SMART MIRROR USING IOT

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ABSTRACT

In this era of evolving technology, the human life is becoming simpler and time efficient. This paper depicts the design and development of smart mirror which will make our everyday life easier and time efficient. The aim of the smart mirror is to provide an easy way to information service such as news feeds, weather, clock etc. The framework depends on Raspberry Pi that runs Raspbian (Linux) Operating System introduced on a micro-SD card. The Camera, just as LCD, is associated with the Raspberry Pi. By confronting the camera, the camera will catch the picture at that point pass it to the Raspberry Pi, which is modified to deal with the face acknowledgment by utilizing the OpenCV library. On the off chance that the student's info picture matches with the prepared dataset picture, the participation results will be put away in the document. In this undertaking, we are utilizing Artificial Intelligence. In man-made brainpower, we utilized Convolution neural organization.

Keywords: Artificial intelligence, speech recognition, facial recognition, Smart Mirror.

1. INTRODUCTION

1.1 Rationale

The Modern science and technology is now more concerned about designing and developing things that can bring comfort to human life and make it easier. The internet transforms peoples' lives by connecting them more easily to information and other peoples in the virtual world. People are now relying more on devices, like smartphone, that can give them access to lot of information with minimum effort. In this paper, this study was proposed to design of a device called "Smart Mirror" which aimed to provide people with an easy way to access information with minimum effort. It will run on the interface of a mirror and provide productive information such as weather forecast, clock, news feed and so on. The mirror will have artificial intelligence and thus will be able to interact with people in real time. It will be intelligent enough to recognize face and voice of a person and thus will be able to identify users. People will be able to retrieve data from internet by interacting with the mirror directly. The mirror will solve the problems that many people experience every day, getting information without distraction. Before going to bed, the user may want to know whether it will be rain in the next morning so that they can plan their commute. Thus, for every little chore like this, mirror will be able to provide solution and make the life of people comfortable by connecting to huge information.

1.2 Background of Study

As the technology and application of digital systems is getting popular, the works on this fields are increasing. Now-a-days the world is getting more into artificial intelligence. The concept is integrating artificial intelligence into people's life. In recent days, the applications of artificial intelligence and its usage in the industry is highly appreciated. The proposed artificially intelligent smart mirror is also a prototype which is from the inspiration of the following fields. However, there were some relevant works on the following field.

The Smart Mirror is a special type of mirror application based on face recognition which provides data feed of various websites and services. Raspberry pi along with webcam and microphone is used in this mirror service. The webcam takes pictures of the person standing in front of the mirror and then sends the image to the pi where the OpenCV application performs a visual analysis and detects the person. Mirror2.0 has the feature of providing news and weather reports as well as providing music and video playbacks. This was done with a MacOS and the music files were fetched from the hard drive of the Mac. The Reveal Project, created in the New York Times research and development, consists of an LCD Display covered by a mirror glass. The device used Microsoft Kinect for real time tracking of user's movements. This module also visualizes different information on its surface, such as calendar, mail, news, mail notification. In addition, it also responds to vocal commands. However, one of the excellent features of this project was the addition of a medicine box scanner, which allowed the user to buy medicines recognizing their prescriptions.

From inspiration of the works described above, the proposed work is little different. A working system has been developed which will be an artificial intelligence-based service with facial recognition and voice command. The mirror will also have the weather, calendar, clock and news services. However, the tricky part that we introduced is the integration of the AI in a raspberry pi which is a very smart and off-theshelf technology.

2. LITRETURE SURVEY

The concept of a smart mirror has evolved significantly in recent years, driven by advancements in IoT and artificial intelligence (AI). A smart mirror typically includes a two-way mirror, a display unit behind it, and integrated systems like AI-powered voice assistants, making it a useful tool for enhancing daily routines. Several studies and commercial implementations have explored this integration, primarily aiming to create personalized, hands-free user experiences. One of the primary drivers behind the development of smart mirrors is the Internet of Things (IoT), which enables devices to communicate and exchange data over networks. IoT allows the smart mirror to integrate with other connected devices, such as smartphones, smart home appliances, and fitness trackers, enabling the display of real-time data like weather forecasts, news, calendars, and health metrics.

