

# Public Smart Mirror with Motion Detection

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**ABSTRACT:** Technology that we generally only see in movies is gradually but surely infiltrating the real world as a result of technical advancements. Nowadays, mirrors are a given at the majority of stores, both within malls and outside. Since there is typically no way to view the outside when we are inside a mall, we can quickly lose track of time. Inside apparel stores and malls, eye-level advertising displays are commonplace. Our public smart mirror can help in this situation. They may use it as a mirror and an advertisement display thanks to the proximity detection and various display screens. Everyone has access to the information that is stored in the device thanks to voice control and motion detection for gesture recognition. Playback of multimedia is possible via speakers. In order to assure the smooth operation of the Raspberry Pi by lowering its working load, an Arduino card is utilised in conjunction with it.

**KEYWORD:** Mirrors, Advertising displays, Voice control, Motion detection, Raspberry pi, Arduino

## I. INTRODUCTION

Technology is evolving at such a rapid rate in our environment that we are unable to keep up with it. People used water collected in vessels or dark, still pools of water as reflective surfaces for mirrors in earlier times. They began utilizing metal polished discs during the Bronze Age. After the first century CE, glass became the material of choice. After the industrial revolution, mirrors as we know them now were developed. Since everything is getting digital in the twenty-first century, the mirror will soon follow suit. The current crop of smart mirrors is mostly intended for indoor use. Imagine using them outside for ads and other such duties. Nowadays most shops, both in malls and outside, is bound to have mirrors in them. When we go into a mall, we lose track of time easily since mostly, there is no way to see the outside. We all see advertisement displays on eye level inside clothing shops and malls. This is where the smart mirror comes in.

With the multiple display screens and proximity detection, they can use it both as a mirror and an advertisement display. Most public places like public transport stations use multiple devices for displaying time, time schedule, etc and mirrors are only found in restrooms. With the introduction of smart mirror, all these tasks can be incorporated into a single device. The main goal is to offer an interactive device that can display numerous pieces of information on a single screen. The main target are public places (display of data like ads, news, etc. to the general public while also working as a mirror).

## II. RELATED WORKS

We were able to obtain a lot of journals and publications on the topic of smart mirror to refer and help us in creating our system. Almost all of the works published includes personalized mirrors that use personal assistants, face detection, etc. Some of the works we referenced are given below.

Smart Mirror: A Reflective Interface to Maximize Productivity [1]:-

The design and development of a smart mirror, which serves as an elegant interface for numerous users to glance at the information in a household setting, are shown in this study. The user is located via authentication based on face recognition. To access data streams and other services, it offers a webpage-based interface. The data feeds retrieve data packets made available through various APIs provided by websites using web service-based communication. A Raspberry Pi 3, a webcam for face identification, and an LCD panel positioned behind the mirror to show the interface handles all the computing necessary for this project. The Raspberry Pi 3 computer serves as the Smart Mirror CPU. This is where each piece of software would be located. The CPU receives video data from the camera, processes it using a facial recognition model, and then determines who the user is. The CPU would retrieve the information intended to display for that user once it recognizes the person in front of it. The linked LCD Screen receives a projection of this information from the CPU. On top of Raspbian, the Smart Mirror is designed to boot. To accomplish this, they altered the Raspbian boot process because Smart Mirror launches right away after booting.

Smart Mirror for Smart Life [2]:-

As a means of communication between users and systems, the system uses Sonus technology. Therefore, in order to receive a response from the system, users must speak their instructions to it. The evolutionary prototyping method is the one employed in this project as it quickly gathers all requirements and creates the system. To assess and provide feedback, a prototype is created. To better the prototype and satisfy users, improvements will be done. A VUI (Voice User Interface) can be rapidly and easily added to any hardware or software project using the Sonus speech-to-text toolkit. Sonus can always offer an offline listening feature for a bespoke hotword, much like Alexa, Google Now, and Series. Once a hotword has been identified, it will stream to the user's cloud-based speech recognition service, after which the findings will be obtained. With the help of the Smart Mirror system, users may easily manage their everyday tasks as well as find solutions to several management issues with regard to some housework. The new technology for a smart existence is the application. According to the testing results, the most of the application's features work as intended, but there is still room for improvement in the creation of the newest features for smart mirrors.

