Smart Mirror - A Secured Application of Artificial Intelligence Recognizing Human Face and Voice

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Abstract— Smart mirrors are a new addition to the IoT family of products that has been receiving great attention in recent years from every hobbyist and industrial manufacturer. This document describes the implementation associated with the planning of a voice-controlled wall mirror, called “Magic Mirror” with artificial intelligence for the home environment. It is a mirror, which can display real-time content like time, date, weather and news at the same time. Magic Mirror consists of functionalities such as real- time information and data updates, voice commands, facial recognition. The user can control the magic mirror using voice commands.

Keywords: Artificial Intelligence, speech processing technique, IoT technology, Two-way Mirror Introduction

I. INTRODUCTION

A smart mirror is a mirror that has been improved by innovation. It is an extremely basic idea that is described in a screen is placed behind a bi-directional reflecting mirror. By using a highly contrasting graphical user interface (GUI), only white tones will infiltrate the mirror, causing an impact that influences the display as if the mirror itself were a screen. The possibility of an enthusiastic mirror is to promote this improvement to also incorporate man-made reasoning. The thoughts regarding what a cunning mirror might incorporate are enormous. It could incorporate anything identified with knowledge. It could be a mirror that perceives individuals, conversing with them, capturing a man’s propensities, it could be used as a segment in recognizing movement as a feature of an enthusiastic home.

Since many people normally use a mirror somewhere around twice a day (morning and night), it is ready to endlessly detect people’s faces without requiring unambiguous information

We need complex computational techniques to be used by less expensive equipment accessible to the general population. Consequently, the goal is to make a smart mirror that can perceive people and use it to tailor the experience to each individual customer. In this business cycle, the goal is to create a customer recognition framework that demonstrates an alternative UI for each user. The following section briefly comments on the literature review and the description of the components and software associated with it. It continues with the proposed mirror architecture. The conclusion and future scope of the mirror are also discussed in the document.

II. RELATED WORK

This part will examine related work that is relevant to this project. There are few research papers, particularly on Smart Mirrors. The main area will focus on the successes found in an appearance of logical writing, using phrases such as reflex spell, sharp mirror, and bright mirror. The next segment will focus on the sharp or cunning mirrors found in a business environment. As we’ll see, numerous manufacturers are busy with the idea, regardless of whether there are approaches before smart mirrors have an undistinguishable dimension of enthusiasm from other home gadgets. The last area will detail the brilliant mirror discoveries in the do it yourself (DIY) domain. The enthusiasm for the shiny mirror initially started as a cool DIY adventure for specialists. FitMirror Daniel Besserer et al. (2016) made a great mirror to

A. *Smart Mirror for Smart Home*

Chidambaram Sethukkarasi et al. (2016) created a smart mirror that distinguishes customers who depend on facial recognition, perceives feelings, records wellness parameters, and encourages garments. His work does not go from top to bottom in any of his subjects, but he strives to unite the thoughts under the idea of an intelligent mirror. They use Viola and Jones for face identification and face highlighting for recognition. The results were not taken into account in the discovery or recognition execution speed, however, as it appeared in this proposal, the speed of identification of faces with waterfalls, lbpfalls classifiers or HOG can be incredibly reduced by replacing the base. They are faster to see. However, the research conducted in section 6 proposes that the proper facial recognition strategy does not measure the most current techniques of the neural system. Considering that this document is from 2016, it is somewhat strange that they have decided to use their own faces.

B. *Wize Mirror*

In 2003 Phillips released his Mirror TV which was built using guidelines indistinguishable from those of smart mirrors. His item was an ordinary television that was placed behind a bi-directional reflection so that the television would ap- pear like a mirror when it kills and like a television when it is turned on. They also had an alternative to make the mirror bigger than the TV. One model of utilization exhibited by Phillips was to have children watch children’s programs while brushing their teeth in the meantime. Later, in 2005, Phillips declared his exploration adventure MyHeart based on the possibility of a light mirror. Although his exclusive Mirror TV was basically a television that also functioned as a mirror, the MyHeart task would incorporate a presentation to highlight the different restorative ideas. However, this task required body devices to collect and break down the information. The mirror itself was completed as a useful presentation.

