern in the input speech waveform. Speech signals come from human speakers, who wish to convey information to listeners. Human speech communication differs greatly from artificial communication systems. ASR designers have little control over speech production, other than asking speakers to talk slowly and clearly

## IV. IMPLEMENTATION

Smart Mirror using hand gesture is a mirror which allows touch-free user interaction with important information displays such as current news, time, date weather, Temperature and setting up of reminders in the form of widgets on the screen. By using hand gesture and voice as input it provides more convenience for user to input the data. The display has mirror-like reflective properties while still displaying information in typical lighting conditions consisting of fluorescent, incandescent and LED light as fluorescent and incandescent lighting are the most common type of lighting in home and offices, which are the most likely environments for the Smart Mirror to be installed. The device should be presentable as a display piece in a home. A camera is

used to capture the face of user and the images are given as the primary input to the smart mirror for face recognition process. After recognizing authorized user it gives the access to smart mirror for further use. In any case if the system not recognize the face it will not give permission to use the smart mirror and only serves as a ordinary mirror. if user is authorized the user can either hand gesture or voice commands as input to retrieve the corresponding results. The camera and microphone that connected to the smart mirror used for access input. Distance between the person and the camera should be less than 240 cm. . LBP based Face recognition system is used which uses Python and OpenCV.

#### 4.1 Local Binary pattern(LBP)

The captured image will undergo image processing for face recognition, Local Binary Pattern(LBP) has been implemented using Python and OpenCV. face recognition considers both shape and texture information to represent face images based on Local Binary Patterns, steps involved in LBP algorithm are as follow:

- A. Crop face(using face detector) and align the face images in order.
- B. Convert all images into the same size.
- C. fix the dimension of the cell size where the LBP will be calculated.
- D. Run an LBP algorithm on the face images. Concatenate LBPs extracted from the image to form a unique face feature vector.
- E. The feature vector for each face image can be used to recognize the person in the face image. This feature vector forms an efficient representation of the face and is used to estimate similarities between images.

#### 4.2 Hand Gesture Recognition

Frames are inputted through the camera. Then, these frames are passed through pre-processing, hand detection and gesture recognition module. The preprocessing module is divided in to three different modules like median filter, skin color segmentation and morphological operation. Median filter is used to reduce the noise from the video frame. Skin color segmentation is used to segment the skin region from the frame and by using the morphology operation the imperfection can be reduced from the binary skin segmented frame. The hand detection module is divided in to two other module like region of interest and finger counting algorithm. The hand is detected using the region of interest module and the fingers are counted using the finger counting algorithm. Apart from these, the gestures which are possessed by hand, are recognized by gesture recognition module.

#### 4.3 Python

All programs and codes are developed in Python. Python's design philosophy emphasizes code readability with its notable use of significant whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed and garbage-collected. It supports multiple programming paradigms, including structured (particularly, procedural), object-oriented, and functional programming. Python is often described as a "batteries included" language due to its comprehensive standard library. Python was created in the late 1980s, and first released in 1991, by Guido van Rossum as a successor to the ABC programming language. Python 2.0, released in 2000, introduced new features, such as list comprehensions, and a garbage collection system with reference counting, and was discontinued with version 2.7 in 2020. Python 3.0, released in 2008, was a major revision of the language that is not completely backward-compatible and much Python 2 code does not run unmodified on Python 3. With Python 2's end-of-life, only Python 3.6.x and later are supported, with older versions still supporting e.g. Windows 7 (and old installers not restricted to 64-bit Windows).

#### 4.4 Design specification

The camera placed in the smart mirror will capture user image and scan the face using face recognition. If the user is authorized then it will give access to smart mirror. If the person is not an authorized user then the smart mirror can only use as a normal mirror. After user can give input to smart mirror as form of voice command or hand gesture for visual and voice outputs. The events of user can schedule using an android application. News, weather, temperature, time are the outputs that displays on the smart mirror.

