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Implementation of Home automation system using Smart Mirror

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ABSTRACT: This paper presents the design and the development of a futuristic and very interactive Smart Mirror with artificial intelligence for the ambient home automation [6] and commercial uses in the organization also in public environments. This application collects the real-world machine data and displayed it to the user based on his / her requirements. The complete control of Smart Mirror is done by the Raspberry Pi module. This Smart Mirror is implemented using some of the peripheral devices like LCD Screen, microphone, speakers and two-way acrylic sheet to cover the LCD Screen and powered by the Raspberry Pi. The features of the Smart Mirror are weather of the city, latest news updates, date and time. We can interact with the Smart Mirror through the voice commands.

KEYWORDS: Raspberry Pi, Internet of Things, Artificial Intelligence, Smart Mirror, Home Automation, Python.

I. INTRODUCTION

The world around us is inconsistent. With the advancement in both science and technology, people are moving towards a more automated lifestyle. Some of the automated areas like smart cities, smart cars, smartphones, and smart homes[8, 9] and to survive in this automated world, we need many home automation systems using the Internet of Things (IoT) devices. IoT is an integrated system used for the running of task autonomously. It is the connection of Wireless Sensor Network devices.

Many real-world applications exist for the home automation like closing and opening of doors/windows automatically when a person enters or exists, turning on and off the light and fan in the home, organization from anywhere and anytime through mobile. This paper mainly focuses on the Smart Mirror using IoT which works with the help of Raspberry Pi.

A mirror is an essential part of everyone's daily routine. What if we find in the mirror more than ourselves? What if the mirror reminds you about the important meeting scheduled at 1 PM? What if the mirror alerts you to wear a sweater or raincoat while you are going out? This is the main purpose introducing smart mirror.

A Smart Mirror can display the weather, time, date and traffic conditions on the mirror. These all features can be implemented by using the Raspberry Pi and the data from the internet. Raspberry Pi runs with Raspbian Jessie PIXEL Operating System (OS). The common procedure of building a Smart Mirror is by using an acrylic sheet covered over the LCD monitors. The Web browser and JavaScript or Python are used for the UI display.

The usage of Smart Mirror provides many advantages, it makes life easier i.e. we do not need to check mobile for notifications, weather updates etc., This can be advanced by introducing the motion sensor to detect the motion of the objects and can be able to watch the movies, read news and also all our home appliances can be controlled with Smart Mirror.

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II. RELATED WORK

The design of Smart Mirror is to perform certain functionalities. A flat LCD Monitor is used for mimicking of mirror and interfaces to display. A two-way acrylic sheet is placed on the LCD Screen and both the mimicking function as well as the newsfeed, date, time are shown on the LCD Screen (in the monitor).

The proposed Smart Mirror enables us to access the different services and information. This design of Smart Mirror is used for the user interaction with the Mirror. Some of the related applications to this Smart Mirror are discussed below:

A. PHILIPS HOMELAB

Philips HomeLab [1] is one of the applications for creating perspective and context-aware home environments. Most of the projects environments the creating of the personal care environment uses the Interactive Mirror [2]. This type of the mirror is used in the bathrooms to provide the weather, temperature and Newsfeed. It consists of the LCD screen and the mirrored surface to display the services to the user using the Web Services[12].

B. INTERACTIVE MIRROR

Interactive Mirror is the touch and gesture-based functional mirror created by Alpay Kasal and Sam Ewen. The user can able to touch the mirror and can able to control the services. The mirror is basically less among data and high in the art. The mouse is also kept handling some of the functions, but the Smart Mirror is used to know the date, time, and News daily [2].

C. HUD MIRROR

The HUD Mirror was designed by 5 students of Chalmers University of Technology in Sweden. They made this mirror to place in the bathroom and it was designed with the LED lights to display the time, date, weather and also toothbrush timer. Touch screen interaction is also done with the LDR's as a button behind the mirror so that if we touch the screen lights will glow [4]. This can be configured by the Arduino and lights will glow when we touch it is similar to the Smart Mirror [3].

D. MAGIC MIRROR

The Magic Mirror was developed by the New York Times Research and Development (NTRD) Lab. It uses Microsoft Kinect to track movements and TV with the mirror to display. It also consists of the voice recognition technology and it is integrated with the RFID Reader to identify the bathroom products. This system runs on Windows and uses Kinect to virtually give the extra features to the user. It also allows the ability to check calendars, email and social media, which are implemented in our Smart Mirror as well [5, 8, 10, 11].

