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# Smart Mirror Using Raspberry PI: A Review

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**Abstract:** *A Smart mirror is a mirror with technology integrated with it. It uses a two-way mirror and has an inbuilt display at the back showing us different information in the form of widgets about the date, time, temperature, daily news updates. The Raspberry Pi acts as the central controller, which powers the display and collects data through sensors. The data collected is stored on cloud servers for further use. The mirror comes with facial recognition technology, which helps authenticate the user every time the user comes in the mirror range. With the help of voice commands, the mirror application can be queried to get the desired data. This automation has helped in multitasking which strives to optimize time in our daily life. In this manuscript we will review different applications of smart mirror.*

**Keywords:** Smart Devices, Smart Mirror, Raspberry Pi, IoT, Cloud, Intrusion Detection, Posture Analyzing, Automation.

## I. INTRODUCTION

In today's time, technological advancement has contributed elevating human living standards as well as saving people's time and effort. When the cellphone was invented its whole purpose was to connect people so they could communicate over a distance. At present, if we consider cell phones, they've become smart. People take more interest in its smart features rather than just communication. Likely something as simple as a mirror can be integrated with technology to take its purpose to another level. People often look at themselves in the mirror throughout the day may it be for brushing teeth, grooming or just commending themselves for their looks. So how about we get to know about the news or social media updates or the weather forecast while we do one of those activities? Yes! The Smart Mirror makes it possible to get all these services while we stand in front of the mirror. With the help of various APIs, data can be fetched from the web and displayed on the screen. The smart mirror can be programmed to provide more complex services like Home Automation, Intrusion Detection, Posture Analysing. The smart mirror is powered by a Raspberry Pi. We can interface various sensors and devices to the Raspberry Pi and data can be collected and stored on the cloud for further use. To implement various modules in the smart mirror an open-source web application called MagicMirror² is used. MagicMirror² is an open-source modular smart mirror platform. The software provides us with the basic smart mirror GUI application. The software allows third-party modules, i.e. we can code our modules for the smart mirror and upload it on their site which can be used by many other people. MagicMirror² focuses on a modular plugin system and uses Electron as an application wrapper. So no more web server or browser installs are necessary. We just need to install MagicMirror² on our Raspberry Pi and then add the required modules from their site and we are good to go. Smart mirrors in the market have a hefty price. Smart mirrors can be made with RaspberryPi. They are not only affordable but also more customisable. New modules can be added to suit our needs. A mobile application can be developed to enable/disable the modules and customize the screen effectively. Step by Step guides to build and configure a smart mirror are available on the internet.

## II. DESIGN OF SMART MIRROR

1. Two-way Mirror (Acrylic mirror)
2. LED Display
3. Raspberry Pi: Raspberry Pi acts as the control sys- tem for the mirror. It provides all the facilities of a morden day computer but in a cheaper price, hence it is beneficial for building smart mirror. It comes in

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2,4,8 GB RAM options with a 40 pin GPIO header for connenting Various components such as Sensors, Camera, Michrophone etc.

4. Sensosr: For motion detection, sensors such as PIRSensor or IR Sensor can be used to detect motion.
5. PiCamera
6. Frame

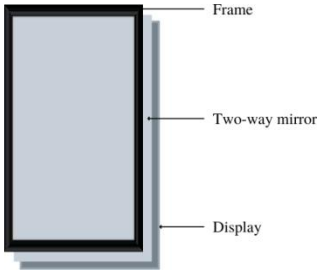


**Figure 1:** Smart Mirror

## III. System Architecture And Components

In the 21st Century, everything is getting automated, all devices are getting smarter. SMART Devices add more flexibility to our life. The main functionality of this systemis to make the normal mirror smarter, ie to add special features like facial recognition and other multimedia-related features. The smart mirror is a Raspberry Pi-based system that connects to the internet and collects data from node devices and uploads it to the cloud. The architecture is as follows:

