Original Research Article

An interactive smart mirror to upgrade human life style by using Raspberry Pi microcontroller

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Abstract

Background: The smart mirror is constructed for general purpose everyday mirror. It belongs to home automation arrangement to meet regulars needs towards modern and optimized life. It provides inhabitants with a series of intelligent practices such as home appliance controller, information procurement, eco-friendly monitoring, entertainment and remote operation. It's based on intelligent home control platform. The smart mirror is planned to solve the problem of smart home communication and information amalgamation in the family. Based on the progress of Raspberry Pi, Unidirectional mirror and the infrared setting with other hardware devices. Smart mirror used as a mirror display screen and bids a kind of safer, more relaxed, more convenient, immediate and open intelligent information-based living space to home in the intellectual area.

Keywords: Automation system, Raspberry Pi, Smart mirror, etc.

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INTRODUCTION

With the help of technological advances, many products used today can be connected to the internet and made more streamlined. Smart technologies generally have an operating system in them. However, microprocessor /microcontroller, memory and peripheral interfaces are included. In the last years, mirror technology has also appeared at this point in the category of products.[1] It is expected that in the next few years, many of the fields will be used, not only in the fashion world, but also in the mirror industry, which is closely followed by fashion companies.[2] Image processing etc. systems can be used to recover the reflection mirror technology. Looking at the workshops related to the smart mirrors, it can be seen that there are many different usage areas. For example, when; all kinds of detailed information about the body (height, weight, etc.) can be given by extracting the 3D model of the body with the assistance of the sensors that the fish is contained within the mirror.[3] Situations associated with the health status are often monitored through the ray mirrors. The user can add daily exercise information by adding the necessary exercise movements. In these studies, image processing techniques are mainly used. Smart mirrors offer a variety of user-friendly possibilities as far as they can be improved. There is an intelligent mirror that also provides the current traffic situation feature with added location information.[4,5] The hypotheses are that a mirror is an ordinary product which exists in more or less every person's home. This mirror might have the possibility to work as a technical center where people could access/manage their data while looking at their reflection at home or at the office. Imagine that a smart mirror that might tell you how the level of energy consumptions looks like in your homebased or give you the chance to regulate your lamps when you are about to leave your home.[6] This speaks for the many opportunities a connected mirror could have. The possibility of this project was to progress a smart mirror into being communicating and to inspect what a user would wish to have in such a product. The process traversed through an iterative design process in

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order to optimize the user experience of The Smart Mirror using RaspberryPi microcontroller. [7,8] The purpose was to display how an interactive mirror could be employed to access and interpretation of user data. Lastly, the goal was to enable morning practices as a person walks by the mirror and could then get an indication of relevant information. In this paper, an intelligent mirror made using raspberry pi microcontroller, intended for the home-based Internet of things. The interactive smart mirror is made of raspberry pi microcontroller as the host controller. In working state, the system by raspberry pi is connected to the network over WIFI, and obtain data about the weather forecast from the API network interface definite dressing index, time, date and other information, and then through the information displayed on the plasma display.[9] The user can interact with the mirror, such as asking the mirror the news, weather, time etc. the mirror can automatically obtain the corresponding data network and broadcast. The planned intelligent mirror has of small size, low cost and simple operation methods has broad application prospects.[10] The drawback of this kind of mirror that it will not support gesture control so as to make the mirror more communicating. B. P. Kulkarni, A. V. Joshi, V. V. Jadhav and A. T Dhamange P proposed a smart mirror system that represents an elegant interface for glancing information and also used for thief detection in a home environment. A smart mirror is a system that functions as mirror with additional capability of displaying date, time, current temperature, weather details.[11] To design a smart mirror that receives an on news on network and show it using Internet of Things (IoT) circuitry and to detect thief when nobody in the house. This research article mostly based on the connectivity and the enhancements that will take place between the mirror and the net.[12] There are this micro-controller cards on-board, these arrangements which can connect to the internet and take data from the internet, can show this information on the places located on the mirror. In this report, the innovative intelligent mirror system contains the weather information, location information and time, user information, current event information camera image taken from web services using Raspberry Pi 3 micro-controller card. Some equipment can be controlled by voice commands via the microphone on the smart mirror. V. Khanna *et al.* created Smart Mirror system which allows users to access information and also control the lights in the house.[13] Relevant information can be traced such as time and date, weather, warning, traffic, and location map. The system put on Sonus technology as a medium of dealings between persons and systems. So, operators essential to provide directions to the system verbally to acquire the system's response. Sonus is a speech to text library that can swiftly and easily add a VUI (Voice User Interface) to any computer hardware or software project. Through this Smart Mirror system, users can be able to do their daily activities at ease as well as resolving numerous problems in managing some household chores. J. Jose, R. Chakravarthy, J. Jacob, M. M. Ali and S. M. Dsouza proposed the interactive mirror with proper embedded intelligence for offering enhanced features such as weather of the city, latest updates of news and headlines and local time corresponding to the location.[14] "The Smart Mirror would help in developing smart houses with embedded artificial intelligence, as well as finding its applications in industries. Ambient Artificial Intelligence (AmI) is technology used in proposed smart mirror".[15]