C. *Cybertecture Smart Mirror*

James Law Cybertecture created an industrially sold Smart Re- flection in 2011. This mirror more closely matches the sharp mirror we have come to know today. The item consists of a 32 “LCD screen secured by a 37” bi-directional reflector. The showcase can indicate weather indicators, transmit web TV, the current time and different devices. Smart mirroring has various information techniques, for example remote control, cell phone application and virtual on-screen console. However, the Cybertectures mirror does not enhance the mirror with any knowledge. The mirror essentially indicates static data as configured by the client.

While an affordable item, a tag price of $ 3,600 to $ 7,700 makes it a brilliant sparking home appliance for the smart home specialty. 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 feature of this project was the addition of a medicine box scanner, which allowed the user to buy medicines recognizing their prescriptions

III. PROPOSED ALGORITHM

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 everyday 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.

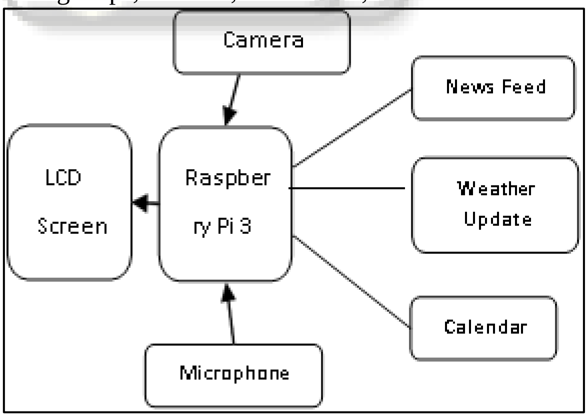
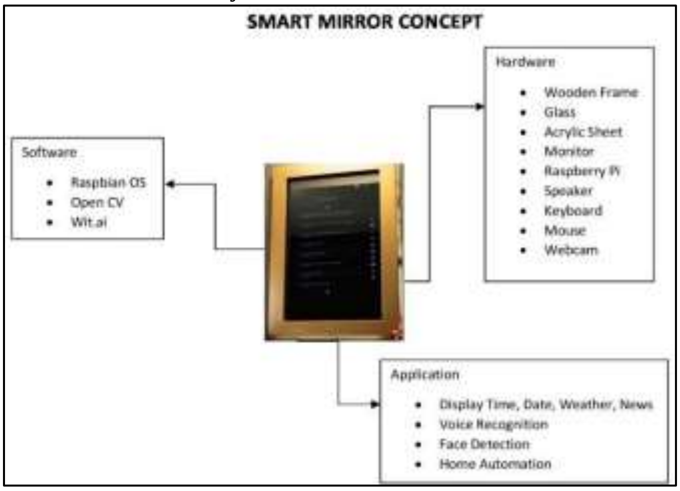


Fig. 1: Schematic view of smart mirror

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.



