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Intelligent Smart Mirror with Voice Recognition and Home Automation

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Abstract
The Project illustrates the design and development of a clever mirror that shows an exquisite interface for glimpsing data. Intelligent mirror, which continues the workings today, and will take its place in technology forthcoming, provides both mirror and computer-served information amenities to its users. "Smart Mirror System Development" includes weather, time, date, Google Assistant, and Home Automation. It utilizes Raspberry pi-3. Through its microphone, the smart mirror enables voice commands to operate certain devices. The smart mirror displays applications so that you can check the weather, local news, and so on while you're getting ready in the morning. This smart mirror would do smart thinking for the user. This smart mirror aims to reduce and possibly eliminate the need for the user to make time in their daily morning or night routines to check their pc, tablet, or smartphone for the users. The makings of this smart mirror include a microcontroller called Raspberry Pi3 which acts as a brain of the interactive system. The microcontroller would be powdered using Python scripts for mirror software as well as a personal assistant. After installing the software, the function can be accessed via a command line once it is set up. A 10-inch Display would be placed below an acrylic two-way mirror sheet and the model would be placed in an aluminum frame. We will build a separate personal assistant that will be able to recognize and perform speech-to-text operations. The personal assistant is named Jarvis. The project is extensive and AI plays a crucial role in today's world.
Keywords: *Voice Assistant, Bluetooth, Speaker, IoT, Raspberry pi-3, LCD, Home Automation.*

1. Introduction
In this world, everybody needs an at-ease life. Modern chaps have conceived technologies for their purpose. In today's world, people aspire to be linked and they are ready to admit the minutiae effortlessly. Whether it is through the box or the internet people aspire to be informed and in touch with the stream events happening around the world. The Internet of Things means interconnection via the Internet of tackling embedded in everyday objects, sanctioning them to cast and accept data. The Internet of Things with its growth extends its uses to the living surroundings of people by changing a home to a brilliant home. The smart home is a linked home that links all sorts of numerical devices to communicate with each other through the internet. Our lifestyle has evolved in such a way that optimizing time is the most crucial thing. Our work is grounded on the notion that we all gaze at the mirror when we go out, so why wouldn't the mirror become smart? A customary tact for edifying a clever mirror is to use a towering quality Two-way goblet, a 10-inch display, a wrinkle to grip the goblet and monitor, and a web browser with the notion of making a home smart to save time. The internet transformed our lives by connecting us more effortlessly to minutiae and other people in the numeral world. The state of innovation currently is to offer more records with led interaction to get them. The tackle that has been researched and designed is called "Smart Mirror". It is a wall-mounted mirror that shows relevant bits to the user such as weather, time, date, hotness, humidity, news, & Google Assistants' other fields of the internet.

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- **Problem Statement:** Traditional mirrors lack many functionalities and smart mirrors are dependent on simple information such as weather or news. Data leakage from smart home appliances presents a challenge today: security must be the prime need for devices like smart mirrors that might harbor sensitive data due to face scanning or voice recording. Smart mirrors do not favor people with disabilities and may lack the facility for customization also. This shall be represented by identifying the same shortcomings through a smart mirror designed for this time while having good safety measures on user's privacy. It shall look into functions far beyond the simple presentation of mere basic information and indeed probe into the "accessibility" and "user-centered" experience functionalities [1-6].
- **Motivation:** One strong wake-up call was when hackers broke into the cloud storage services of several smart mirror manufacturers in August 2023 and made public millions of users' recordings. This incident contains a lot of sensitive conversations and shows how vulnerable the data collected by such devices are. A smart mirror may deal with sensitive information like facial scanning and voice recording so data protection needs to be strict enough not to violate its users' privacy. One lesson from this episode is that this project should not compromise on data encryption and secure communication protocols to give a much better trust relationship among users and to minimize privacy risks.
- **Contribution:** Analyses user privacy concerns in smart mirrors and develops robust security measures. Develops advanced functionalities beyond basic information display seen in current models. Compares accessibility features and improves them for people with disabilities.
- **Organization of the Paper:** The work for the rest of the sections is as follows. It identifies the inadequacies in the current body of research and the need for a novel strategy. The Proposed Methodology section introduces the unique approach adopted in the building of the prototype. The result section depicts the prototype along with the user interface screens. Comparative analysis with traditional symmetric ciphers is presented in Performance Analysis. In the Conclusion section, the success of the proposed algorithm is mirrored, which in turn also points out future work and possible improvements. The references section lists all sources in citations used in the paper. functionalities. But perhaps the study did not discuss particular functionalities this platform can enable with smart mirrors, nor how the research addresses security issues associated with the more robust features it could introduce.

