INTERNET OF THINGS-ENABLED SMART MIRROR USING RASPBERRY PI

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ABSTRACT

The processing power of the cloud propels IoT applications to the level applicable in real-time based use cases, with the support of more immersive and conducive UI based interactions. As the Internet of Things matures, it will enable a wide range of independent residential and industrial systems to be built. One of the most recent and ubiquitous smart home accessories is a connected mirror. In this work, a low-cost smart mirror was built on the Raspbian OS platform, which is based on the Debian distribution, and projected over the display interface using the Apache web server. Users were provided with information that had recently been updated on the ThingSpeak cloud service. It was composed of a regular mirror and a projection device. Its intelligent open-ended voice search interface is widely used to display prompt notifications and up-to-the-minute information such as weather, traffic, calendar, news feeds, maps, and social media. It also incorporated enhancements in a more convincing fashion. The programming of interfaces and server-side processes was governed by web technologies like PHP, java script, and Cascading style Sheet. It relied entirely on PHP scripts, with no complicated third-party requirements. In order to collect data from the internet, many open APIs were used, such as the Google Maps API, the Google Calendar API, and the open weather chart API. The intelligent smart mirror's suitability for both domestic and industrial applications was established through a battery of performance tests.

Index Terms : Cloud, IoT, Raspberry Pi3, and Smart Mirror.

1. INTRODUCTION

Over the years, numerous technological advancements have been made to facilitate a higher standard of living for all people. It's no secret that technologies that mimic human behaviour have made their way into people's daily routines and develop into the fad of the moment. One example is the Internet of Things (IoT), which is a collection of interconnected devices that can exchange data over a network without the need for human or machine-to-machine (H2H or H2M) interaction [1]. Implanting a biochip transponder in a human for more precise heart monitoring is just one example of the many ways the Internet of Things (IoT) is being put to use today. The Internet of Things (IoT) is the result of a convergence of wireless technologies, miniature electromechanical (MEMS) systems, scaled-down services, and the Internet itself.

Incorporating Internet of Things–based technology into a household item like a mirror is a novel idea that was inspired by the smart mirror. Though users can always pull up this or that piece of data on their phones or other portable devices, having it displayed in the mirror during routine bathroom tasks saves time and is more convenient. Many businesses have begun emphasising and promoting products whose efficiency and performance are seen as competitive advantages. The fact that every manufacturer is in a constant state of competition or expansion speaks volumes about their commitment to quality. In this research, we focused on finding a low-cost way to boost the smart mirror's functionality. The proposed intelligent smart mirroring system's behaviour has been evaluated through performance evaluations.

2. PREVIOUS RESEARCHES ON THE CONCEPT OF THE "SMART MIRROR"

Using the concept of smart interaction, which also included touch functions, Toshiba [2] created a TV in 2014. M. Anwar Hossain et al. [3] described the design and development of a cutting-edge smart mirror that acts as a discreet interface for monitoring the home's environment. Users' smart devices can be managed and accessed via the smart mirror's custom services, which were designed to meet their specific needs.

Building an easily expandable home automation framework that promotes the combination of clan machines and different altered displays is demonstrated to demonstrate the smart mirror's functionalities control systems for data. Accessibility to these services with a minimum amount of client mediation is also a point of focus. For instance, a mirror-based face-recognition-based verification system was implemented to automatically identify the customer in front of it, and a device-based interface was provided to encourage user interaction with various services. The adoption of administration-oriented engineering has led to the development and dissemination of a wide range of administrations, including a mirror interface, apparatuses, and online benefit communication systems for sharing news and knowledge.

In [4], Fujinami K and Kawsar analysed the pros and cons of sending smart clients both images and data. A client was able to perform an audit of their electronic data using the inventive mirror while also engaging in their own personal hygiene practises. Customers can use the futuristic mirror to check in on breaking news as it develops, respond to messages, and peruse their schedules before heading out the door. The mirror functioned in either of two ways. When it was completely turned off, the smart mirror functioned as any other intelligent mirror would. The smart mirror was a showpiece device back when it was in its always-on, always-connected incarnation. During the presentation, the client could interact with the presenter via a small screen [5].

3. SMART MIRROR AND ITS EXPECTATIONS

From initial setup to regular use, this section addresses common questions and concerns with smart mirrors. An invention where technology and, by extension, commonplace aspects of human life, come together to provide a superior experience would be necessary for the success of this gadget. To what extent this gadget can be put to use is directly proportional to the user's expectations of the product's utility. Smart mirrors are typically used to check the time, the weather forecast, to send and receive social media greetings, and to view calendar-based notifications [6].