In parallel, AI-powered voice assistants, such as Amazon's Alexa, Google Assistant, and custom-built AI solutions, offer users the ability to interact with the mirror through voice commands. This enhances convenience and accessibility, especially in smart home environments, by allowing users to control various IoT devices or access information without needing physical input. Research shows that voice-controlled systems improve user engagement and streamline interactions with complex interfaces. Various studies emphasize the use of **OpenCV** and other computer vision libraries to enable features like facial recognition and gesture control, further enhancing the interactivity and customization of smart mirrors. These systems can recognize users, display personalized information, or adjust settings based on individual preferences. Current challenges include privacy concerns related to data collection, system integration complexities, and the need for efficient real-time processing. Nonetheless, the convergence of IoT, AI, and advanced display technologies has paved the way for further innovations in smart mirrors, making them a significant component in future smart home ecosystems.

Security and privacy concerns are common areas of focus, as the mirror collects significant amounts of personal data. Researchers are working on encryption methods, user authentication, and other security protocols to protect users' data.

Additionally, efforts are ongoing to address challenges such as improving the efficiency of real-time data processing, ensuring smooth device integration, and enhancing the affordability of smart mirror systems for widespread consumer adoption Several research papers have also explored the potential applications of smart mirrors in various domains. These include smart homes, retail, healthcare, education, and hospitality. Studies have highlighted the benefits of smart mirrors in providing personalized information, enhancing user experiences, and improving efficiency in these sectors.

3. RELATED WORK

The integration of smart mirrors with IoT, voice assistants, and computer vision has garnered significant attention in recent years. Numerous studies and research papers have explored the potential applications and technical challenges associated with this emerging technology. One area of focus has been the development of two-way mirror systems. Researchers have investigated various techniques to create transparent displays that can be integrated into mirrors, allowing for both reflective and digital functionalities.

These include using transparent OLED displays, reflective LCD panels, and specialized optical coatings. IoT integration has been a key aspect of smart mirror development. Studies have explored the use of different IoT platforms and protocols to connect mirrors to a wide range of devices and services. This includes smart home devices, wearable technology, and cloud-based applications. Researchers have also investigated the challenges of ensuring secure and reliable communication between the mirror and IoT components.

Voice assistants have played a crucial role in enhancing the user experience of smart mirrors. Studies have explored the integration of popular voice assistants like Amazon Alexa and Google Assistant into mirror systems. Researchers have focused on developing natural language interfaces that allow users to interact with the mirror using voice commands, making it more intuitive and accessible. Computer vision has been another area of interest in smart mirror research. Studies have explored the use of OpenCV and other computer vision libraries to enable tasks such as facial recognition, object detection, and gesture control.

Researchers have investigated the challenges of real-time processing and accuracy in these applications, particularly in low-light conditions or with varying user profiles. Several research papers have also explored the potential applications of smart mirrors in various domains. These include smart homes, retail, healthcare, education, and hospitality. Studies have highlighted the benefits of smart mirrors in providing personalized information, enhancing user experiences, and improving efficiency in these sectors.

4. METHODOLOGY

This study was conducted in the Department of Computer Science and Engineering, BRAC university, Dhaka, Bangladesh during the year 2017. The requirements and specifications of the Smart Mirror took inspiration from people's every day devices that they use including PCs, tablets and smartphones. The integrated similar features from each to give the user what they would expect out of a modern 'smart device'. Some basic features like clock, calendar, news feed, etc. which are essential part of the everyday life are included in the smart mirror so that people can now have access to these features more easily than ever. Figure 1 is a schematic view of the smart mirror concept that has been proposed in this study. There are a lot of previous projects related to smart mirror but only few with AI integrated with it. People will be able to interact the mirror through AI in real time and access information available on internet such as accessing maps, weather, news feeds, etc. Method and analysis which is performed in your research work should be written in this section. A simple strategy to follow is to use keywords from your title in first few sentences.
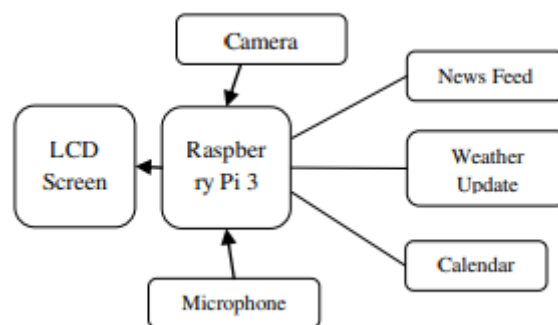

Figure:4.1 Systematic view of Smart Mirror using IOT

For CPU, Raspberry Pi 3B minicomputer was used and all software components were installed into the operating system. The CPU will take the video and audio information from the camera and microphone respectively and through facial recognition and voice recognition model it will identify users. Once the smart mirror senses the presence of any person, it will 'wake up' and display basic features like clock, calendar, weather update, etc. Smart mirror will also have some basic AI features integrated to it. Users will be able to interact with the mirror in real time and search for information on internet, ask questions, perform certain tasks like setting alarm, reminder, etc. with the help of smart mirror. All the information is displayed on the LCD screen connected with the raspberry pi. All components reside behind a special mirror known as two-way see-through mirror which is made of acrylic material.