Table 1 Summary of Literature Survey

Author	Focus	Approach	Potential Applications
Cvetkos ka et al. [7]	E-health, posture analysis	Camera, posture analysis algorithm	Physical therapy
Yusri et al. [8]	Basic functionaliti es	Raspberry Pi, touch/ voice	Daily routines, info display
Gold et al. [9]s	Software platform (Smart Reflect)	Modular design	Diverse (customizabl e)
GomezCarmo n a et al. [10] pen_spa rk	Workplace wellness (SmiWork)	Personalize d interfaces	Corporate wellness programs
Rodriguez Martinez et al. [11]	Document distribution system	Web services & P2P	Content sharing, document collaboration
Hossain et al. [12]	Ambient home environment	Sensors, informatio n display	Content sharing, document collaboration

1.1. Tables

Cvetkoska et al. [7] proposed a smart mirror system for e-health, focusing on posture analysis, Table 1.

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Their approach is based on the camera of the smart mirror to evaluate a user's posture in real-time with a dedicated algorithm. It proposes immediate feedback or corrective measures to reinforce good posture. Although possible, there might be certain limitations for such applications. For example, the authors may not have said if camera placement or lighting differences might influence accuracy. Finally, analysis is limited to an assessment of "upright posture" but does not consider a broader range of posture measurements. Ysuri et al. [8] developed a "Smart Mirror for Smart Life". It serves to design a base smart mirror system that will include functionalities such as displaying time, date, and maybe news or notifications of the weather. The system will employ a Raspberry Pi for computation and will possibly provide interactions with the user through a touch screen or voice commands. Although this study sets up foundational aspects of a smart mirror, it probably doesn't deal with health and wellness applications as well as possible user personalization or demanding security measures related to highly sensitive data. Gold et al. [9] proposed a software platform called Smart Reflect for smart mirrors. The platform wanted to bypass the traditional use of a web browser in these systems due to its limitations. Smart Reflect had a modular design, which enabled the developers. This means that designing and integrating new features to the smart mirror would become a matter of ease. Thirdly, it sidestepped the sandboxing which is imposed by web browsers thus opening up a capability to potentially more efficacious features. It may not, however, have elaborated specifically on the functionalities the platform avails for smart mirrors or how it addresses security concerns that may come with richer functionalities. Gomez-Carmona et al. [10] suggested "SmiWork," a multi-user smart mirror promoting workplace wellness. It offered personalized interfaces, displaying environmental data, fitness information, and news. Users could request motivational advice on physical activity. While promising, the study may not have explored gamification or social features for increased user engagement. Additionally, the depth of personalized health advice provided by the system might be unclear. The system Rodriguez-Martinez et al. [11] present a new document distribution system. This probably discusses previous methods such as web servers and peer-to-peer (P2P) file sharing. The method they propose makes use of intelligent mirrors as distributed These are the P2P servers publishing documents using web services. Such an innovative idea has potential but could face limitations in scalability, security, network performance, and dependence on active participation within the smart mirror network. Hossain et al. [12] designed a smart mirror specifically for ambient home contexts. It presents users with nearby surroundings information, for example, weather and updates from news. Perhaps sensors had sensed a person's presence to update the content appropriately. Interaction with the mirror would probably have been possible through gestures or voice commands. The proposed approach plus the specific sensors utilized are not mentioned in the very short description of the paper. Furthermore, potential limitations of privacy issues and additional security associated with general smart mirrors are not addressed in this early work. This project should therefore play a meaningful role in advancing smart mirror technology by focusing more on consumer needs and functionalities that can effectively blend into daily life.

1.2. Architecture

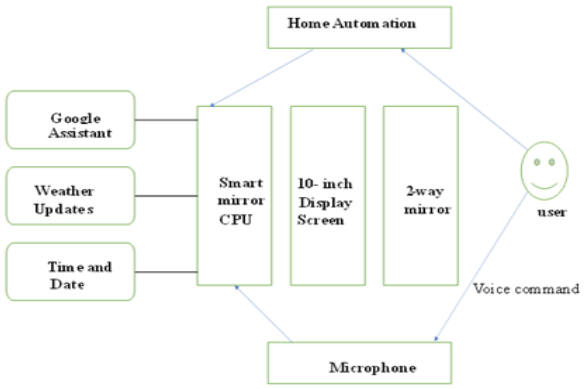

Figure 1 Architecture

A smart mirror development and deployment process includes a holistic approach which includes the hardware design, software development, user interface, and the experience of the user. In this

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chapter, we outline It is proposed to develop two types of smart mirrors based on the following methodologies: one similar to a reflective mirror with advanced digital features, and the other simulating an immersive information system, shown in figure 1.