MATERIALS AND METHODS

2.1. Proposed system architecture

Smart Mirror is the latest advancement, where a mirror becomes interactive by providing the user with required information displaying on the mirror. An individual in his/her daily life finds it difficult to find time for news-updates or any other information. So, the Smart Mirror kinds it way for construction a conventional mirror to work "Smart".

Figure 2.1: Smart Mirror Architecture

Fig 2.1. shows the construction of Smart Mirror, wherever a two-way mirror, LED monitor, Raspberry Pi 4B is used. Raspberry-Pi 4B has built in wi-fi access such that the information which is displayed on the monitor is accessed via Wi-Fi. A two-way mirror with wooden frame is attached to the LED monitor, such that the information displayed on the mirror is appeared on the mirror.

2.2. Working

- Interactive mirror is a RaspberryPi microcontroller (low powered minicomputer) based and shows necessary information in the presence of the user with the help of internet.
- In the planned system, Raspberry Pi 4 B microcontroller is used which includes 1 GB SD-RAM, runs on Linux platform and needs 700mA.
- For display here we used LED monitor

- A single sided mirror is placed on the LED screen which acts as a regular mirror when there is no light behind it or act as a glass window where information is displayed.
- In order to retrieve updated data from the web sources various data feeds can be used such as RSS feed.
- For compliment we can use coding which is change and upgrade from system programming of magic mirror.
- For live weather update it use weather forecast internet side.

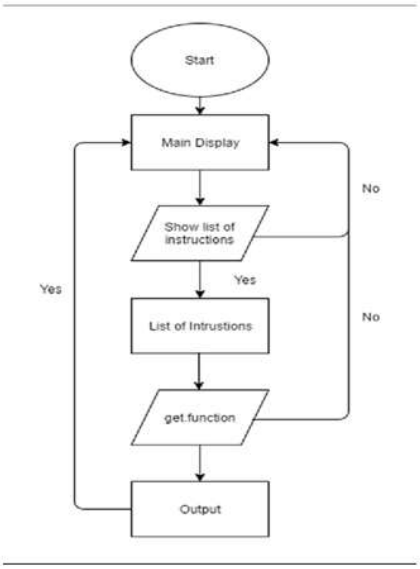

Figure 2.3: Flow chart

2.4 Software used

2.4.1 Raspberry pi imager

The Raspberry Pi microcontroller Foundation just released a new tomography application for burning SD cards for the Raspberry Pi. The novel program, called as Raspberry Pi Imager, debuted on March 5th, 2020.

Raspberry Pi Imager creates the imaging procedure much cooler and faster. It concentrates all of the most common imaging apparatuses and software you need into one bundle. Raspberry Pi Imager contains Raspbian as well as other operating systems. If somewhat remain listed, you can use the custom image tool to include your own images. Raspberry Pi Imager is free to install from the official Raspberry Pi website. It's existing for Windows, MacOS and Ubuntu systems Download the Raspberry Pi Imager installer in your system for supporting operating system.