1. Data collection and storage unit (Internet)
2. Data processing unit (Raspberry Pi, Sensors)
3. Data Visualization unit (Smart Mirror)

### 3.1 Data Collection and Storage Unit

Data collection and storage refers to acquiring and systematically keeping data in response to a given purpose. Similarly the smart mirror stores data on Cloud Storage with the help of the Internet. Many Frameworks such as AWS (Amazon Web Services) can be used for connecting the mirror to the cloud. When the smart mirror performs any operation like face recognition or accepting voice commands it uses Web Services to collect the data for the particular query fired. Saving all the data on a Local Computer (Raspberry Pi) can be more complex hence it is easier to store the data collected on a cloud storage unit.

### 3.2 Data Processing Unit

Raspberry Pi is a small, low-powered, Single-board mini- computer that is used to run the OS for the smart mirror.The key factor of using a Raspberry Pi is that it offers good performance at a cheaper price. It comes in 2GB to 8GB Ram variants which are sufficient for running the Operating system as well as the Camera and other IoT components.All these components can be made interactive using python scripts.

### 3.3 Data Visualization Unit

Data visualization means visual representation of data. This proposed model uses a two-way mirror which enablesus to watch our reflection and the screen at the same time.The display is powered by Raspberry Pi 4 which supportsup to 4k resolution. The position of all widgets (temperature, Time, Calendar, Songs, etc) can be controlled accordingto the user which helps in better Data visualization. We can also add different pages/screens in the mirror withthe help of NodeJS Framework, with which we can createa user-friendly UI that helps in presenting data in a better way.

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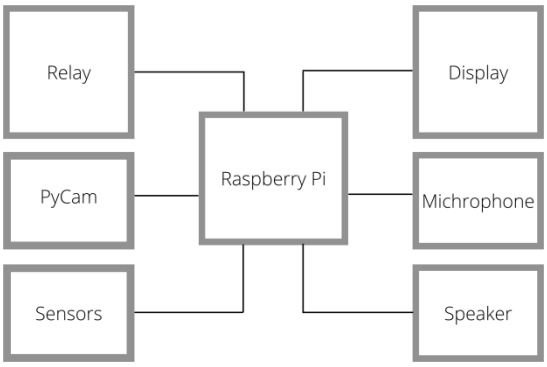


**Figure 2:** Smart Mirror Components

## IV. LITERATURE REVIEW

### 4.1 Smart Mirror: A Novel Framework for Interactive Display

Smart mirrors offer a digital display behind the glass and they have connectivity options such as Bluetooth or WiFi. We can typically get information such as the date and time, daily news, weather forecasts, and traffic reports with onlyjust a voice command. Also, we can stream videos. These mirrors are extensively used in different industries such as automotive, healthcare, retail, residential, and others. In the automotive sector, smart mirrors can also be used as rearview and side-view mirrors for safety purposes[2]. More and more devices are getting smarter by connecting to the internet and using IoT services. In the past few years, Home automation systems changed in many ways by adding a smart mirror tothe system. Smart mirrors can act as a control unit for the entire system, showing the status of all other components. It uses ZigBee Protocol for communication between the IoT devices since ZigBee is used for transmitting data over long distances thus giving could storage accessibility.

### 4.2 A Mobile-Programmable Smart Mirror for Ambient IoT Environments

Due to the ever-advancing technology, we have seen an increase in smart devices in our daily life. IoT gave rise to connecting different embedded systems over the internet. The proposed smart mirror provides us with local news, weather updates and time. It allows us to create user profiles that are managed through a mobile application. It helpsus to customize the mirror settings without having conflict with other users settings. The mobile application is used to authenticate the user through credentials. Only then user profile will be initiated by the system. The application enables us to customize services as per need. The preview ofa mirror display can be monitored by the mobile application. Being able to manage users through an application increases intractability and performance.