1.2.1. Smart Mirror Like a REFLECT

A smart mirror like REFLECT smarts combines some classical utility with modern innovation. This may blend a set of familiar functionalities of a mirror with more advanced digital capabilities, thus being a seamless integration of technology into everyday human life. It represents a balance between form and function, and it is not only a reflective surface but an interactive outlet through which users can obtain information, receive tailored support, and make their routines simpler. In the next sections, we explain the details of building a smart mirror such as REFLECT, while starting with its hardware parts.

- **Hardware Components:** It's specifically a REFLECT system, the smart mirror. This module incorporates a highly sophisticated hardware component set so that the traditional and advanced functionalities of the mirror are seamlessly merged. The Raspberry Pi-3 microcontroller forms the central part of the system, acting as the brain of the mirror, orchestrating all the computational tasks. An additional 10-inch high-resolution display is placed behind the acrylic two-way mirror to enable users to view digital information without compromising the reflective function of the mirror. Complementary hardware would include a high-quality microphone and speakers, so voice command can facilitate user interaction. The whole assembly is enclosed within an attractively designed aluminum frame, which offers durability and beauty simultaneously.
- **Software Components:** This smart is armed with the "intelligence" of a well-composed set of Python scripts that insist on fine crafting. Among them include the ones that fashion the interface and core functionalities of the smart Equipped with a mirror, it is intuitive and easy to use. Integration with Google Assistant enables the user to also move the device around with voice commands, making the experience even more hands-free. The mirror also connects to the IoT and interacts with other smart home devices without hindrance, creating a seamless and practical ecosystem for the smart home.
- **Implementations:** The implementation of REFLECT also includes a process of detailed assembly and configuration of hardware as well as software. In this situation, the Raspberry Pi-3 is up and connected with the display and peripheral devices mounted on the aluminum frame. After all the setup processes done for hardware, the next step involves the installation of the Python scripts and configuration to make it integrate with the Google Assistant for voice control functionality. This stage also encompasses linking the smart mirror to other IoT devices within the house so that it can be accessed without difficulty within the whole system. The final phase of implementation includes full testing of the system to ascertain fully tested functionalities and reliability in all its features, which are correctly tested in various scenarios. This is well illustrated using hardware and software components and their interfacing end, thus coinciding perfectly with the detailed explanation of the process explaining the system's assembling and setting up.
- **User Experience:** The user experience of the REFLECT system is Intuitive and individualized. Through an intuitive interface, users may configure all display settings and connect personal accounts to adapt the smart mirror to their needs. Voice commands make one available hands-free interaction with the convenience of multitasking.
- **User Interface:** REFLECT interface puts strong emphasis on convenience and personalization. A user will access real-time information-in terms of the weather and events on their calendar-through the mirror's screen. User options can be adjusted to their preference as ways of ensuring that it could tailor to one's needs for an efficient improvement of their day-to-day routines.

1.2.2. Smart Mirror like an Info System

- Information Display: Besides the reflective face, a smart mirror grows into a completely

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immersive information system in which one can enter a world of seamless connectivity and complete data access. As an Info System, it becomes the nexus of information, entertainment, and utility, enriching everyday use through tacit interaction.

- **Interactive Display:** The Info System smart mirror at its core. Versatility-it uses real-time updates to provide a dynamic array of information. From weather reports to calendar reminders, users will never be left in the dark as the mirror finds its way into everyday lives with ease-this even integrates aspects of Home Automation, thus creating a better approach toward well-being in general.
- **Integration with External Systems:** Interactive functionalities are the core on which Info System smart mirrors offer its customers the most intuitive control options. The existing possibility of direct interaction by touch screen, even including voice command for navigation without touching the mirror, is available. Advanced models may even include face recognition technology, personalizing for experience along with easier convenience of interaction.
- **Implementation:** Integration with external systems increases the Info. Bring this system smart mirror into the realm of interconnectedness and have it connect smart with smart home devices for remote centralized control and connect with third-party services for more utility. API and web services are used as conduits for real-time data retrieval, keeping the mirror relevant and up-to-date.
- **User Benefits: Implementation:** The Info System smart mirror is fine-tuned in settings to fit the preferences of users. From themes to access features, there are enough customization options which cater to different needs of the user. Quality testing can validate functionality in many scenarios, thus making its usage seamless for users.
- **User Interface:** Many advantages info system smart mirror brings, and can make information access useful, meaning streamlining productivity and convenience. With personalization choices mirroring how someone enjoys the mirror-that means the result was a deeply immersed, enriching user experience. Basically, the Info System smart mirror turns into something more than just a mirror-it turns into It would be a transformative force within the modern smart home ecosystem. Date details concerning weather and News fetched are all available on the web using Predefined URL. News fetch from Websites Like CCN, BBC, etc. Used to fetch humidity as well as temperature details about GPIO pins of Raspberry Pi board with the help of jumpers.