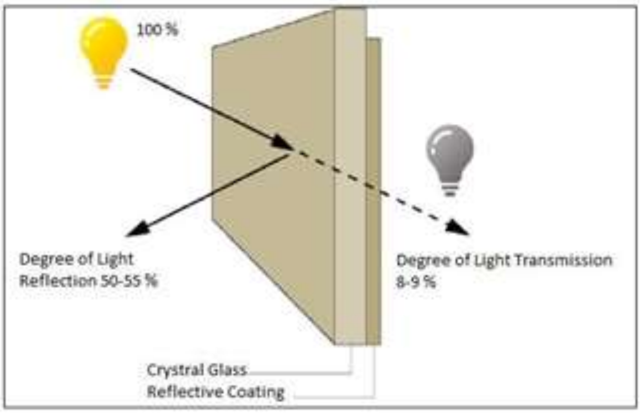

Figure 1: Light reflection in a two-way mirror

Due to the physical properties of light waves, a restricted mirror is often used as a clearly ordinary mirror in an extremely well-lit room, with a much darker room on the other side (Figure.1). Those on the side with the bright light will be able to see their reflection clearly, as if in a regular mirror. To those on the clear side, the cloudy side appears to be a simple window. It's possible that the sunlight from the bright room, reflected from the mirror and back into the area, would be far more impressive than the sunlight transmitted from the dark room, thus negating any benefit the latter might have received from the former. However, the sunlight transmitted from the bright side overwhelms the sunlight reflected back into the clouded side. Someone lurking in the shadows can sneakily keep an eye on the lively room.

When used for one-way reflection, these mirrors are typically placed behind a curtain or in a double-doored vestibule to prevent outsiders from peering into the observation room. These insights into black rooms have been put to use in the following examples:

- Places of execution
- Investigative interviews with police officers
- Laboratory experiments
- Market research
- Security assessment decks in uninhabited areas

Both practical and aesthetic needs are considered in this analysis of the proposed smart mirror's implementation. The capabilities of the smart mirror must fulfil the following criteria:

a. Figuring out what exactly the client requires
b. Evaluating relevant factors for realizability
c. Locate the system definitions.

As a result, the following specifications have been established. To begin, the system's components must allow it to perform its intended function.

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Customer requirements and issues with the smart mirror should be prioritised. The features needed to please users and simplify their lives by improving content delivery.

4. SYSTEMS ENGINEERING

Substantial investigation had been made to develop a mirror design that was both practical and in line with user expectations. Before beginning this work, we looked into related projects and products to gain a firm understanding of what has already been accomplished, as well as what might be required of us in a more traditional sense, given the constraints of the shapes we're working with. The mirror's constituent parts had previously been broken down into subcomponents for the purpose of determining the desired qualities of the final product. The smart mirror's architecture was broken down into subsystems to better illustrate their roles in the overall project. Since both hardware and software must be designed, a diagram is required. During the prototyping phase, detailed technical specifications were drafted for each individual subsystem.

4.1. Developing Equipment

Raspberry Pi and Tablet with 2-way mirror make up the bulk of the hardware. Using the tablet's built-in microphone, we were able to take advantage of the device's voice recognition feature and follow the user's spoken commands. These instructions were processed as input, allowing the system to carry out the necessary operations, such as displaying a calendar or a set of maps. Figure 2 depicts this layout.

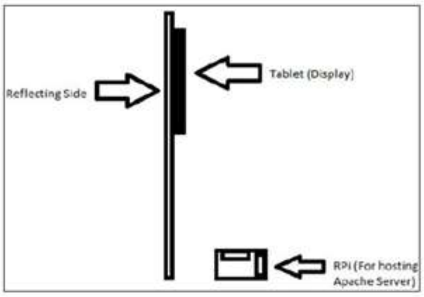

Figure 2: Diagram of Smart Mirror's Printed Circuit Board (PCB) Hardware Design

A total of four use cases informed the design of the user interface software. The Weather Outlook, Google Calendar, a Custom Greeting, and an RSS News Feed are all examples of such programmes. These programmes' user interfaces were designed with a minimalist aesthetic in mind[7, 8]. All of the interface elements have been optimised to fit on a single interface page while still providing optimal viewing comfort. This and the forecast for the next few days up to a week could be found by using the weather app.

