https://doi.org/10.46335/IJIES.2025.10.4.6 **e-ISSN: 2456-3463**
Vol. 10, No. 4, 2025, PP. 26-29

International Journal of Innovations in Engineering and Science, www.ijies.net

Smart Mirror Using Raspberry Pi

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Received on*: 14 March, 2025* ***Revised on****: 18 April,2025* ***Published on****: 22 April,2025*

Abstract *– This paper introduces an innovative Smart Mirror system using a Raspberry Pi, designed to enhance daily routines by integrating technology into a familiar household fixture. Smart Mirror serves as both a reflective surface and a dynamic information display, providing real-time updates on weather, time, calendar events, and news. Powered by a Raspberry Pi, this system incorporates a two-way mirror, an LCD screen, and open-source software like MagicMirror² for customizable functionality. It also explores features such as voice control, facial recognition, and IoT integration to deliver a personalized, hands-free user experience. This project demonstrates how affordable components and open-source platforms can create a user-friendly smart home device that is scalable, energy-efficient, and versatile for various smart living applications.*

Keywords*- Internet of Things (IoT), Smart Mirror, Magic Mirror, Home Automation, Human Computer Interaction.*

I. INTRODUCTION

In today's fast-paced world, blending technology with everyday objects has become essential, leading to the creation of smart devices that enhance convenience and efficiency. Among these innovations is the Smart Mirror a striking device that combines the traditional mirror's functionality with a digital information display. It not only reflects your image but also offers real-time updates on time, weather, news, calendar events, and personalized reminders, transforming daily routines into seamless experiences.

Thanks to advancements in the Internet of Things (IoT) and embedded systems, creating such intelligent devices is increasingly affordable. The Raspberry Pi stands out as the ideal development platform due to its low cost, versatility, and robust processing power. This compact computer serves as the brain of the Smart Mirror, managing data retrieval and user interaction with ease.

In this project, we present a Smart Mirror system powered by Raspberry Pi, featuring a two-way mirror over an LCD monitor that displays digital content while retaining reflection capabilities. Utilizing MagicMirror², an open-source platform, we offer a customizable array of information. Optional enhancements like voice commands, facial recognition, and IoT integration highlight the potential for personalization in smart homes.

Our research demonstrates how everyday objects can evolve into interactive smart devices, making the ordinary extraordinary. The Smart Mirror is a step towards smarter living environments, blending practicality, efficiency, and innovation to enhance the user's daily life.

2. LITERATURE REVIEW

As smart home technologies surge in popularity, researchers and developers are actively exploring innovative applications that seamlessly integrate everyday objects with computing systems to elevate user experiences. The Smart Mirror has emerged as a

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compelling concept, skilfully combining functionality with aesthetic appeal.

Numerous studies and projects have successfully implemented smart mirrors using various hardware and software configurations. For example, Lee et al. (2016) introduced an intelligent mirror system that displays personalized information such as weather, traffic, and schedules through facial recognition, showcasing the tremendous potential of smart mirrors to offer context-aware services.

Bharambe et al. (2018) developed a smart mirror prototype utilizing Raspberry Pi, demonstrating the advantages of open-source platforms like MagicMirror² for streamlined development and modularity. Their system efficiently presents the time, date, calendar events, and weather updates, establishing a robust model for everyday use.

Chaurasia and Verma (2019) enhanced their smart mirror project by incorporating voice recognition via Google Assistant APIs, enabling users to interact with the mirror through voice commands. This feature significantly improves user-friendliness and promotes hands-free operation, solidifying enhanced human-computer interaction.

Other researchers, such as Kumar and Sharma (2020), concentrated on integrating vital health monitoring features—like heart rate and temperature sensing—using sensors connected to the Raspberry Pi. Their smart mirror targets elderly care and health-conscious individuals, reinforcing its relevance in today's health-focused environment.

From a hardware perspective, the Raspberry Pi is the favored choice among researchers due to its cost-effectiveness, GPIO support, and broad compatibility with various sensors and displays. On the software front, MagicMirror² stands out as a leading solution, bolstered by an active developer community and a comprehensive array of plugins.

The existing literature clearly indicates that while many smart mirror systems have been developed, substantial opportunities remain for enhancing personalization, IoT integration, real-time data processing, and AI-driven features. This project will build upon these established frameworks to create a reliable and customizable Smart Mirror prototype that is perfectly suited for modern smart home environments.

3. PROPOSED METHODOLOGY

The Smart Mirror system is a sophisticated integration of both hardware and software components, designed primarily around the Raspberry Pi 4, a versatile and powerful single-board computer. The system begins with an HDMI monitor, which is connected to the Raspberry Pi and strategically positioned behind a two-way acrylic or glass mirror. This unique arrangement allows for a seamless blend of reflection and digital display, transforming any ordinary mirror into an interactive smart device.

To power the Raspberry Pi, a reliable 5V/3A adapter is used, ensuring that the system runs efficiently without interruptions. On the software side, the first step involves installing Raspberry Pi OS, which provides the necessary operating environment for the smart mirror. Following this, MagicMirror², a robust open-source modular platform, is configured to serve as the user interface for the smart mirror.

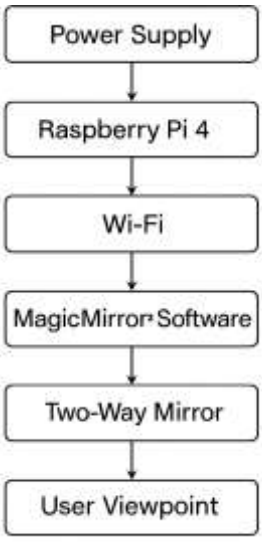

Figure 1 Block Diagram

The diagram of the project consists of Raspberry Pi 4.