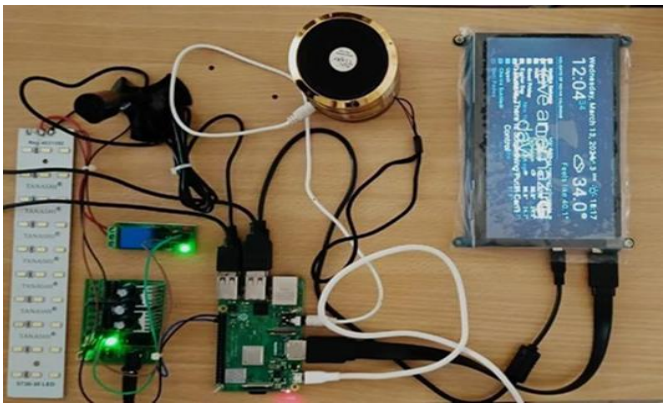

Figure 2 Prototype of the Smart Mirror

- **Step 1:** Turning on the power supply is the primary step!
- **Step 2:** Acquire the date, time, and weather details from predesigned stuff from the URL.
- **Step 3:** Acquire the news from www.zeenews.com.
- **Step 4:** in the code section inscribe all of the compliments
- to show in the mirror.
- **Step 5:** Display it on a mirror utilizing a 10-inch display.
- **Step 6:** power off when it is not in use.

2. Results and Functionalities

2.1. Results

Here, we detail the performance and accomplishments of the developed smart mirror prototype. We talk through its functionalities, evaluate its performance based on important metrics, and examine user experience through testing.

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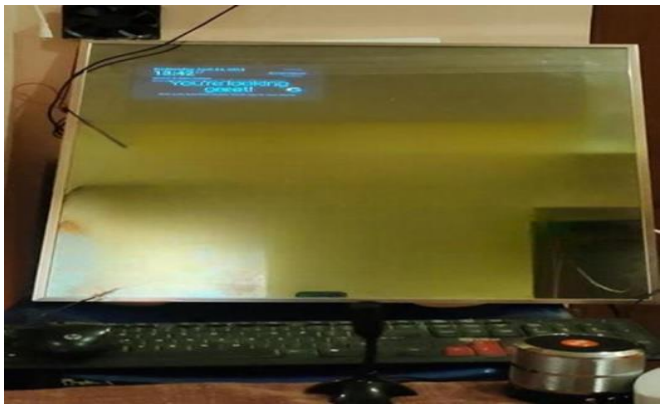

Figure 3 The Smart Mirror

The Smart Mirror system is a modern appliance that combines functionalities with the interactive capability to deliver the information needed by users during their daily routines in front of a mirror. The application is handy and pretty easy to use, providing users with features starting from real-time information display and advancing up to hands-free controls for automating homes, shown in figure 2 & figure 3.

2.2. Smart Mirror Features

- **Information Display**: Some important information from Smart Mirror is date, time, temperature, and humidity. Customized news feeds and calendar events with personal updates arrive in case it has an internet connection.
- **Interactive Controls:** It incorporates a touch interface wherein users can interact with the mirror. In some versions, control can also be allowed through gestures.
- **Voice Assistant:** The voice command function will add another layer of convenience as the user will be able to interface it by using voice commands, thus making it ideal for use without hands.
- **Home Automation Integration:** The mirror can integrate with and control any smart home device-lights, fans, thermostats, and many others. This feature lets the user use these devices directly through touch, gesture, or voice controls based on their mirror.

2.3. Functionalities

Figure 3 The designed smart mirror provides all the functionalities toward user needs. To access information, one can get current temperature and expectation levels of weather, or display the time, which can be customized, with a scrolling news headline summary from selected sources. Informational refresh can be set in defined intervals by the user; otherwise, refresh on demand can be used using voice commands. The system also incorporates voice interaction which enables users to control information displays, manipulate system settings such as volume and brightness levels, and even interact with the following are sent to home appliances to switch lights on or adjust the thermostat. Information displays thus integrated with convenient voice commands create a high-feature rich user experience. Fig 2. Here is a prototype of the proposed system