An Interactive Smart Mirror Based On IoT Platform [3]:-

In order to eliminate the necessity for the user to memorise any commands in order to use the mirror, the prototype they constructed primarily focused on natural language understanding. It makes using the mirror simple for the user. They were able to complete their project's objective thanks to the voice and speech recognition system. The second area they concentrated on was their user interface (GUI), which might be compared to many online DIY projects. Only a few icons, like those for the weather, holidays, date, time, news, and compliments, were added to the screen. The primary precaution they needed to take was to make sure their internet connection was strong because the user's request for information would need them to retrieve it from the internet, process it, and then provide it to the user.

Novel Approach of Designing of a Smart Mirror using Raspberry Pi [4]:-

Smart Mirror with artificial intelligence is presented in this article for both residential and commercial applications across a variety of industries. The Raspberry Pi is used to handle the project that would gather actual machine data that would be communicated from the unit. One of the most fundamental common amenities is provided by the Smart Mirror includes local weather information, the most recent updates to news and headlines, and local time that is appropriate for the location. Therefore, the Smart Mirror communicates with the user through spoken commands, performs, and listens to the user's inquiry and appropriately responds. The process entails downloading the Debian-based Raspbian operating system, extracting the image to an SD card, and then installing the card in the Raspberry Pi's SD slot and carrying out the necessary actions. They intended to deliver a functional prototype, i.e., the design and

construction of a futuristic Smart Mirror on a Raspberry Pi 3, for both residential and commercial applications across a range of industries. The idea of a smart mirror that you can interact with appeals to most people as they all have mirrors in their homes. There are times when no one has the time to read the newspaper or turn on the TV in the morning to check the news or the weather. If a mirror is used for this, one can only think how much time it will save and how useful it will be. The contraption was designed to resemble a typical mirror but would be equipped with a screen. The project that would gather actual machine data, like location-based news and headlines, weather reports, and would also display the current local time. The information would be transferred from the device and kept in a centralised database. The prototype offers a flexible framework that may be used to give the user even more capabilities.

#### Smart Mirror [5]:-

The Raspberry Pi would control the project that would use the data to display on the mirror. One of the most fundamental amenities is provided by the smart mirror, which is a customised digital device equipped with Raspberry Pi, microphone, speakers, LED monitor, webcam, and peripherals like microphones and LED screens, as well as the most recent updates in news and headlines and local time that corresponds to the location and schedules using face recognition. Three components make up the bulk of the Smart Mirror system: a two-way mirror, an LCD screen, and a Raspberry Pi. A two-way mirror is one that is transparent on one side and reflected on the other. Behind the glass side will be a webcam that can collect and recognise faces for security purposes. Different widgets are displayed on the mirror using the LCD monitor. The Raspberry Pi will be connected to the LCD monitor. Python programming will be done on the Raspberry Pi for a variety of widgets. Using a voice command like "Hello Mirror!" or "Good morning mirror," the Smart mirror can be turned on. The Smart Mirror will respond in text and voice, for example, by wishing the user a good day or offering a praise. For these purposes, the system will employ a microphone and speaker that are compatible with it. The procedure will begin with programming for the display of images that will be shown on an LCD monitor, and when the Smart Mirror is turned on using the keyword, the user will be able to see those widgets on the mirror. The Smart mirror will also provide some basic personal information when a user's face is recognised.