Run the installer and track the prompts to complete the setup.

Figure 2.4.1: Raspberry Pi imager

By using Raspberry Pi Imager to burn images to SD cards for the Raspberry Pi. Raspberry Pi Imager comes with a few operating systems to select from, so you don't have to download whatever distinctly. If you want to install a custom image, you can follow the commands on the following step.

1. Launch Raspberry Pi Imager.
2. Click Choose OS. The options rather replace NOOBS, provided that a couple of fundamental operating systems like Raspberry Pi OS.
3. Select an OS from the list.
4. Click Choose SD card.
5. Select from the list the SD card you want to write to.

Click Write to begin the image writing process.

2.5 Operating system

2.5.1 Raspbian

Raspbian may be a free operating system which constructed on Debian optimized for the Raspberry Pi computer hardware. Any software system is the set of basic programs and utilities that build your Raspberry Pi run. However, Raspbian provides over more than a pure OS: it comes with over thirty-five thousand packages, pre-compiled code software bundled in a very nice format for simple installation on your Raspberry Pi.

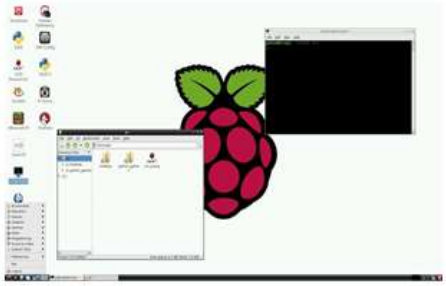

Figure 2.5.1: Operating System Raspbian

The initial build of over thirty-five thousand Raspbian packages, optimized for best performance on the Raspberry Pi, was completed in Gregorian Calendar Month of June of 2012. However, Raspbian continues to

be below active development with focus on rising the steadiness and performance of as several Debian packages as possible. Every Raspberry Pi board comes with the official Raspberry Pi OS. At the start titled Raspbian, it is an Operating System associated with the Raspberry Pi microcontroller. Though the primary instances of the board weren't running this OS, the Raspberry Pi Foundation quickly created it, thus any board afterward June 2012 was well-suited with it. It practices an Open box stacking window manager associated with its own unique theme to bring a cohesive and unique user experience. Each distribution of the OS will come with an algebra program called Wolfram Mathematica, likewise the Minecraft: Pi Edition game, in addition to a hyper-lightweight version of Chromium.

2.6. Proposed System

This planned Interactive mirror is intended to achieve numerous activities i.e., it shows time and date sideways with current weather, compliments and news feed impulsively whenever the system is turned ON. Despite of displaying the information that is already in the existing system, this system is advanced enough to provide the latest information like Real-time COVID- 19 news, Calendar along with Indian holidays, Weekly schedule and activities, Weekly weather forecast, Random Quotes. These all features are again included in an on-screen menu so as to Hide and Show the information whenever needed on just One-click. It can be used as a normal displaying mirror when the system is turned OFF. This system lets the operators to use even if their hands are dry or wet or dirty, daytime or night.

The Proposed System Is Further Divided into Two Modules. They Are:

- Hardware configuration module
- Smart mirror display module

2.6.1 Hardware Configuration Module

The two-way mirror is positioned in front of the whole setup, facing non – reflective side (dark side) to the front and the display made of LED is positioned at the reflective side (bright side) of the mirror. Mouse and Keyboard are also connected to Raspberry Pi so that they provide commands to run the MagicMirror and also to control the modules present in the mirror. Raspberry pi which works as a CPU connected to the whole setup is provided with power supply using a cable so as to supply power to every component. Raspberry pi is also associated with Ethernet / Wi-Fi to capture Internet that is used to apprise information every minute. To work in raspbian OS, it is installed and dumped onto SD card, which is inserted in a Raspberry pi. This complete setup is established in a wooden frame to protection.