III. IMPLEMENTATION OF HOME AUTOMATIONSYSTEM USING SMART MIRROR

The proposed Smart Mirror has many features like home automation, controlling the home appliances like A.C, TV, lights and fans like Google Home. It will display news feed, date, time and weather to the user in the monitor display. It is designed using building block architecture, so it can be used for extended functionalities and scalable. IoT systems can be controlled using the Smart Mirror.

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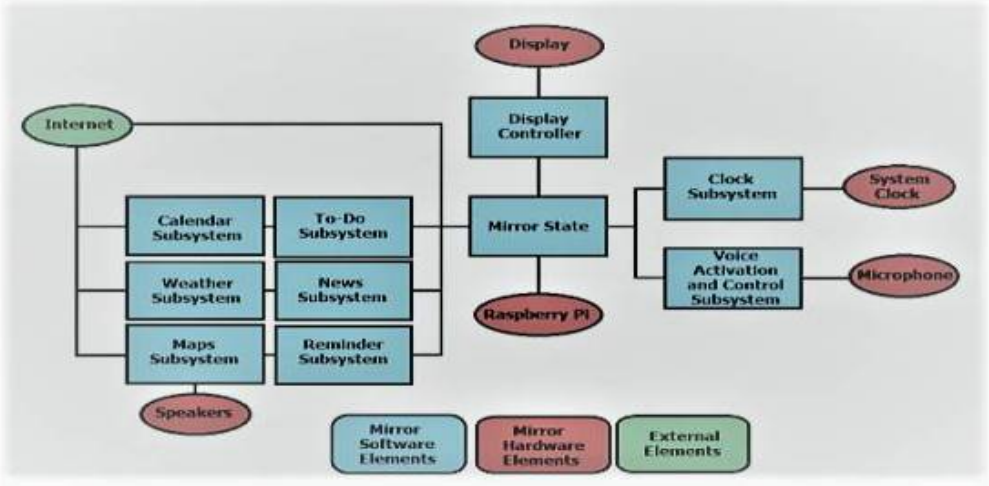

Figure 1: Data flow in the Smart Mirror

This Smart Mirror is designed to mimic the natural mirror interfaces. A two-way acrylic mirror used for displaying the mirror and the regular functionality of the mirror. Flat LCD monitor is used for display which is powered by Raspberry Pi.

The Smart Mirror has the functionalities of the modern-day smartphone applications implemented in form of the widgets. Some applications like Google Maps (Real-time traffic displaying), YouTube (playing videos), and date, time widgets (displaying date and time). It collects the data from the Internet. Weather widget (displays the weather). Location services (automatically or manually). The temperature widget (displays the temperature in Fahrenheit or Celsius). The complete system is designed according to the requirement of the user.

Users can get the multiple updates of the News and public headlines with Rich Site Summary (RSS) feed widget. Along with the features explained above and much functionality are present like event reminder, timer etc.

IV. SYSTEM ARCHITECTURE AND DESIGNSIMULATION RESULTS

The Smart Mirror is decorated with several widgets. It is a simple window frame that contains an embedded browser in it. There are two types of widgets one is automatically displayed to the user like date, time and newsfeed etc., by invoking a starting of the Mirror. The Second was triggered as per the command is given to the mirror like switching on/off fan, light etc.

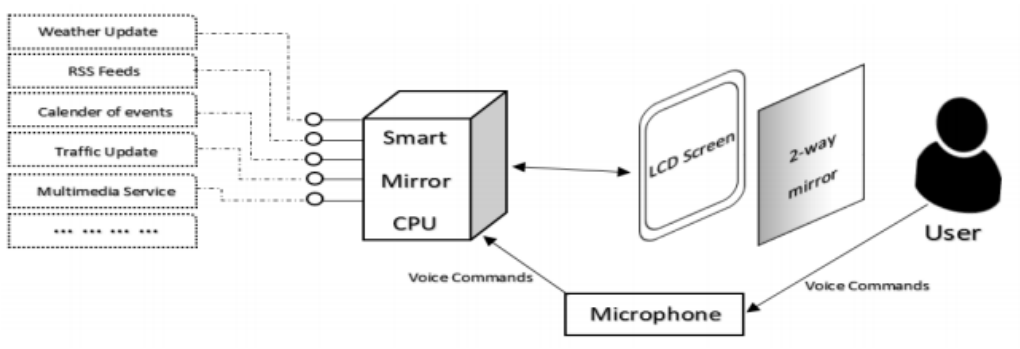

Figure 2: Architecture of Smart Mirror

The Mirror UI widgets instruct Raspberry Pi to control the requested Services by the user. The Raspberry Pi is configured to listen to voice commands and performs associated task with it. The Smart Mirror is powered by

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Raspberry Pi and the output is displayed in monitor to the user. The acrylic sheet was placed on the monitor so that it gets covered completely and displays the complete widgets and, ourselves and can be implemented in the home, work, college and public environments.