Easy-to-understand Helvetica font and strategically placed icons in a list format make up the UI. Information can be quickly retrieved from within the application with the help of a special APPID key. The APPID was obtained from the open-source OPENWEATHERMAP.API service and stored in the GUI's local variables of the configuration file (Ref. Figure 3).

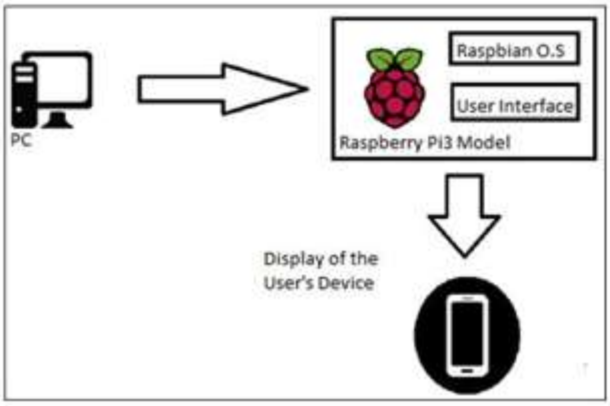

Figure 3 : Smart Mirror System Architecture

The purpose of the app's calendar feature is to display the user's schedule for the current day [9]. This app was designed to use the user's personal "iCal" file, which is associated with a *.ics custom calendar link obtained from services like Google and Apple.

The smart mirror app made the request for the file via its associated URL. Due to the ASYNC tasks file being called in the background by the smart mirror's corresponding links, [10, 11] this was a necessity. The downloaded files were then opened and parsed in order to present the correct information. The event's time and structure, as well as the date, were extracted from the custom parser and analysed. This information was added sequentially to the local vector variables to facilitate a neat presentation in the GUI. Newest headlines and articles from the NYTIMES news site have been culled for the RSS feeds. The NYTIMES RSS feed was designed to be pulled by the RSS reader. The RSS URL was queried, and the necessary string was sliced using local variables for formatted presentation.

5. GUI DEVELOPMENT FOR THE SMART MIRROR SETUP

5.1. PROCESSING IN THE FOREGROUND AND BACKGROUND

The raspberry pi coordinates with the web server and supplies all the necessary functionality for the entire model [12,13]. The following data were fetched and displayed on the GUI to support the type of interaction the user performed in Figure.4.

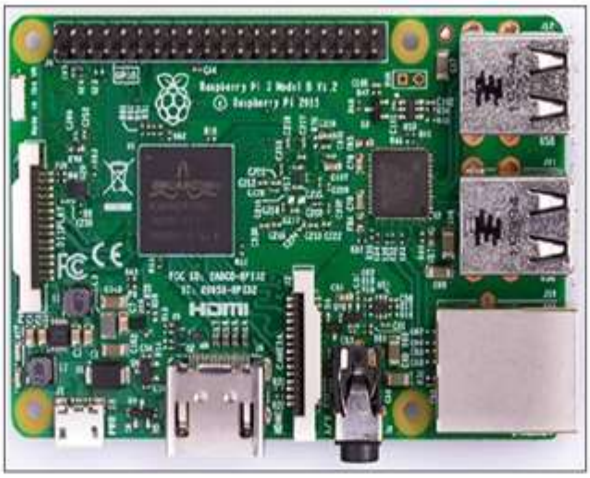

Figure 4 : Raspberry Pi 3 Model B kit

5.2. LAYOUT OF USER INTERFACES AND GRAPHICAL USER INTERFACES

The software and its user interface are tailored to the requirements of the average user (Figure 5,6). The GUI was given some polish with eye-catching effects to make things make sense, not be too distracting, and be easy to read. During the course of the show user-friendly interaction options were made available. In this paper, we explore the steps involved in developing the smart control framework that operates the intelligent mirror. It was developed for Android that has a simple graphical user interface and helps users connect with the smart framework. Quickly responding to user inputs, the application and control framework were integrated using a wifi across cloud architecture. RGB RED PANEL light governed the limits of the shading's temperature and brightness. PDA applications allow for control of inverter-type climate control systems, which is why a framework for controlling the inverter's IR remote module was developed. The smart mirror was designed with a manual control mode for the sake of efficacy.

Figure 5: Remote Access Welcome Screen with IP Address

Figure 6 : Remote Access Welcome Screen

The commercial products must be created with the highest level of consumer usability, adhering to all the desired standards in terms of functional and non-functional design requirements in Figure 7.