A. Validation

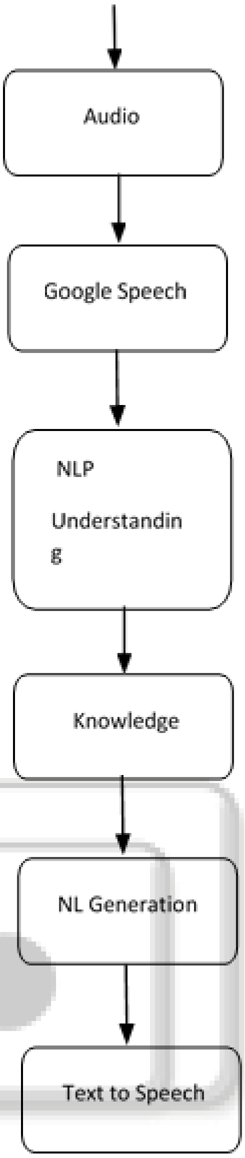
1) Time Optimization

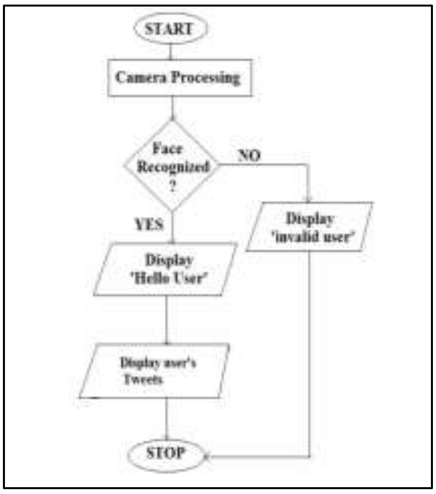
The time optimization tests were performed comparing the estimated time it takes a person to prepare to start their day in front of a mirror, while reviewing informative applications on the cell phone. For this experiment a sample of 5 people was used, to which they were asked to take the time they spend in front of the mirror at the beginning of the day and then the time was measured using the mirror. Authors and Affiliations

B. Speech Recognition Program

By the python language, which is comprised the following steps:

1) Step 1. Write the necessary voice library, including storing an array of strings for playing voice content, an array of strings storing song file names etc.
2) Step 2. Write the function of 'audiorecord' to complete the user's recording work.
3) Step 3. Write the function of voice recognition V2T, the recorded voice files submitted by Baidu voice API to return value that is converted to text results. If the API returns is 0, the recognition is successful, return otherwise the recognition is not successful, return' bad '.
4) Step 4. According to the returned string results keyword matching, the main program for the corresponding operation to meet the conditions of the voice command





C. Face Recognition

With the rapid development of smart home, we must pay attention to the issue of security [11]. For some necessary occasions, the smart mirror adds the function of face recognition. The smart mirror completes the user's face recognition operation by calling the API of the excellent figure face recognition. When there is no user in front of the smart mirror, the mirror remains in the main interface. When a user comes closer in front of the smart mirror, the smart mirror automatically turns on the face recognition service, and the contents of the mirror jump to the face recognition page.

The system automatically submits the picture of the photographed by the camera to the API of the excellent figure face recognition, and then the face identification page displays the result of the face recognition. The system compares the result with the picture in the image gallery to determine the degree of matching face. If the matching degree is higher than the set value, perform a specific task, such as outputting the voice: "the owner is back" or turn on the important door lock; if the matching degree is lower than the set value, perform a specific task, such as controlling relay conduction excitation alarm. When the mirror closer to the front again no one, the smart mirror to jump to the main interface.

In order to achieve this function, the technical solution writes face recognition webpage using html language, realizes the page jump and detects the person in front of the smart mirror using python language, which includes the following steps:

1) Step 1. Compile the face recognition pages using html language, including face recognition home page and results page.
2) Step 2. Call the GPIO library by python language, to achieve HC-SR501 infrared sensor control of face recognition and page jump control. When someone is near the front of the smart mirror, the infrared sensor outputs a high level. At this time, the system simulates pressing the ctrl + tab key to complete the page switching and starts the Raspberry Pi special camera to complete the photographing of the user. The system uploads the taken photos to the excellent face recognition API. The excellent face recognition API identifies the uploaded images and compares them with the pictures in the pre uploaded gallery by the user. After obtaining the return value of the face recognition, the results are displayed on the face recognition page, which gives results about the person's age, gender, charisma, the person most similar to the gallery, and the matching degree.
3) Step 3. According to the obtained matching degree, compared to the pre-system to set the threshold for comparison, the system will perform a particular operation whether higher or lower than the settings. When it is higher than the set value, the smart mirror will make a sound to the user. When it is lower than the set value, the smart mirror control relay will be on and the alarm will be activated.
4) Step 4. The infrared sensor constantly detect the mirror in front of the situation. When the infrared sensor does not perceive the infrared information in a closer distance, the system will press ctrl + tab key to jump to the smart mirror's main interface.