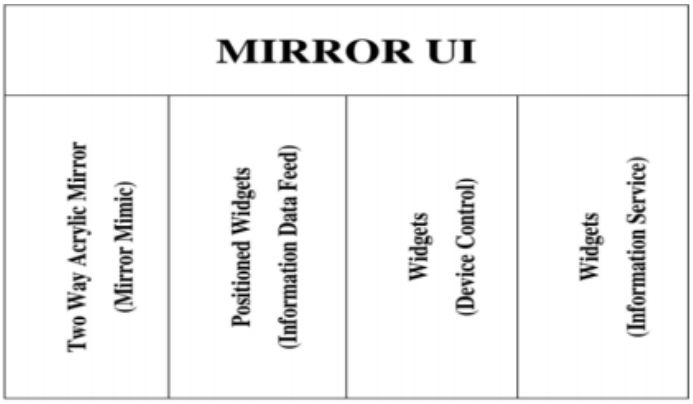

Figure 3: Mirror User Interface

The Smart Mirror widgets are very customizable according to the user's requirements. These are implemented in building block manner so that the users can choose functions of the widgets easily and displayed the result to the user at any point of time.

A. SMART MIRROR CPU (Raspberry Pi)

This Raspberry Pi is used to collect the data from the internet through various API's and websites for weather, date, time and newsfeed. This Raspberry Pi is responsible for doing all the computations and performances in the Mirror.

B. TWO – WAY ACRYLIC SHEET

The two-way acrylic sheet is used for mimicking the natural mirror interfaces and also the regular functionality of the mirror.

C. LCD SCREEN

The LCD Screen is used for the displaying of the widgets to the user by collecting data from internet and converting it into widgets.

V. SIMULATION

The main functional features and modules of the Smart Mirror were simulated and tested prior to the completion of the system. Each aspect constituted a test case for simulation of the Smart Mirror. The test cases were documented in a systematic manner and each test case contained the following fields of information - A serial number, the name of the functional module to be simulated upon, the description of the simulation, the input data and conditions for the module to be simulated upon, the output of the simulations on the module based on the input data and conditions, and a results section which indicated whether the particular simulation was successful, partially successful, or unsuccessful on the module in consideration.

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Serial Number	Module to be Simulated	Description	Input	Output	Results
1	USB Microphone and Audio Output Jack on the Raspberry Pi	Advanced Linux Sound Architecture (ALSA) needs to be configured and explicitly notified about the input and output devices for sound. This is because manipulating sound input/output in Linux systems is complex. Hence, Raspbian (Operating system used) needs to be explicitly informed about the audio input and output devices (USB Microphone and Audio Output Jack on the Raspberry Pi.	Using commands in the terminal, the hardware information of the devices are determined and used to alter the operating system files and configure ALSA.	The hadrware device information was detected, the files modified correctly, and the devices were recognized and usable as required. When the hotword "Smart Mirror" was given while testing the USB Microphone in the terminal, it was detected correctly.	The simulation was successful.
2	Node Package Manager (NPM) Database Connection	When the Smart Mirror program is executed, it tries to connect to NPM Database (SQL server) using the data source and catalogue. If the connection details are correct, the Database is connected, else an error is displayed. Successful connection results in execution of the Smart Mirror appliction.	The command "npm start" is used to initialize the Smart Mirror application.	The connection was established and the Smart Mirror application executed and run successfully.	The simulation was successful.
3	Speech to Text and Hotword Detection	When the user inputs a voice command, it must be recognised and interpreted. A voice training method is adopted to enable the mirror to get activated when the attached microphone picks up on a voice command. Sonus, Sound Exchange (SoX) Libraries, Snowboy, and Google Speech API are used to detect voice commands and convert speech to text.	User's voice is input for interpretation.	Sonus uses SoX Libraries to convert raw audio input into 16-bit binary files that are sent to the Google Speech API for conversion to text. Snowboy is responsible for the Smart Mirror to always listen for an output as well as for detection of the hotword. Once the hotword is detected, the bottom of the Smart Mirror screen lights up, indicating that the user can subsequently input a voice command. If the voice can be decoded, the speech is appropriately converted to its respective text format and displayed and its associated command is executed.	The simulation was successful.
4	Module and System Functionality	The functionality of individual modules as well as the combined functionality of all the modules implemented into the system are simulated and tested.	User gives voice commands to activate the functionality of the various modules implemented in the Smart Mirror system.	The individual modules like Maps, YouTube videos, Countdown Timer, and others that have been implemented, display the appropriate outputs to the user based on the input commands. The entire system works correctly as one cohesive unit.	The simulation was successful.

