Smart Mirror

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Abstract- *The future of Home Automation depends on Internet of things or IoT. Though the applications of IoT are diverse, the one that concerns the common man is how it can be used to make day to do life easier and faster. This is where Home Automation using IoT comes into the picture. In this paper, we demonstrate the function and working of a smart home mirror. The mirror will possess the ability to display date and time, the current weather condition and outside temperature, reminders, to-do lists and traffic conditions.Also this mirror will do facial recognition of person standing in-front of mirror and show facial profile details of that person.The pi board is programmed with the Raspbian operating system which is part of Linux. The mirror will also be lightweight, adjustable, durable and aesthetic. This paper presents the implementation and application of the smart mirror and how it is an integral part of home automation.*

Keywords- Internet of Things, Raspberry Pi, Home Au-tomation, Mirror, Networks, User Interface, Machine Learning.

I. INTRODUCTION

Using IoT for home automation has many real-world appli-cations, for example, we can build a smart home which will automatically close or open the windows based on the weather conditions outside. This paper presents the implementation of a smart mirror using IoT. A smart mirror is one that is capable of displaying the date, time, weather and traffic conditions on it reflecting surface. These features will be shown with the help of MagicMirror.The Pi board is programmed using Linux OS.

There are many benefits of using a smart mirror. It makes life easier as the need to look at phones every time we need to check the date or weather, is reduced. We have all the information that we need right in front of us. The smart mirror can also be upgraded to display browsers and social media websites. Adding a motion sensor to the mirror will save the power when there is no one infront of mirror.We can get dressed and read the news or watched YouTube videos at the same time at the same place.

II. RELATED WORK

In the late 1990s, Eli Zeikha and his team at Palo Alto Ventures presented a vision for the future known as Ambient Intelligence (AmI) [1]. This vision is for the time frame 2010-2020. This vision leads industry for developing smart environments. The vision is that to develop an environment and natural interface which consists unified heterogeneous computing devices connected with everyday objects. This environment can recognize and responds to the user's actions. This environment uses different types of smart technologies like networking, voice recognition, facial recognition, artificial intelligence, machine learning, sensing, reasoning, etc. [2]

The AmI provides home automation, socialization, enter-tainment, etc. Our intentions are to develop a smart mirror for AmI environment.The technologies that can be used to enable AmI environment are:

1. Bluetooth
2. RFID (Radio Frequency Identification)
3. Sensors
4. Software Agents
5. Nanotechnology
6. Biometrics
7. Artificial Intelligence

There are different kind of smart mirrors that are being pro-posed or available in the market. Some of them are discussed below:

A. Microsoft's Magic Mirror

This mirror is proposed by Microsoft in 2016. This smart mirror works on Windows 10 IoT Core on Raspberry Pi 3. This is powered by Windows Hello cognitive services. This was an open source project. Its web app was made open to GitHub repository so that anyone can build its own smart mirror. The mirror shows traffic updates, weather and supports voice recognition.[3]

B. Ekko Smart Mirror

This smart mirror runs on their own linux based platform on Raspberry Pi and it required an installed app on the user's smartphone. It also has sensors which could recognize the gestures of the user. Other than highlighting news, weather and time, the user can also play videos and music.[4]

C. Apple Mirror (Rafael Dymek)

This smart mirror prototype is based on iOS 10 that mirror the iPhone display. The mirror can launch all the mobile apps desired by the user. This mirror sleeps after every 45 seconds of ideal situation. This is a touchscreen smart mirror.[5]

D. Nuovo Smart Mirror

This android based smart mirror required an android ap-plication on the user's smartphone. The mirror supports mu-sic and videos playback. This mirror also supports features like weather, maps and the social networking like Twitter, Facebook, etc. The auto sleep mode is also supported by the mirror.[6]

E. Perseus Smart Mirror

This smart mirror runs on the separate platform on Rasp-berry Pi. This mirror doesn't require any application on the smartphone. This mirror is available in different sizes. This mirror supports music, videos and social networking.[7]