2.6.2 Smart Mirror Display Module

Whenever the system is turned ON, the Mirror displays the information like time, date, compliments, current weather information and News feed. The modules that are displayed on the interactive modular smart mirror are: Time, Date, Current weather, Weekly weather forecast, Compliments based on time, News feed, Calendar with Indian holiday.

2.6.3 Advantages of the Proposed System

A two-sided mirror shows like a actual reflecting mirror (i.e., normal mirror). • The mirror will automatically sleep whenever there is no action. • As the system is enabled with various No. of components, the usage of phones and all electronic gadgets are abridged.

2.6.4 System Design

The system architecture of an Interactive modular based Smart mirror is shown in Fig 2.6.4. The two-way mirror which is chief object located at the front of entire setup and acts as both for reflection and transparent purpose. Then an LED display which demonstrations the info to a user is located just behind the mirror. The other physical devices i.e., Power supply cable to supply power to whole setup from Raspberry pi, Mouse and Keyboard to provide input/exit commands to the mirror. The user can select any of the modules from an On-screen menu present in the mirror that can be accessed using Keyboard/ Mouse. The entire code is dumped onto an SD card and inserted into Raspberry pi. The whole data is occupied by raspberry pi using internet connection i.e., connected using either Ethernet (LAN) or wireless (Wi-Fi) connectivity.

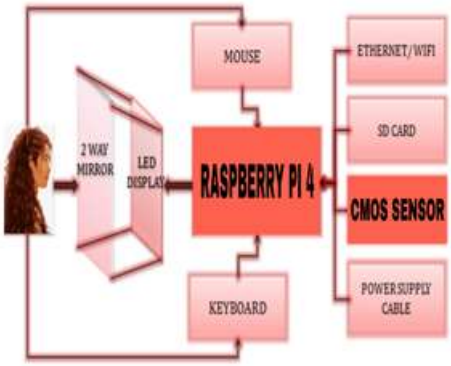

Figure 2.6.4: Block diagram of Interactive Modular Smart Mirror

2.6.5 Arrangement of Components

The components arrangement is as shown in Fig 2.6.5.a The 2-way mirror is positioned at the front of the setup right after the front frame which places every component right. Behind the mirror, LED display is placed i.e., at the reflective side. At the same side, it also has touch sensor to wake up when display is off along with the keyboard and Mouse. These components are directly connected to the

Raspberry Pi along with the power supply. Then this is positioned in a back frame.

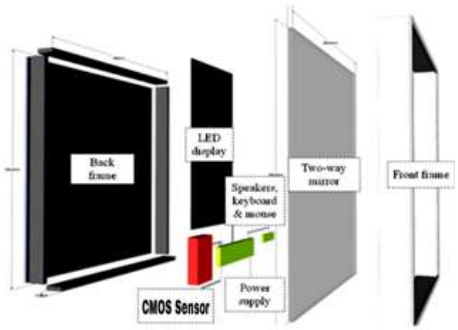

Figure 2.6.5.a: Arrangement of components

The figure 2.6.5.b shows mirror's user interfaces which is of high-level. Firstly, the mirror mimics as a normal mirror. Secondly the user can access the inner modules using an On-screen menu. Then the user can gain access over personalized service using the information services.

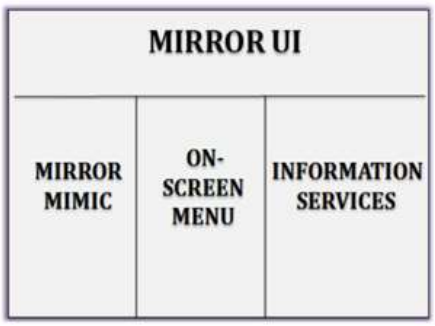

Fig 2.6.5.b: Mirror User Interface (UI)

2.7 The Proposed System Functions

Mirror mimic: The first and foremost function of this smart mirror is to perform its usual functionality, i.e., to perform it as a real time reflective mirror until the system is turned ON. On-screen menu: The user gains accessibility over the modules that are of non-basic modules and can even be hidden or shown to the user with just One-click using either Mouse / Keyboard. Information service: The mirror performs a smart activity by displaying various kinds of information over a normal Two-way mirror. Since the system is connected to an internet, it gets Real-Time updates.