Table 1: Simulation and Results

The given input data for modules for simulation and testing consists of module-specific data. The inputs must be relevant to the module and it's being simulated and tested for an accurate result. The test cases used for checking the correctness of the development of the Smart Mirror and find whether the complete system works correctly individually and in a combined functional unit. The above following table represents the simulation process on the different main functional modules of the Smart Mirror system as well as the results obtained from each simulation case.

VI. RESULTS AND DISCUSSION

The Smart Mirror system is developed to use like a Smartphone by the user. The concepts and methodologies that are implemented in the way, we can have the interaction with the mirror directly and it is very interactive, reliable and easy to use by the users. The architecture adopted is to develop and deploy many services like date, time etc. by collecting data from the internet. This Smart Mirror can be used for the extended home automation systems also by controlling the fans; lights etc. from the Smart Mirror display by touching or by gestures can be implemented.

A user's personalized data such as newsfeed, date, calendar and other information can be known and displayed back to the user on the Smart Mirror screen. The Smart Mirror uses voice commands to perform the tasks given by the user to mirror. We can implement this Smart

Mirror system in schools, colleges, and public environments.

This Smart Mirror has been developed by using building block model, so it is very easy to extend the project. The extension of the project can be done just by writing it as a plugin to the system and implemented as per the user needs. It is very scalable and future enhancements are done very simply.

The Smart Mirror developed takes an average of 15 seconds to start the execution once the command is executed in the terminal window of the Raspberry Pi. On starting the process, the Raspberry Pi connected to the internet collects the data from various websites and finally displayed it to the user.

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Figure 4: Smart Mirror displaying temperature, date & time and news feed

The output of the Smart Mirror is shown in above figure 4 which contains the temperature, date & time and news feed. The temperature can be displayed either in Celsius or Fahrenheit. The date can also be displayed in both 12 and 24 hours format as per the user requirements.

Figure 5: Smart Mirror interacting with the user

The Smart Mirror interacting with the users is shown in figure 5. The Smart Mirror interacts with the voice through the speaker and takes the input from the microphone.

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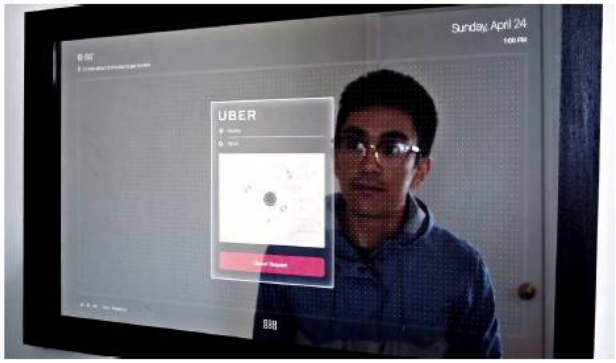

Figure 6: Smart Mirror finding place in the Uber Website.

The Smart Mirror displaying the location to the user in the Uber website is shown in figure 6. The Smart Mirror able to display the Uber website to book the cab or to track the location of the user through voice commands.

VII. CONCLUSION AND FUTURE SCOPE

The proposed work is successfully designed, implemented and tested. Our Smart Mirror is the futuristic Smart Mirror provides natural interaction between home services and the users. The main purpose of this Smart Mirror is to automate the home and it provides a lot of functionalities like displaying the time, date, weather and news feed to the user. It can also play the videos and interact with the users through voice commands. It is very easy to implement, and it displays the content to the user in the monitor which is covered with an acrylic sheet to mimicking the natural mirror interfaces and the natural display. The content will be collected from the internet and this is powered by Raspberry Pi. This project can be extended by controlling the Smart Mirror with the hand gestures. This system can also be extended by adding the camera module for the authentication of the user to operate the Smart Mirror.

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