4.1 Hardware components overview

4.1.1 Raspberry Pi- Raspberry Pi is a credit-card sized computer manufactured and designed in the United Kingdom by the Raspberry Pi foundation with the intention of teaching basic computer science to school students and every other person interested in computer hardware programming and DIY-Do-it Yourself projects. The Raspberry Pi has a Broadcom BCM2837 system on a chip (SoC), which includes 4 ARM Cortex-A53 1.2 GHz cores as the processor, VideoCore IV GPU and with 1.0 gigabyte of RAM. It doesn't include a built in hard disk or solid-state drive, but it uses a microSD card for booting and persistent storage. It also includes Bluetooth 4.1 low energy and a 2.4 GHz 802.11n Wi-Fi. The Raspberry Pi 3 computer is one of the key components of this project and we have used Model B of the Raspberry Pi 3. Operating system and all other software were installed and stored in a microSD card.

4.1.2 Webcam- A simple USB powered webcam was used for facial recognition. It was used as an input device to take video or image as input.

4.1.3 LCD Screen- LCD screen was placed behind the mirror which was used to display the desired information to the user.

4.1.4 Mirror- Acrylic two-way see-through mirror which was a special mirror, was used in this project. Unlike the normal household mirror, the two-way mirror was not painted with a color on the back, instead its left untouched. Thus, it was made reflective on one side and transparent on the other side.

4.1.5 Microphone- Microphone was connected with the raspberry pi and was used to input audio information to the CPU. Interaction with the mirror was done over microphone. USB microphones had to be used because the Raspberry Pi does not have regular microphone input.

4.2 Software Components Overview

4.2.1 Raspbian OS- Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. Raspbian comes with over 35,000 packages, pre-complied software bundled in a nice format for easy installation on Raspberry Pi computer.

4.2.2 NodeJS- NodeJS is an open-source cross-platform JavaScript run-time environment for executing JavaScript code server-side. It comes included with Electron which is used to launch processes to control things that are not available in web API's such as the sensors and microphones for voice recognition.

4.2.3 Python- Python is a widely used high-level programming language for general-purpose programming, created by Guido Can Rossum and first released in 1991. It has lots of support and libraries which makes it very popular among raspberry pi community. Most of the codes of this project were written in python.

5. WORKING PRINCPLE

First, a frame for the mirror was built and attached the twoway see through mirror with it. One side of the frame was for the viewing of user and on the other side was assembled all the hardware components. A LCD was attached to display with the frame and connect the LCD display with the raspberry pi via HDMI cable. USB microphone and USB web were then connected with the raspberry pi. Finally, the power source for both the raspberry pi and LCD display was established. As the raspberry pi has its own operating system, the Raspbian operating system was booted for the project into the raspberry pi. It was updated and upgraded to increase the CPU speed. The default version of the operating system consisted of an older version of the Node which did not consist of NPM. So, the Node was reinstalled which included the NPM. Next, pip was installed which was a package installer of python and it helped to install numerous packages. However, python Speech Recognition was installed as it was used to convert audio into texts and for processing the video inputs. An OpenCV, a library of programming functions was used which focused on real time computer vision. And for the AI and other modules, python programming language was used. However, an open-source AI library was used to train our AI.

The key features of our design are:

(1) Time and Date: The time of the CPU used (Raspberry Pi) in the mirror was shown

(2) Calendar: The international calendar in the mirror as well as the upcoming holidays was integrated in the system. The help of open-source website to fetch the API of the calendar was taken.

(3) News: The news functionality was integrated, which will show the RSS feed of any newspaper of the world.