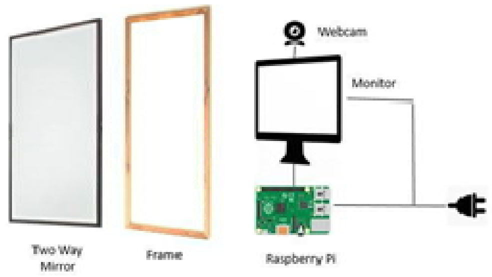
III. DESIGN AND ARCHITECTURE

Smart mirror is implemented in such a way that it displays information retrieved from the internet. Retrieved data includes weather condition, time, calendar, notifications from social media.[8]

A. Hardware Component Overview

The procedure for implementing Smart Mirror is realized in the following steps:

1. The idea and the mirror
2. The monitor
3. The casing
4. Hardware installation



1) The idea and mirror:: Our lifestyle has progressed for optimizing time, it is the most important thing. Our work idea was evolved from thought when we looked at the mirror when we go out, thinking why don't that mirror do something better. The mirror selection

A regular mirror would not work. The mirror should be semi transparent or to be more accurate, it has to behave like a mirror when the screen behind it is black, and should behave like a glass window

2) The monitor: After a few measurements and some tryouts by tape on the wall where we planned to eventually mount the mirror, we figured an appropriate measurement that would give the perfect monitor size. Eventually we choose to use LCD monitors that met most of the expectations. They are relatively cheap simple touch buttons and the right connector orientation. This control panel of monitor is to be connected and mounted within the casing.

3) The casing: Measured the dimensions needed for the new casing and we decided to make a wood casing that would create a strong and steady frame. This casing acts as a shelf where the things can be kept. Since the prototype would probably generate some heat, air ventilation holes were provided. Also a nice and firm mounting point was added on the backside of the casing.

Installing Hardware: Installing hardware required the following components

1. The Monitor
2. A Raspberry Pi
3. A HDMI Cable (to connect the Raspberry to the Monitor)
4. A USB to micro USB cable (to power the Raspberry Pi)
5. A power cable to power the monitor Installing hardware is just required to simply connect all the components, plugged in the power cable and then provide power to the monitor. The Rapsberry is booted and the system didn't create any signif-icant heat. The hardware installation part included mounting the the panel behind the mirror and

attaching the raspberry pi to it using HDMI cable. We make use of a micro USB cable to power the raspberry pi

B. Software Component Overview

We installed Geany, which is a very lightweight IDE and used it to write all the HTML, Javascript, CSS and Python code.[9]

1) OpenCV: OpenCV (Open Source Computer Vision Li-brary) is an open source computer vision and machine learning software lirary. OpenCV was built to provide a common infras-tructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD-licensed product, OpenCV makes it easy for businesses to utilize and modify the code. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state-of-the-art computer vision and machine learning algorithms. These algorithms can be used to detect and recognize faces, identify objects, classify human actions in videos, track camera movements, track moving objects etc. OpenCV has more than 47 thousand people of user community and estimated number of downloads exceeding 7 million. The library is used extensively in companies, research groups and by governmental bodies.This project will utilize the facial recognition algorithm from the OpenCV library to recognize users.[10]

2) Raspbian OS: Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware.Raspbian comes with over 35,000 packages, pre-compiled software bundled in a nice format for easy installation on Raspberry Pi computer.[11]

3) NodeJS: NodeJS is a javascript engine for server side applications. It comes included with Electron and we used it to launch processes to control things that are not available in web APIs such as the sensors and microphones for voice recognition. We also used it to access the filesystem and read the app files.[12]

4) Python: Python is a high-level, general purpose, inter-preted programming language. Its very popular in the Rasp-berry Pi community and it has lots of support and libraries. We used it with the microphone to detect sounds and also for control of sensors.[13]

IV. METHODLOGY

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 a two-way mirror, acrylic glass, monitor (LCD), 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 mir-ror.This will require internet access which will be provided by the wi-fi module (LAN can be also used) on the raspberry pi.