In a picture. Face training is the process of studying several pictures of the same person to learn the features specific to the individual. This process creates a database of the known users. Face prediction is the process of identifying a known or pre-registered individual in a new image. With the support of OpenCV, two modules, namely *user registration* and *user authentication*, were developed in the authentication framework. Figure 4 shows the general procedure of face recognition and registration.

1) User Registration - face detection and training

This module was implemented by taking images with a Raspberry camera. The images are passed into an OpenCV cascade classifier to identify human faces. A cascading clas sifier is a model that is pre-trained with several hundred face images, called positive examples, and negative examples arbitrary images of the same size. A sample code snippet is shown as follows:

```
//Import opencv Library
import cv2
//Loading required cascading classifiers
face =
cv2.CascadeClassifier('frontalface.xml')
//Load image and convert to grayscale mode
img = cv2.imread('image.jpg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
//Face detection in converted image
faces = face.detectMultiScale(gray, 1.3, 5)
//Save image containing faces to disc
```

If a face is identified in an image frame, the frame is saved. This step is repeated until 20 pictures of the user are saved and entitled with a unique integer and the image count (ranging 1 - 20). A unique integer is generated for each user in the system. Then the training process starts. All the saved images are loaded into an array, named faces, and passed into a recognizer. The recognizer is created as an instance of the OpenCV Local Binary Patterns Histograms class. Local Binary Patterns (LBP) describes a method for extracting useful features from face images. Basically, this method summarizes the local structure in an image by comparing each pixel with its neighbors.

say the selected pass phrase, e.g., "remember to wash your hands before eating". Once the pass phrase is detected using the Google speech-to-text" API, it is saved as a wave file and represents the user's voiceprint. The voiceprint is then passed to the "createEnrollment" method of the VoiceIt API to create an enrollment for the user. Five enrollments are required from each user to ensure high accuracy.

2) User Authentication

To authenticate a user using the voice recognition module, the microphone is turned on and the user is prompted to say the pass phrase saved during registration. The pass phrase may not be sensitive, but how the user says it is (i.e., the voiceprint). Again, like in the enrollment stage, the user's voiceprint is recorded as a wave file and passed as a parameter to the "authenticateUser method of the VoiceIt API. A response is sent in the form of a JSON file indicating whether the authentication is successful or not. A response code of "SUC" indicates success and a response code of "ATF indicates authentication failure, which is determined by a confidence value that ranges from 0 to 100. A value of 100 indicates a perfect match. The system has a learning capability wherein it enrolls new voice prints for the user using authentications that have a confidence of 90% and above. In this way, the system keeps learning little changes that may occur over time in the voice pattern of the user, as shown in Figure 6.

D. Voice Based Command

The system supports interaction between user and system. Users can control all functions using voice commands, includ ing registration, authentication, searching, and signing out. The
Speech-to-Text is implemented in "wake word" detection,

1) Wake Word Detection

Like other voice-controlled systems, this project implements the use of a wake word. A wake word is a word or phrase that is uttered by the user to notify the system that he is ready to give an instruction. The system, upon detection of the wake word, begins to wait for instructions. The smart mirror uses the phrase "smart mirror" as the wake work. Once the smart mirror detects the wake word, it listens for the following instruction, such as login, logout etc.

IV. PERFORMANCE EVALUATION

After setting up all the hardware and software components, the model was checked for the outcome. The first launch wasn't successful as the AI wasn't taking any voice command due to the failure of ffmpeg and speech recognizer package. However, the library and package were reinstalled and then launched the model again. This time, it could recognize the voice but the model was responding very slowly.

Next, the problem we faced launching the system was to make the AI understand the different types of entities, as the app was trained under wit.ai. The different entities in every launch was created as the amount of voice command as well as understanding level of AI was increasing. So, some fixed entities were added to enrich knowledge of the AI.