#### 4.5 Raspberry Pi

One of the core components of the Smart Mirror is the central computational device with which the display and the microphone interface. This central device is the Raspberry Pi 3B, a small single-board computer, which runs Python programs in the background on an installed Raspbian OS (Operating System). This displays location based weather forecast, the top five most trending news headlines and the date & time, which involves the use of different web based services such as weather and news tokens to extract information from the internet and display it to the user, in the form of widgets. In order to achieve this, the Raspberry Pi unit is connected to the Internet via a constituent Wi-Fi module in the Raspberry Pi. It also receives input from the connected microphone via an external USB sound card, which allows the user to perform various functions including web search, setting up of reminders and even engaging in two way conversations with the voice assistant, with the help of Google's voice assistant API.

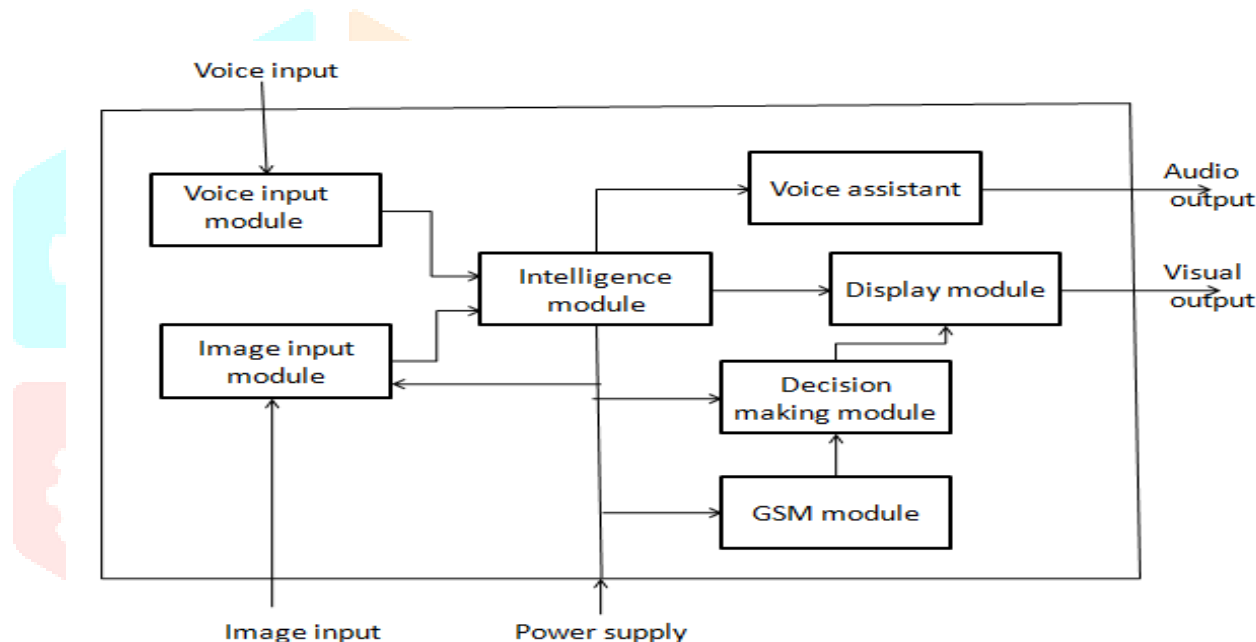


Figure 4.1 Architectural design of smart mirror

## V. CONCLUSION

The smart mirror is a conventional a mirror with technology inside it. It displaying valuable day-to-day information to the user and provide interactive emergency triggering technology while keeping the device usable for any age groups. Voice inputs and hand gestures also make the device easily usable. The face recognition technology that used in smart mirror ensure the security of the smart mirror by identifying and verifying the face of the user. The product extends its applications to various environments such as in hospitals, offices, retail shops and so on. Smart Mirror architectural designed with voice assistant, the device enables users to perform tasks like web searches, without the need of touch input.

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