2.8 Implementation

The Interactive Modular Smart Mirror consists of various kinds of modules that perform over the normal Two-way mirror. Whenever the mirror is turned ON with a power supply, the Raspberry pi takes it to the Raspbian environment. Then in the Raspberry pi terminal when the command "cd MagicMirror" is run, the Raspberry pi will be working under MagicMirror operating system. Then again when the command "npm start" is given, the Magic mirror will be turned ON. It directly displays the basic modules of Time of the corresponding location, Date, and Compliments based on time and are of random that are given within in the code, News feed and headlines which are updated from time - to - time and are also taken from the one of the famous News articles: "Hindustan Times" and it also displays the updated time and date. If the News was updated on same day, it displays as "updated at so and so hours or minutes ago". The system also displays Current Weather forecast along with the temperature that is felt to a human body and is based on the city which is mentioned. This system doesn't only consist of the basic modules but also have various advanced and latest modules which are integrated onto one display screen. It has a Weekly Weather forecast module which displays the weather conditions of one whole week along with the maximum and minimum temperature conditions. But the user must register in the open weather website and provide the API (Application Programming Interface) key as well as the location ID to display the weather conditions based on the particular city. It has a Live COVID-19 news which displays the top 4 countries present in the statistics provided by a webpage and the data feeds are given to an authenticated user who provides the API key given by the registered website. It displays the total no of cases present all over world. Not only that but it also consists of the rate of newly confirmed cases, total no. of deaths and newly confirmed cases, recovered cases and the rate of presently active cases along with the statistics of updated date and time. It also has a Calendar with Indian Holidays along with duration and the top 5 are taken in them. Whenever we wanted to learn some quotes, my proposed smart mirror also displays some random quotes. The screen which is displayed is never a black back grounded one, but has a screen which variousimages that are displayed randomly based on the specific amount of time. Whenever the user forgets some of the important meetings or any of the schedules, this smart mirror displays the schedule as per the week. My proposed system consists of weekly Household chores and the activities along with a small note written on it and that are to be performed and also the fruit to be eaten on a particular day with some image of it. So as to not make the screen clumsy, I have included an On screen menu that has various modules that can be either hided or displayed whenever I want with just One-click using a mouse or even can be operated using a keyboard. The mouse pointer doesn't interrupt the display purpose.

2.9 Dataflow Diagram

The Interactive Modular Smart Mirror as shown in Fig – 5.9. Once the operator gives somewhat input commands after turning ON the device from sleep mode, the interactive mirror is turned ON and shows Time and Date,

Compliments, News Feed and Current Weather Forecast. The user can select either Hide or Show the modules from an On-screen menu like COVID-19 news, Weekly schedules, Calendar with Indian holidays or weekly weather forecast, it performs accordingly. Whenever the user gives an exit command, the smart mirror display turns OFF.

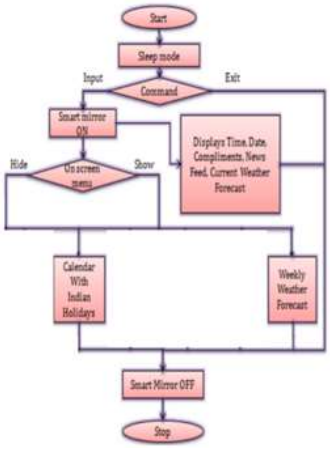

Figure 2.9: Flowchart of an Interactive Modular Smart Mirror

Step-1: Start
Step-2: The system is in sleep mode when is no activity.
Step-3: When the user gives an input command, the Smart
Step-4: Displays Time, Date, Compliments, News Feed, and Current Weather Forecast.
Step-5: The user can select either Hide or Show the modules from On-screen menu
Step-6: The mirror displays COVID-19 news, Weekly schedules, Calendar with Indian holidays, Random compliments or weekly weather forecast based on the user's choice.
Step-7: When the user gives an exit command, the Smart mirror turns OFF
Step-8: Stop