Figure 7 : Page headers in the home page view

All applications, including the clock, were made readily accessible to the user and were able to detect their actions [15]. The mirror was designed with a very vertical layout in mind, so it features a simple, elegant, and bold design on the top left and right edges, as well as the centre and left and right sides. View the images below to get a feel for the interface design in Figure 8 & 9.

Figure 8: A Menu of Actions

Figure 9 for a screenshot of a mapping application.

RASPBERRY PI 3 INITIALIZATION

The Raspberry Pi 3 Model B and a screen that supports the HDMI standard were used to create: A screen was linked up to the Raspberry Pi. The Raspberry Pi was set up with a USB keyboard and mouse for navigation and configuration [16][17]. A MicroSD card contains the Raspberry Pi's operating system. Raspberry Pi-based devices should not exceed 8GB of storage space [18].

A micro USB port and a 2.5A power supply were used to supply juice to the Raspberry Pi. Therefore, we have set up Raspbian 3 along with a photo-editing programme (win32 disc manager). Raspberry Pi 3 is a 64-bit, 1.25-gigahertz board for the Raspberry Pi 2. It supports a variety of interfaces, including Bluetooth, wireless LAN, HDMI, Ethernet, and more. Raspbian is the Raspberry Pi's official operating system. Raspbian is responding to PIXEL commands (Pi Improved X windows Environment Light). There's also the LXDE desktop environment and window manager. Putty is a free and open-source terminal emulator that works with a wide variety of protocols. Putty was used to operate the Raspberry Pi headless [19].

The new Raspberry Pi 3 features an ARM processor and is network and Bluetooth interface compatible. The Pi 3 includes a faster GPU. All the ports on both Model B sheets are in the same places, so they are essentially identical. Chips like the central processing unit (CPU), memory, and USB controller are all under your command thanks to the GPIO header [20]. Despite the fact that metal cases designed for the Pi2-Model B work perfectly with the new Pi 3, you should probably avoid using one to prevent interference with the Wi-Fi radio wire [21], [22].

The micro-SD card slot on the Pi 3 has been updated from the previous spring-stacked push-push type to a grinding-based design. The Pi3 includes this notable feature [23]. To prevent the board from being reset by xenon camera flashes, the U16 control controller chip [24] has been painted over more heavily in the Pi 3. The data from the far-off node was received by means of the GPIO header.

IN-TEST SETUP

Common usage conditions were used in the tests. The masses can be lined up next to each other, and time, speed, and performance metrics can be measured and compared as the same tasks are performed in the same environments. The new Pi 3 Model B can get very hot; after running the CPU at 100% for a few minutes, the average temperature was found to have risen above 80 degrees Celsius. Both the

SoC and the microchip on the other side of the board have heat sinks that draw their cooling power from the GPU's fan assembly. The Raspberry Pi 2 System-on-Chip (SoC) will maintain consistent temperatures, so a radiator is usually unnecessary.

METHODS OF OPERATING SYSTEM SETUP AND BOOT TIME

The primary test was obviously installing the default Raspbian-based environment, which took nearly 15 minutes on the Pi 2 and nearly 13 minutes on the Pi 3. A bar chart is provided for visual representation below.

THE EFFICIENCY OF OPENGL

The speed of 3D rendering was measured with the Open-Gl performance test. There was an introduction of the plateau utils bundle. Both models' sting rates were put through their paces using the glx gears installed on Raspberry Pis. The RPi2 managed around 26 frames per second, while the RPi3 managed 38 frames per second, an increase of over 49 percent. The motor was activated via rasbpi-specialized config's GL Driver configuration options. On the flip side, /boot/config.txt has the road data overlay=vc4-kms-v3d built in. The following displays the results of a comparison study that was conducted using information made available through an open-source online platform.