### 4.3 Smart Mirror using Raspberry Pi as a Security and Vigilance System

Security systems with cameras need to be monitored by humans all the time. The absence of humans increasesthe risk of robberies and suspicious activities. Generally, intrusion detection based smart mirror using PIR sensors for detecting suspicious activities has proven to have false alarm rates. The detection range is also low. The proposed mirror is a Raspberry Pi based Smart Mirror designed forsecurity which overcomes the former issue. It also featuresan interactive system that displays weather information, news and temperature, all of which we can query using voice commands. Python programming is used along with the Yolo technique with OpenCV to detect intruders. Security cameras can be damaged easily, putting our houses at risk [10]. In the proposed system, the camera sits on top of the mirror. Also, the mirror appears ordinary making it difficult for the intruder to spot the camera. Whenever the intruder gets detected in the Picamera, the image gets captured along with the timestamp. The owner is alerted of the intrusion without the intruder's knowledge. The mirror settings can be monitored andconfigured using mobile devices. A mobile-based application has to be made to support mobile devices. The mirror also works on touch input. In future, a buzzer alarm can be added to alert neighbours of possible robberies. This IoT based vigilance system not only acts as an information source but also eliminates the need for sustained monitoring.

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### 4.4 Smart Mirror E-health Assistant – Posture Analyze Algorithm

A good posture improves blood flow, helps keep our nerves and blood vessels healthy, and supports your muscles. The proposed system is a smart mirror that analyses posture and detects health-related issues early on. It provides face recognition authentication for better user experience and data corrections and updates with minimal user interactions at minimal levels [4]. Some of the daily used applications like current time, daily news, weather reports can be queried using voice commands. We can also set alarms and to-do lists or get our emails read by the assistant. The Posture Analyzing Model can detect people's health problems or bodychanges by in-depth analysis and comparison of the images of the individual from the database. It visually guides the individual on how to position their posture correctly. Based on posture, it diagnoses the user with health issues and allows them to schedule an appointment with a health specialist directly using the mirror features[4]. The Posture Analyzing Algorithm requires that the user reflection is within the marked area of the mirror and that the posture points matchthe position of the balance points. The algorithm is designedin such a way that it keeps track of our health progress and constantly updates us on health advice. The algorithm requires the fulfilment of predefined criteria in order to proceed with the evaluation of the results. Once the criteria are satisfied, the camera integrated with the mirror captures the upper body image and compares it with the database of misaligned images. In this way analysis of posture is done. The mirror notifies the user if the alignment is incorrect.

### 4.5 Home Automation Using Smart Mirror

This paper states how a smart mirror based on RaspberryPi can automate home appliances. Like the majority of smart mirrors, it displays the date and time and weather reports.As a result, we can easily plan our day to day travel[8]. This smart mirror technology is powered using firebase cloud services. It authenticates the user using a fingerprint scanner. Instead of connecting all appliances and sensors to the RaspberryPi, some slave microcontrollers are used with relay modules. The slaves feed data collected from sensors and home appliances to the firebase. Then, the data fetched from firebase is displayed accordingly on the mirrorby the RaspberryPi. The house lights can be controlled by querying voice commands through our mobile phones. The home control module carries out its execution. Similarly, the Music System can be controlled by the Music System Control module. It also has a fire alarm system. Whenever the sensor reads a temperature rise, the user gets a notification of the same. The proposed system also has a Whatsapp Bot created, which is an alternate way to query commands. Hence, we can easily control the home appliances from the mobile.

## V. PRICE ANALYSIS

| Name | Price |
|---|---|
| 3D Fitness Tracker | 1,04,700 |
| Avita Imago 1M100 | 59,999 |
| Nuovotec Smart mirror | 39,999 |
| Perseus Smart Mirror | 33,700 |
| Kohler Smart Mirror | 22,000 |
| RaspberryPi based Smart Mirrors | 20,000+ |

### 5.1 Nuovotec Smart Mirror

The Mirror runs on Android OS thus having the benefit of controlling the mirror remotely from its mobile app. It shows the Date and Time, Weather, News updates and it has a non- touch display.