(4) Artificial Intelligence (AI): the working principle of AI is based on speech recognition module and pyttsx3 library

AI will take voice information as input and through voice recognition, will identify users. Processing audio or speech is more time consuming than processing text. So, the audio input will be converted into text through speech software, here used google speech to perform this task. To make AI understand the text, wit.ai was used which would have intent and entity.
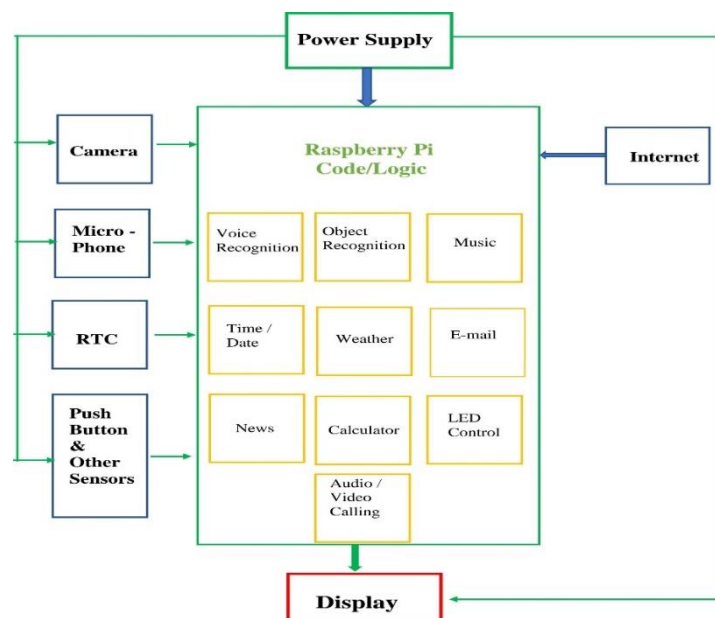

Figure 5.1: System Architecture

6. MODULES

1) **Voice Recognition:** This feature integrates popular voice assistants like **Google Assistant**, **Amazon Alexa**, or custom AI systems into the smart mirror, allowing users to interact through voice commands. It offers a hands-free experience, letting users control smart home devices, access information, and perform tasks like setting reminders or playing media. The voice recognition system can also personalize responses based on the user's voice profile, enhancing the interaction. Additionally, it improves accessibility for people with disabilities or in situations where manual interaction is inconvenient.

2) **Object Recognition:** By leveraging computer vision technologies such as **OpenCV**, the smart mirror can identify objects in real-time images or videos. This feature assigns labels or categories to recognized objects, enabling a wide range of applications, from product identification to home security. The system can be trained to recognize specific items, which is useful for automation, inventory management, or educational purposes. It adds a layer of interactivity, where users can interact with identified objects via gestures or voice commands.

3) **Music:** The smart mirror streams music and podcasts from popular services like **Spotify**, **Apple Music**, or **Google Play Music**. Users can control playback, adjust volume, or create personalized playlists via voice commands. The integrated system allows seamless transition between audio experiences, offering recommendations based on listening habits. Users can also sync music across multiple devices, creating a cohesive audio experience throughout their home. With voice-controlled playback, users can enjoy music while performing other activities without manual input.

4) **Time/Date:** The mirror displays the current time and date prominently on the screen, making it easily visible at a glance. This feature often includes the ability to set alarms or timers through voice commands. It ensures users can stay on schedule without needing additional devices like smartphones or clocks. The display can be customized to fit user preferences, with options for 12-hour or 24-hour formats, and integration with global time zones. This functionality makes it a practical tool for daily routines and time management.

5) **Weather:** The smart mirror provides real-time weather updates, including temperature, humidity, wind speed, and forecasts for the coming days. It pulls data from weather services like **AccuWeather** or **The Weather Channel**, allowing users to prepare for daily activities accordingly. Voice commands enable easy access to weather alerts and warnings, such as storms or extreme conditions. It can also be programmed to display weather-based suggestions, like recommending umbrellas or jackets. The system can localize forecasts, offering hyper-local data for greater accuracy.

6) **Email:** The smart mirror displays email notifications from accounts synced with the system, such as **Gmail**, **Outlook**, or other email services. Users can check, read, and manage their emails without needing to access their phone or computer. Voice commands allow users to compose or reply to emails, enhancing productivity and convenience. Notifications are tailored based on user preferences, reducing distractions. The email functionality also supports calendar integration, letting users stay connected to appointments and events directly from the mirror.

7) **News:** The news feature keeps users updated with the latest information on current events, drawn from trusted sources like **BBC**, **CNN**, or **Google News**. Users can customize news topics, such as politics, sports, or entertainment, to match their interests. Voice commands allow users to hear the headlines or dive into specific articles. News updates are typically displayed in brief, easily digestible formats to suit quick viewing. This feature helps users stay informed while engaging in other daily tasks, like getting ready in the morning.