Within MagicMirror², users can customize a variety of modules, such as a clock, weather forecast, news headlines, and calendar events. These modules are set up through the config.js file

4. IMPLEMENTATION METHEDOLOGY

4.1HARDWARE DESCRIPTION

A. Raspberry Pi 4 (Model B):

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The Raspberry Pi 4 Model B is a compact, affordable, and powerful single-board computer developed by the Raspberry Pi Foundation. Designed primarily for educational and development purposes, it has grown into a widely used platform for a variety of applications, including robotics, IoT devices, home automation, and smart systems like the Smart Mirror. It features a quad-core ARM Cortex-A72 processor clocked at 1.5 GHz, and is available in 2GB, 4GB, and 8GB RAM variants, allowing it to run a full Linux operating system and handle multitasking smoothly

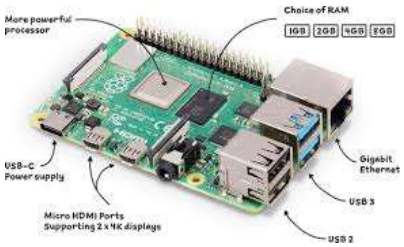

Figure 2 Raspberry Pi 4 (Model B)

B. HDMI Monitor / Display Screen:

The HDMI Monitor serves as the visual output unit for the Smart Mirror system. It is a standard LCD or LED screen that connects directly to the Raspberry Pi 4 via an HDMI cable. The monitor is mounted behind a two-way acrylic or glass mirror, allowing the graphical interface to be visible through the mirror while still functioning as a reflective surface. The monitor displays real-time information such as the clock, weather forecast, calendar events, news headlines, and other modular content generated by the MagicMirror software.

Figure 3 HDMI Monitor / Display Screen

C HDMI Monitor / Display Screen:

The two-way mirror is one of the most essential components of a Smart Mirror system. It is a specially coated transparent mirror that reflects light from one side while allowing light to pass through from the other. In the Smart Mirror setup, a monitor is placed behind this mirror, so users see both their own reflection and the digital content displayed on the screen.

Figure 3 HDMI Monitor / Display Screen

D. Power Supply Adapter:

The Power Supply Adapter is a crucial component in the Smart Mirror setup, responsible for delivering stable and sufficient power to the Raspberry Pi 4 and any connected peripherals. The Raspberry Pi 4 requires a dedicated 5V/3A (15W) power supply to function efficiently, especially when running graphic-intensive applications like MagicMirror² and using USB-connected devices such as cameras or microphones. The adapter typically comes with a USB-C connector, which plugs into the Raspberry Pi 4's power port. It is essential to use an official or high-quality power adapter to ensure voltage stability and prevent issues like boot failure, random restarts, or peripheral disconnection.

Figure 5 Power Supply Adapters

4.2 WEB SERVER

In the Smart Mirror system, a web server is essential for delivering and managing the dynamic content displayed on the mirror interface. The core software of the Smart Mirror, known as Magic Mirror, operates as a local web server on the Raspberry Pi. This server is responsible for generating the user interface and providing modular content such as weather updates, calendars, and news to the connected display. When the Raspberry Pi boots up, it automatically starts the MagicMirror² server, which hosts the application on a local port (typically localhost:8080).

5. RESULT AND OBSERVATIONS

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Figure 4 Connectivity of Hardware Components

Figure 6 shows the back of the Smart Mirror has a compact and organized hardware setup. An LCD screen is securely mounted at the center and connected to a display driver board that links to the Raspberry Pi 4 via HDMI. The Raspberry Pi is on the right side and powered by a 5V/3A adapter. All components are neatly arranged in a wooden frame with foam padding for insulation and protection, allowing for easy maintenance and proper airflow.

Figure 5 Display Front Interface

Figure 7 illustrates the front view of the Smart Mirror displays a clean and interactive interface powered by

MagicMirror². The screen shows essential modules such as the current date and time, a list of upcoming Indian holidays, and real-time weather updates including temperature, conditions, and forecasts. These elements appear clearly through the two-way mirror, creating the illusion that the information is floating on the mirror surface, while still allowing the user to see their reflection. The layout is minimalist and user-friendly, designed for both aesthetic appeal and functional utility.

Figure 6 Smart Mirror

CONCLUSION

The development of the Smart Mirror using Raspberry Pi is a brilliant example of how cutting-edge technology can transform everyday objects, enriching both their functionality and user experience. By seamlessly merging a reflective surface with a dynamic digital display powered by the Raspberry Pi 4 and MagicMirror² software, this innovative system provides real-time information—including the time, weather, calendar events, and news—in a striking and easy-to-navigate format. This project not only highlights the power of open-source tools and modular design but also embraces the exciting possibilities of the Internet of Things (IoT). The result is a compact, interactive, and user-friendly smart device that redefines convenience. With minimal hardware requirements and a versatile software platform, the smart mirror stands as an affordable solution that can be effortlessly customized or enhanced with features such as facial recognition, voice control, and personalized modules. In essence, the Smart Mirror project is not just a valuable learning journey into embedded systems and web development; it also opens the door to a world of practical applications for smart homes, commercial environments, and enhanced personal productivity.

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