### 5.2 Avita IMAGO 1M100

This mirror also runs on the Andriod platform that has an HD display with a touch screen, Interactive applications. Comes in various designs. It also has an automatic sleep function which puts the mirror in sleep mode if not interacted within 45 secs.

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### 5.3 Perseus Smart Mirror

The Perseus smart mirror has the option of using a customized OS. This gives the user flexibility for deploying the mirror in different fields.

### 5.4 3D Fitness Tracker

The most expensive mirror of all, this touch-enabled smart mirror is a full-size body mirror that analysis the posture ofour body. This mirror is widely used in performing yoga and other exercises.

### 5.5 Kohler Smart Mirror

This smart mirror is ideal for installing where there is arisk of water damage. Since it is waterproof it is more reliable for industrial work. It also has anti-fog and voice command features.

### 5.6 RaspberryPi based Smart Mirrors

The most basic RaspberryPi based smart mirror can bemade for around 15,000 - 20,000 Rupees, considering we do not have any components to build one. Owning an old display and RaspberyPi beforehand cuts down the cost almost by half. We can add as many modules as we want from open source to get the desired services. We can make it a DIY project if the cost isn't an issue. The table mentioned shows that the smart mirrors made with RaspberryPi are comparatively cheaper as well as modular.

## VI. Advantages and Disadvantages

### 6.1 Advantages

1. Interactive and easy to use.
2. It is a DIY project, since, components are quite afford- able compared to the smart mirrors found in the market and we can add as many modules we want to get the desired service.
3. Maximizing home security with minimal human inter- vention
4. We can also use smart mirror as a control unit to manageall of our home devices from one place securely.
5. Without opening apps it can display useful information at once. On the display we can get information News, Weather Forecast, Date and time, traffic report by just querying voice command.
6. Posture analysing algorithm keeps track of our posture and suggests us the necessary steps needed to correct our posture promoting healthy lifestyle.

### 6.2 Disadvantages

1. Fixed position, little to no mobility depending on size.
2. They always need to be connected to the internet, if itloses connection it would unable to fetch and update data and all systems would fail. Security systems would get compromised.
3. RaspberryPi is a micro-controller with confined resources and execution. Services might get delayed if load increases.

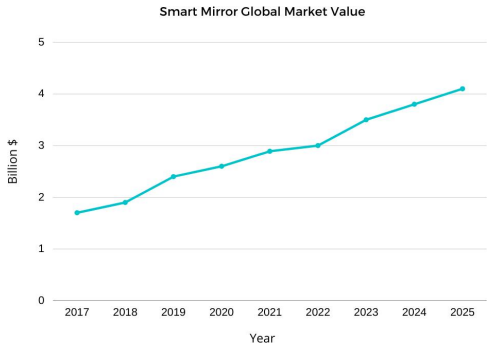


**Figure 3:** Global Market Value

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## VII. Future Scope

In the year 2017, the global smart mirror market was valuedat $1.75 Billion and is projected to reach $4.52 billion by 2025, with a growth rate of 11.5% from 2018 to 2025. More and more industries have started using smart mirrors cause it offers advanced technology embedded with sensors, cameras, displays, etc. The concept of IoT is getting recognized day by day by many people, as each device now comes with Internet or Bluetooth connectivity options. Because of this, there will be a vast increase in the smart mirror market globally.

## VIII. Conclusions

Smart mirrors have great potential, and we are likely to see them more in future due to the need for automation, security and ease of use. People have become busy due to the dynamic lifestyle; the addition of such a device would help optimize time and save effort. RaspberryPi based smart mirrors aresomewhat cheaper to build compared to the smart mirrors in the market. Their modularity is what enables us to get services customized. Through a mobile application, we can easily manage users and services. With the improvisation ofAI and the IoT field, there will be increased possibilities for new features in the future. In this manuscript, we discussedthe design and architecture of smart mirrors and reviewedtheir various uses and scopes.

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