#### Smart Mirror for Home and Work Environment [6]:-

This study aims to give users more information without requiring them to do additional effort to obtain it; it is also where the concept of the smart mirror first appeared. However, this interactive mirror enables users to swiftly and comfortably access data using speech and other devices. Modern appliances demand input through a keyboard or touch screen interface, which requires no effort to access information. The smart mirror has a one-way mirror on top and is equipped with speakers, a microphone, an LED monitor, a camera, and LED lights. This interactive mirror offers certain standard features by default, such as the time, news headlines, and the weather, as well as some more sophisticated features, such a monitoring system that connects directly to smartphones and supports all smartphone features. The smart mirror has been suggested as a way for users to quickly access information in a convenient and time-saving setting. One of the interesting features of this smart mirror is the monitoring system for the user's home or workplace, which enables them to monitor their place from smartphones or other devices while they are not physically present. The futuristic smart mirror display is provided by a flat LED monitor, external lights that enable user to be more focused on their looks, and one of the interesting features of this smart mirror is the monitoring system for user's work place. The functionality of a smartphone are also included in this smart mirror, which offers news, a calendar, emails, weather data, and the ability to replay audio and video.

#### Design Of Smart Display Using Raspberry Pi [7]:-

This paper describes the Raspberry Pi-based smart mirror implementation. A smart mirror may show the time, date, weather, and clouds. Because we no longer need to look at our phones every time we want to check the time or the weather, utilizing a smart mirror has several advantages. We frequently check the mirror and the internet to see how we appear and how we are dressed. The interactive mirror was created with the appropriate embedded intelligence to provide features like the local time that corresponds to a location, the current news, and headlines, and the city's weather They chose and displayed a smart mirror that offers the customer a thoroughly modern experience. Their approach makes use of a Raspberry Pi-based CPU board, a mirror-equipped display, IOT-based circuitry, and various sensor interfaces. To build the exterior frame, they employ a panel that has been meticulously modeled. The system is then enclosed in customized glass with a rear frame. The Raspberry Pi, two-way mirror, acrylic glass, LED monitor,

and motion sensor are the components of their suggested smart mirror. A mini computer called Raspberry Pi 3 B+. The Raspbian operating system is utilized. The Raspberry Pi and all the sensors will be prepared in a wooden frame with LEDs affixed behind the glass. The Raspberry Pi is connected to a power supply, which will run the sensors and LED monitor. According to the block design, it would gather individualized data such as the date, local time that corresponds to the location, the weather in the area, the most recent news and headline updates, and the date. Internet access is necessary for this operation, and the Raspberry Pi's Wi-Fi module will provide it. The smart mirror is capable of displaying basic information, i.e. time, date, and weather. Our system includes a voice assistant, Spotify module, etc. The voice assistant makes the mirror more interactive, and the to-do list and calendar helps us to keep track of the upcoming events and unfinished tasks, respectively, while we are getting ready in front of the mirror. Thus, helping us be more efficient with our time.

#### Smart Mirror Using Raspberry Pi [8]:-

This smart mirror will serve as our personal digital assistant, giving us reminders for our daily to-do lists, appointments, and meetings as well as helping us keep track of important dates and upcoming events. It will also provide us with news and updates on the weather forecast and news, while also keeping an eye on our investments in the stock market and keeping us up to date on current events taking place around the world. The implementation of the smart mirror makes use of accessories like the Raspberry Pi and an LED display coated in two-way acrylic sheets. The Raspberry Pi's microcontroller connects to the internet and can retrieve data from it, allowing us to show all of the items described above. The suggested smart mirror seeks to show daily updates and offer customizable information. Raspberry Pi, a two-way mirror, and a monitor are used to construct the smart mirror. The two-way mirror is covered in acrylic sheets so that it can function as a mirror and two-way glass. On one side of the mirror, the monitor is fastened. When the monitor is off, the display functions as a typical mirror. When the monitor is turned ON, it serves as a mirror and displays the data at the same time. The Raspberry Pi 3, which is connected to the monitor through an HDMI, runs the display. AUX ports, which are present on both speakers and the raspberry pi, are used to connect the speakers with the latter device. The Bluetooth – equipped wireless USB device is used to communicate between the raspberry module and the wireless keyboard. Wi-Fi allows Raspberry to connect to the internet, allowing a smart mirror to access the data it needs to function. The primary input device, a wireless keyboard, is connected to the raspberry pi's USB connection through a wireless connector. The USB port and keyboard are Bluetooth-connected to one another, allowing users to use the keyboard up to 100 meters away from a mirror. A user can access the command they require in the mirror using the keyboard. If the user selects one of the options, such as knowing the weather outside, the raspberry will use the internet to communicate and the speaker will do its function.