8) **Calendar:** Integrating with digital calendar platforms like **Google Calendar** or **Apple Calendar**, the smart mirror provides users with daily schedule updates, reminders, and upcoming event notifications. Users can add or edit events via voice commands, making it easier to manage appointments. The mirror displays an overview of important dates, helping users stay organized. Custom notifications can be set to ensure that users never miss important deadlines. The calendar feature can also sync with other devices for a cohesive scheduling experience across platforms.

9) **LED Control:** The smart mirror can control ambient lighting, allowing users to adjust brightness and color settings for **LED** lights. Users can modify lighting to suit different environments or moods, such as dimming the lights for relaxation or increasing brightness for tasks. This feature often integrates with smart home systems like **Philips Hue** or **LIFX**, enabling voice-controlled lighting adjustments. Users can set pre-programmed lighting scenes or create their own for various scenarios. LED control also contributes to energy efficiency, as users can optimize lighting conditions based on their needs.

10) Audio/Video Calling: The smart mirror allows for audio and video calling using platforms like **Zoom**, **Skype**, or **Google Meet**. It offers users the ability to stay connected with friends, family, or colleagues directly from the mirror interface. Integrated cameras and microphones provide high-quality communication, making it suitable for both personal and professional use. Calls can be initiated via voice commands, allowing hands-free operation. This feature enhances the convenience of virtual communication, especially in smart home setups where mirrors are located in frequently used spaces

7. CONCLUSION

Efforts have been made to build an efficient and intelligent smart mirror that optimizes our time of doing works and increases our daily productivity. The Smart Mirror will play an important role in the field of IoT and home automation. Not only this can function as a normal mirror but can also provide other functionalities like weather forecast, calendar, time, etc. which makes it more desirable. The functionality of the mirror can be expanded by connecting it to other home appliances, mobile devices, etc. Smart Mirror can be a great example of how AI can be integrated into home appliances to make our life easier, efficient and more enjoyable. In future, Smart Mirror can be made smarter by upgrading the AI. There is still a great scope to improve the AI. Soon, normal mirrors will be replaced by smart mirrors if they can be made affordable.

8. REFERENCES

[1] Joshi, A. et al. (2020a) IOT BASED SMART MIRROR WITH NEWS AND TEMPERATURE, International Journal of Creative Research Thoughts.

[2] Mehta, D. and Jain, M. (2021) 'Personalized Smart Mirror with User Detection', International Research Journal of Engineering and Technology [Preprint]

[3] VOICE CONTROL IOT BASED SMART MIRROR 04/April-2024 Dr. D.D. Chaudhry*1, Avinash Hivale*2, Tushar Chavan*3, Vikas Prasad*4 Professor, Department Of Electronics And Telecommunication, Sinhgad Institute Of Technology, Lonavala, Maharashtra, India.

[4] School of Computing and Mathematics Computing Individual Project BSc (Hons) Software Engineering Kathriachchi Pinnawala Integrated Smart Mirror Model 2022/2023.

[5] M.A Iqbal, S Hussain, H Xing, and M Imran, "Internetof Things (IoT) Fundamentals," in Enabling the Internet of Things, pp. 1–28, Wiley Publishing, 2021.

[6] Future IoT based on Smart Mirror: A Literature ReviewSeto Benson Handoyo1, Michael Vincentius Setiawan1, Mikhael Valensius1 and Mochammad Haldi Widianto2, Informatics Department, School of Computer Science,Bina Nusantara University, Jakarta Indonesia.(Received 01 July 2020, Revised 07 August 2020, Accepted 31 August 2020).

[7] Thejowahyono, N.F. et al. (2022) 'Smart Mirror to Enhance Learning: A Literature Review', International Journal on Emerging Technologies, 11(5), pp. 226–233.

[8] Johri, S. Jafri, R. N. Wahi, and D. Pandey, "Smart mirror: A timesaving and affordable assistant," in 2022 4th International Conference on Computing Communication and Automation (ICCCA), pp. 1–4, IEEE, 2022

[9] R. A. Nadaf, S. Hatture, P. S. Challigidad, and V. M. Bonal, "Smart mirror using raspberry pi for human monitoring and home security," in International Conference on Advanced Informatics for Computing Research, pp. 96–106, Springer, 2023.

[10] Y. Sun, L. Geng, and K. Dan, "Design of smart mirror based on raspberry pi," in 2021 International Conference on Intelligent Transportation, Big Data & Smart City (ICITBS), pp. 77–80, IEEE, 2021