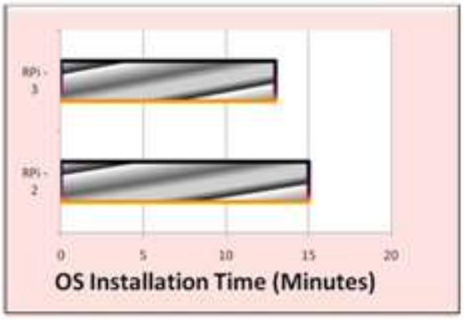

Figure 10 : Install times for various Raspbian distributions

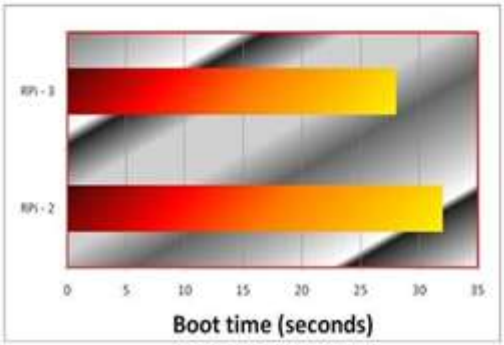

Figure 11: Boot Time Analysis of Several Raspbian Distributions

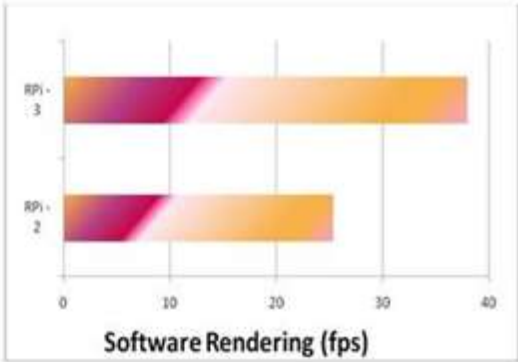

Fig. 12: Software Rendering in Raspbian 2 and 3

6. EVALUATION OF PERFORMANCE

A Windows 7 computer and both the Pi2 and Pi3 smart mirror implementations communicated with one another and shared the generated data via a local network. Each experiment was repeated several times to ensure reliability, and an average value was subsequently calculated, with out-of-range data being ignored. So as to eliminate any potential variations, all experiments used a dynamic setting for only the independent interface. In the

6.1 GENERAL OUTCOME

A Windows 7 computer and each smart mirror implementation using a Pi2 and a Pi3 shared the generated data via the local network. We ran each experiment multiple times to ensure reliability, and finally settled on a consensus value after discarding individual measurements. To eliminate any potential for variation, the separate interface was made dynamic in all the aforementioned experiments. To determine how quickly data could be transferred from one computer to another over a Windows network, we used LAN Speed Test, which simulates this process with file sizes of 50, 100, and 200MB. One can easily see that the RPi-3 outperforms all other processors in terms of overall performance. The inference made above is repeated in table 1.

Table 1. Performance comparison of the Raspberry Pi 2 and 3

Performance Analysis	RPi - 2	RPi - 3
OS Installation	15 minutes	13 minutes
Boot time	32 seconds	28 seconds
Software Rendering	25.4 fps	38 ps

7. CONCLUSION

As a result, a cutting-edge combination of IoT and AI allowed for the creation of a novel smart mirror design that greatly improves the user's ability to interact with the device. Raspberry Pi3 Model B. versions 2 and 3 are used to implement the SM's controlling features. There was an increase in features and user interfaces so that domestic appliances could be managed. In order to improve the smart mirror display, a flat monitor is placed behind a two-way mirror, and the information is displayed in such a way that it does not obscure the user's field of vision.

Essential examination Using LAN Speed Test, which simulates data duplication from one PC to another over a Windows network with document sizes of 50, 100, and 200MB, we were able to determine how quickly the interfaces could transfer these files. The following procedures were taken to test the LAN exchange rate:

PROMOTE COLLABORATION.

To do this, I first made a sharing envelope, and then I modified the Samba client's arrangement document. It appears that the Pi 3 and Pi 2 had distinguishable quality differences with the 150MbpsWi-Fi USB connector. The response time of each board was tested under varying conditions using a CPU stack. In order to ensure more consistent results, we spaced out the tests by 20 seconds at a time. It was tested whether or not every computer could act as a server or a client during the data transfer.

to impede the normal use of a mirror. After a thorough requirement analysis, the working prototype is put into action. Consequently, a framework for the next generation of smart mirrors was created and tested on both Raspbian 2 and Raspbian 3. There are a variety of ways in which Smart Mirror systems have been put into practise. New features, such as facial recognition for user authentication and remote appliance control, can be added to the Smart Mirror to make it more useful. Users may be able to see live news reports, traffic alerts, and calendar events in the mirror of their vehicles as they go about their day. Since the needs of its users may vary, there is a great deal of room for this project to grow. So we decided to survey people of all ages to find out what they wanted, and then we came up with the idea of a novel smart mirror that could be used to control other home appliances via the Internet of Things.

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