#### IOT Based Smart Mirror [9]:-

Their proposed system uses a Raspberry Pi 3 to create and implement an interactive smart mirror. Numerous devices are already entering the market based on this technology, and with its intelligence, it is delivering cozy, secure, and practical personal services everywhere. The project's goal is to provide a smart system for users that shows essential information such as the date, time, news, and weather. The Smart Mirror is made up of numerous components that execute tasks better than the traditional Two-way mirror. The Raspberry Pi switches to the Raspbian operating system whenever the mirror is powered on. It immediately shows the fundamental modules of the time for the relevant place, the date, and compliments depending on the time. The device also shows the current weather prediction and the temperature that a human body can feel for the specified city. This system includes both the fundamental and cutting-edge components, all of which are combined onto a single display panel. It contains a weekly weather forecast module that shows the week's worth of weather conditions. To display the weather for a specific city, however, the user needs to register on the open weather website and supply the API (Application Programming Interface) key and location ID. A calendar containing Indian holidays is also included. The LED display is placed at the reflective side of the two-way mirror, which is facing the non-reflective side of the arrangement toward the front. The Raspberry Pi, which serves as the setup's CPU, is connected to the power source through a cable in order to power each component. In order to access the Internet, which is used to update information every minute, Raspberry Pi is also connected to Ethernet and Wi-Fi. Raspbian OS must be installed and dumped onto an SD card before being put into a Raspberry Pi for use. To protect it, the entire arrangement is mounted inside a wooden frame.

#### Design And Fabrication Of Smart Mirror [10]:-

In order to create household goods and save a lot of time, this project was created. The “Smart Mirror” is the name of the device that has been studied and created. It is a wall-mounted mirror that shows the user information that is relevant to them, like the weather, time, and date, Smart mirrors are committed to offering the greatest user experiences for information retrieval and interactive spoken communication with the mirror when self-grooming. They are renowned for information exchange, but they may also be connected to a larger system to provide consumers with higher expertise, including news change, home security, home automation, intrusion detection, medical utilization, and much more. They used an arduino board. It is an open-source electronic device that can read inputs (such as light on a sensor, a user’s finger on a button, or a tweet) and then generate output based on those inputs (such as turning on an LED or activating a motor). Unlike the Raspberry Pi, which is a full computer with its own operating system, Arduino boards are microcontrollers. They merely run C/C++ code that is already included in their firmware. An open-source program called the Arduino Integrated Development Environment (IDE) is used to create codes and upload them to Arduino boards. While Arduino boards do not support the internet, the Raspberry Pi does. When compared to the Raspberry Pi, it has far less processing capability. The above-mentioned system uses thermal sensors to show room temperature, GPS hardware to fetch longitude and latitude and the display space is poorly utilized and the appearance is not aesthetic.

The above mentioned mirrors are ideal for personal use, but when it comes to the case of use for the general public, it’s a whole different matter. Cameras, the need for an input device, fetching and storing personal data, etc cannot be done for a system intended for public use. Hence cannot personalize it according to the preference of every single person who approaches it on a single day. Instead we need a generalized approach. So that information that are approached commonly by all is to be used.

### III. METHODOLOGY

The proposed system is a smart mirror that is intended for public use. It is constructed and implemented similar to the personalized ones, except the entire concept of personalization is removed. Voice commands and motion detection replaces the assistant, and only information needed to the general public is displayed on the screens. In other words, no personal data on anyone is required.