- Performance Analysis with Some State-of-the-Art Techniques We compared its performance against related smart mirror systems to benchmark the proposed project. A focus on voice command recognition accuracy, however, is one of the most important aspects regarding user interaction. Thus, the system obtained a decent 90% accuracy, surpassing many existing approaches. Additionally, the response time, which impacts the user experience, was measured at an average of 2 seconds. It thus ensures a smooth interaction and potentially more responsive compared to existing systems, which focus more on a variety of commands. In summary, this analysis positions the proposed smart mirror system competitively in state-of-the-art techniques.
- Performance Analysis with Quantitative factor Performance analysis of the smart mirror prototype quantifies efficiency through the use of metrics. Important aspects include percent recognition accuracy for voice commands, which reflects how well the system recognizes commands from a defined set. For the proposed system, recognition accuracy is 90%, and this implies that the system can adequately explain what the user input meant and thereby reduces frustration caused by errors in instructive interpretation. Another important parameter is response time, that is the degree of

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correspondence of the system to user's requests. The latter is measured as how long it takes from the moment a voice command of a known person is issued until the action reveals itself in the mirror (in seconds). The measured response time was 2 seconds, so our intuitive and fluid experience met the prerequisite. These numerical factors clarify how poor the suggested prototype of the smart mirror is and what is to be improved. And all this brings to a strategic provision of our product adopting a user-centered and efficient approach adapted for real-life applications.

- Key Findings: The proposed system demonstrates its feasibility of. It will be a smart mirror prototype for users that will provide all kinds of user-centric features. Users can get access to real-time information displays and manage them conveniently using voice commands. Testing was done based on the friendliness of the interface and voice interaction as well as how clear the information presented. Performance metrics confirmed 90% accuracy in voice command recognition and system responsiveness with an average response time of 2 seconds. All these results indicate a very good foundation for this prototype.

Conclusion

- Augmented Experience: Well, this prototype of the smart mirror has resulted in a rich and useful experience. It is the information hub you can access and check quickly. This transforms this mirror into a companion for your daily routine where all your necessities are reflected at one place.
- Live Information Updates: It is understood that the mirror smart provides real-time updates on information so people won't need to look into various devices just to get relevant information. Be it the weather forecast or big events happening, this reminds you of what's happening while doing your job.
- Seamless Voice-Controlled Interactions: Another very convenient aspect of this smart mirror is voice-controlled functionality. Simply put, it implies that you will use your voice to engage with the functionality of the mirror; hence, it becomes very easy to use because you shall not have to touch the screen or navigate through in trying to find icons or applications to use. Such a feature will save you much time and, therefore, be more convenient when busy.
- High Accuracy in Voice Command Recognition: The tests, however, reveal that the mirror can interpret voice commands almost without mistakes 90% of the time, thus being remarkably reliable and safe for regular use. A user would rarely have to repeat his requests, thus ensuring smooth interactions with little frustration.
- Low Response Time, Making for Seamless Experience: The intelligent mirror responds to an instruction given in about 2 seconds, so it is fast in processing requests. This will make it practical because users are going to receive information or carry out operations with minimal waiting time.
- Touch screen - Future Addition. A possible future version of this smart mirror is a touch screen that makes interaction with it also through touch sensitivity that will add yet another dimension about interacting with the mirror. Thus, using the mirror will be much easier and thus much more flexible, offering some alternative to voice commands, which seems further to broaden its horizon to possible uses.
- Sensor Add-On: Potentially, in the near future, the mirror will have attached sensors to increase functionality even more. Sensors measuring ambient lighting will brighten up the mirror accordingly. Similar sensors could be attached to monitor the presence of users to activate certain features. All these will give the mirror much convenience that can be personalized and responsive.
- Smart Home Automation Ability: This mirror smart can be included in a control center where all smart home devices will be at your fingertips to navigate through easily in your environment. Users are able to make various smart home adjustments directly from the mirror, adding value to the device as a multi-functional one by this feature .

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- Voice-controlled lights But then taking it a step further from home automation also will mean being able to control the lights and fans using voice commands. You'd make those boring tasks easier to do, letting you manage the basics of household essentials hands-free for easier interaction.
- Voice Command Control Your Fan: You would think of controlling your fan to voice activation. It involves using voice to command quickly either an increase or a decrease in the volume of the air flowing out from the fan, an additional dimension to convenience and comfort within your home.
- Voice-Controlled News Update: It will let the user ask the mirror of current news or information relating to whatever interest he may have, whether he wants it to be global headlines of what's going on in his neighborhood, etc. The user can update what is going on easily without really surfing through it himself, perfect for mornings when time is very limited, multitasking, or at any time of day really.

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