Furthermore, the model was not fast enough as the RAM of the Raspberry Pi was only 1.0 GB and the processor was only 1.2 GHz. However, overclocking the pi processor was tried and came up with a good result. The GPU was decreased to get the maximum amount of speed from the Raspberry Pi.

CPU Speed (arm speed) (CC/s)	GPU Speed (CC/s)	Efficiency (%)
800	126	80
1100	126	85
1350	16	90

V. WORKING PRINCIPLE

Figure 2 shows the overall architecture of the smart mirror.

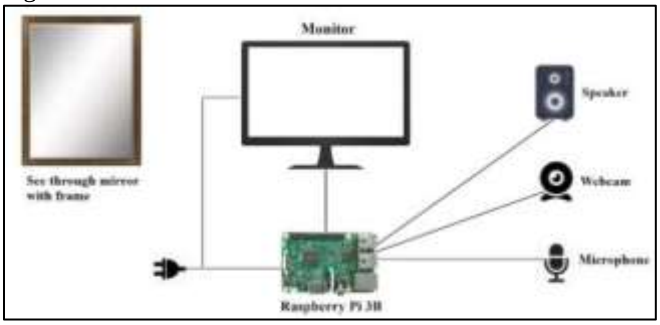


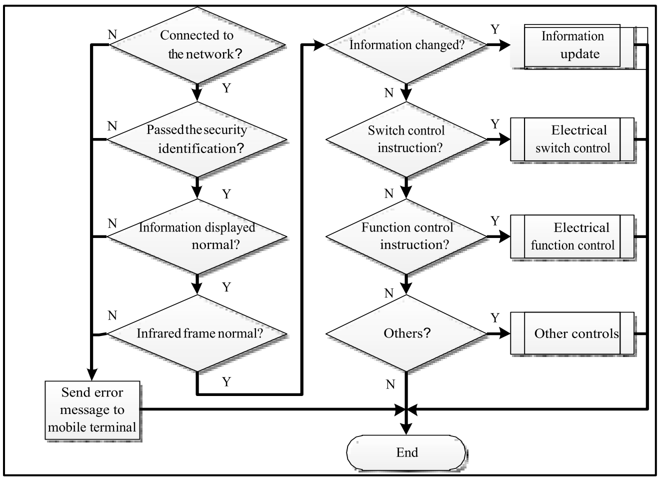
Figure 2 is a pictorial view of the overall hardware set- up. First, a frame for the mirror was built and attached the two-way see through mirror with it. One side of the frame was for the viewing of user and on the other side was assembled all the hardware components. A LCD was attached to display with the frame and connect the LCD display with the raspberry pi via HDMI cable. USB micro- phone 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 v5.1.1 was reinstalled which included the NPM v1.9. Next, pip was installed which was a package installer of python and it helped to install numerous packages. However, python Speech Recognition 3.8.1 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.

Now moving to the coding and designing part, HTML, CSS and JavaScript were used to display the information on the LCD display in such a way that only the information's would appear before the user. 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): Figure 3 shows the working principle of AI.

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. Then the AI needed to retrieve relevant information as per user request and this the knowledge phase was called. Once the information is obtained, AI needs to form a complete sentence to express the information, so this is done in the Natural Language Generation state. The AI has a complete MagicMirror2 is a measured structure initiated by Michael Teeuw that is transmitted by most specialists as they make their own mystical mirror. The structure offers a simple combination of external modules and has a working network that helps extend the utility accessible to enchant- ing mirrors. My commitments will be a module created in this system, so it can very well be taught to other delighted customers.



This area will clarify the system in detail. The MagicMirror2 structure is composed in NodeJS. NodeJS is a caused non-concurrent JavaScript runtime. Essen- tially it is used to create system applications, however, the charm mirror structure without obligations as a facilitated server accessible to other people, but as a local host. MagicMirror2 uses Electron as an application container. In layman's terms, this allows the product to keep running like a standard workspace app.

VI. 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.

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