The virtual layout that will be prepared using HTML and CSS will be displayed on the mirror when it is turned on and willshow 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 as follows.

Facial Recognition Algorhm:[14]

1) Eigenfaces (createEigenFaceRecognizer())

2) Fisherfaces (createFisherFaceRecognizer())

3) Local Binary Patterns Histograms (createLBPHFaceRe-cognizer())

The Smart Mirror uses Local Binary Patterns Histograms algorithm. A more formal description of the LBP operator can be given as: with (Xc,Yc) as central pixel with intensity

$$LBP(x_c, y_c) = \sum_{p=0}^{P-1} 2^p s(i_p - i_c)$$

and being the intensity of the neighbour pixel.S is the sign function defined as:

$$s(x) = \begin{cases} 1 & \text{if } x \geq 0 \\ 0 & \text{else} \end{cases} \quad (1)$$

This description enables you to capture very fine grained details in images. In fact, the authors were able to compete with state of the art results for texture classification shown in Figure 4. Soon after the operator was published it was noted, that a fixed neighborhood fails to encode details differing in scale. So the operator was extended to use a variable neighborhood. The idea is to align an arbitrary number of neighbors on a circle with a variable radius, which enables to capture the following neighborhoods: For a given Point (Xc,Yc) , the position of the neighbour (Xp,Yp),p belongs to P can be calculated by: R is the radius of the circle and P is the number of sample points.

The operator is an extension to the original LBP codes, so it's sometimes called Extended LBP (also referred to as

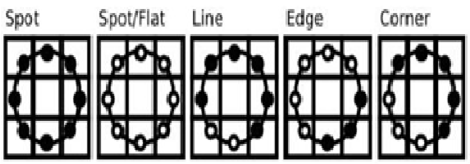


Fig. 1. Texture Classification

$$x_p = x_c + R\cos\left(\frac{2\pi p}{P}\right)$$

$$y_p = y_c - R\sin\left(\frac{2\pi p}{P}\right)$$

Circular LBP). If a point's coordinate on the circle doesn't correspond to image coordinates, the point gets interpolated. Computer science has a bunch of clever interpolation schemes, the OpenCV implementation does a bilinear interpolation: By

$$f(x,y) \approx \begin{bmatrix} 1-x & x \end{bmatrix} \begin{bmatrix} f(0,0) & f(0,1) \\ f(1,0) & f(1,1) \end{bmatrix} \begin{bmatrix} 1-y \\ y \end{bmatrix}$$

definition the LBP operator is robust against monotonic gray scale transformations. We can easily verify this by looking at the LBP image of an artificially modified image.

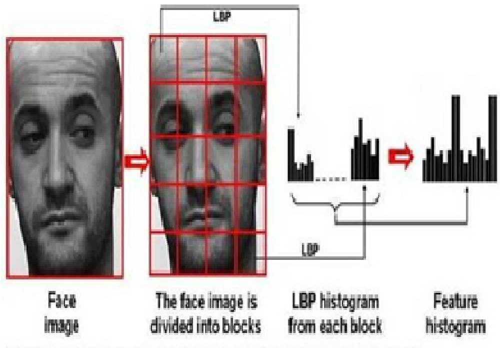


Fig. 2. Working of LBPH

V. CONCLUSION AND FUTURE WORK

The Smart Mirror has scope in the field of IoT and home automation. The Smart Mirror can be connected to the home appliances, mobile devices, etc. which can expand the func-tionality of the mirror.

The facial recognition technology used can be future en-hanced as a means of security. Adding security means that no one can try to access sensitive data that maybe displayed on your mirror via the use of APIs. We believe that the future of the home will be a brilliantly connected ecosystem of smart technology designed to make your life easier, more enjoyable, and efficient. Obviously there are a ton of opportunities in the home for technology integration but a mirror is one of the best places to start.

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