The hardware requirements include:

1. Monitor
2. Raspberry Pi
3. Microphone
4. Speaker
5. HDMI-VGA Converter
6. USB Charger
7. DAC (Audio Adapter)
8. PIR (Passive Infrared) Sensor
9. Ultrasonic Distance Sensor

The software requirements include :

1. Raspbian OS (Raspberry PI OS) or Debian Os
2. Balena Etcher
3. VNC Viewer

The system architecture for the proposed system is shown below :-

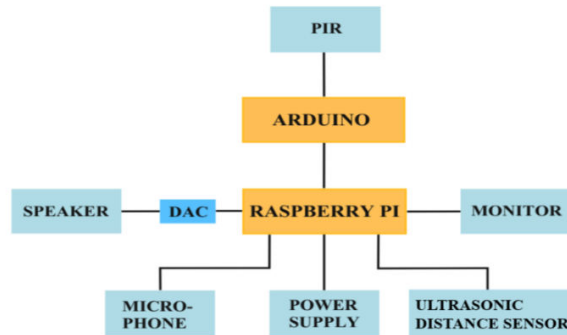


Figure 3.1 : System Architecture

A USB charger is used to supply power to the Raspberry pi in the range of 5V and the power supply ensures that the display panel gets 12 V current. The Arduino is connected to the Raspberry Pi via GPIO. The DAC (Digital Audio Converter) is connected on the Raspberry Pi for voice input and sound output from the microphone and speaker respectively. They are connected to a 5V power supply with the help of a charger. The charger is then connected to the main power source or outlet. An HDMI cable is used to connect the Raspberry pi and the display panel using a VGA-HDMI converter. Then check if all the components are connected appropriately. Then, all the components are neatly arranged in the circuit. All of these are then enclosed in an aluminium alloy frame casing (box) with a glass covering on the back. The PIR sensor is interfaced with the Arduino, since it will be controlling the input and output from the PIR sensor and doing the motion detection. The Ultrasonic distance sensor works as a proximity sensor.

The internal contents include a mirror software which is needed to run the mirror software. The raspberry pi operating system is flashed onto an SD card using the Balena etcher tool after the SD card is formatted using an SD card formatting tool. The codes of the required modules are added to the config.json file and then installed via the terminal using npm commands. Python is the language used to implement the coding within the raspberry pi. The ultrasonic distance sensor acts as a proximity sensor for the sleep-wake cycle to work. It is connected directly to the raspberry pi. The distance value that is output by the sensor is used to determine whether to wake or sleep. The next sensor used is the PIR sensor. It sense the heat (thermal) of the object in front of it to detect motion. It is connected to Arduino. The sensor outputs LOW when no motion is detected and HIGH when a motion is detected. This data is used to incorporate the page changing feature. Since our system has more than one display page, a way to change it without having to wait for it to change automatically, without the need of an external input device is required. This is where the PIR sensors come in. Two PIR sensors placed at an inclined angle such that a small area in front of the mirror will not be detected. When the person waves their hand to the direction they want to move the pages, the sensor on that side will detect motion and the output will be sent to Arduino. The Arduino processes the output from the sensor and sends a message to raspberry pi. Once the raspberry pi receives the message, it will check the contents and depending on the data in the message, the window will be changed.

As for the voice commands, a microphone is used for voice input and a speaker for sound output from the smart mirror. A trained voice model is used to detect the keywords from the user’s voice input and act accordingly on the mirror.

#### IV. EXPERIMENTAL RESULTS

We observed that the mirror was working properly as intended. The ultrasonic distance detector wakes the display and turns it off according to the distance of the person in front of it. The mirror flawlessly displays data on multiple pages. One of the problems we faced was with interfacing the Arduino with raspberry pi, connecting the sensors and processing the input. Assigning ports had to be done carefully. The speakers output the sound of the video successfully. The PIR sensor recognizing motion successfully was the one thing we were worried would not work since

it had a wide motion sensing region. The PIR sensor had to be placed in such a way that both will not detect the motion when a person in front waves the hand.

## V. CONCLUSION

In conclusion, our project successfully demonstrated the working of a smart mirror intended for public use, It can successfully display the basic data, like time, date, weather, etc and show advertisements and other content on the other pages and act successfully as a mirror when no one is in front of the mirror within a certain distance. We also arrived at the conclusion that the Raspberry Pi OS is the best operating system to work with the raspberry pi out of all the other operating systems out there.

Our project can be further developed by adding more features that are public friendly, i.e., does not use or need personal data and a database. The display size and quality can be changed by using better display panels. The thickness can be reduced by using thinner displays, which are expensive.

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