RESULTS AND DISCUSSION

An interactive mirror is a Raspberry Pi microcontroller (low powered minicomputer) based display when coupled to the internet it picks and shows the essential information in the presence of the operator. In the proposed system, Raspberry Pi 4 B is used which contains 4 GB SDRAM, runs on Linux platform and needs 700mA. A one sided mirror is positioned on the LCD screen which turns as a regular mirror when there is no light behind it or act as a glass window where information is displayed. Only when the user stands in front of the mirror the customized information will be displayed. In order to retrieve updated data from the web sources various data feeds can be used such as RSS feed. The personal schedule of events and the updated weather reports can be obtained by using Google Calendar API and Weather API. For displaying these useful information Tkinter, a standard library GUI python module is used. We plan to design and develop such kind of futuristic smart mirror which provides a whole new experience to the user with the flavor of AmI. Our proposed smart mirror consists of a two-way mirror, acrylic glass, monitor (LED), Raspberry Pi, Raspberry Modules, sensors. A wooden frame will be prepared with LED attached behind the glass with all the sensors and the raspberry pi. The power supply is attached to the raspberry pi which will power the LED monitor and the sensors. Once the mirror is activated, it will connect to the docker which contains all API and software needed to run the mirror. This will require internet access which will be provided by the Wi-Fi module (LAN can be also used) on the raspberry pi.

Figure 3.1: Mirror displaying date, time and whether; **Figure 3.2:** Displaying components, wiring, RaspberryPi microcontroller of system; **Figure 3.3:** Mirror displaying compliments

The virtual layout that will be prepared using HTML and CSS will be displayed on the mirror when it is turned on and will show calendar, weather and news headlines. The mirror will perform facial recognition which will be helpful for real time image zoom in and out. This will be one with help of OpenCV and some java programming. The software will be programmed on java and python and Node.js will be used as a server-side language. The proposed smart mirror will perform some advanced features that are discussed in the V section of this report.

The proposed smart mirror will perform these tasks: 1. A normal two-way mirror and acrylic glass will display real time image. 2. After activation the mirror will display weather, time and news. 3. The mirror will automatically sleep, if we want to again turn the mirror display then just touch the CMOS sensor which mounted on the right side of the mirror. The output is generated from the smart mirror in the form of text feature. Mainly the output contains the basic features of a smart mirror like weather, time, calendar, holidays etc.

Power Consumption

power usage is measured in kilowatt hours 1000 watts, used for an hour. watts are volts times amps. so, aspect on the tag for the power devices and get the volts and amps used. (Not supplied). My pi4 power source usages 120vac at 0.3 amps, so 36 watts per hr. my 55 in tv uses 120v and 82 watts (already multiplied) (while turned on) (5 watt turned off) so, that is 36+82 = 118 watts for both. multiply each and then add them together. (118) my power is measured and paid once-a-month, multiply the cost (watts cast-off in an hour) times 24 * 30 for a month's usage, mine 84860 watts per month divide by 1000 (kilo) 84 KW/month into my power cost 8 cents/kilowatt is about $6-7 a month at 24 hr. a day usage. I blanked the screen (tv doesn't support programmatic turn off/on) so it must be less, ought to measured it the TV usage from the manufacturer say $19/year, but they don't expect 24/7 usage, and don't provide the power cost info in spreadsheet form

CONCLUSION

A completed and functioning Smart Mirror is now ready using RaspberryPi Microcontroller. The project set out to have a mirror that could display a dynamic date and time. We were also able to include a weather display and IR senser that allowed us to motion-activated start for saving power consumption. We achieved a smooth and natural interaction behavior between users and the Smart Mirror, as well as investigate what content is of interest for the users. So, we conclude that interactive smart mirror using RaspberryPi Microcontroller met most of the goals laid out in our original Scope Statement.

Future Scope

In our future plan following upgradation is to be a scope of improvement

1. We aimed to have the product be able to display information that the Alexa (smart home device) would return, upon a user's request.
2. Touchscreen and voice-controlled is to be added for alternative input source in order to allow a smoother experience.

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