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Design of Smart Mirror Based On Raspberry Pi

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***Abstract*: Intelligent systems are not only used on phones and computers, but also more and more intelligent products are coming into the market. There will never be an end to make a device 'smarter' with the help of adequate technology. In this paper we are designing a smart mirror based on Raspberry Pi for the home of the Internet of Things (IoT). Raspberry Pi is used as a host controller and STM32F030C8T6 microcontroller as a core control chip. Raspberry Pi is connected through Wi-Fi, and information about the weather forecast will be obtained from the API network interface. Time, date, weather, calendar, and other information are displayed on the display device. The user can interact with the mirror. Speech synthesis module SYN6288 is interfaced with voice interaction. Face recognition is done where a picture of a face is captured through webcam. The proposed smart mirror has the advantage of small size, low cost, user friendly, and has a broad application.**

***Keywords*: Raspberry Pi, Internet of Things (IoT), STM32F030C8T6, Wi-Fi, API, SYN6288.**

1. Introduction

In this world everyone needs a comfort life. Modern man has invented different types of technologies for this purpose. In today's world people need to be connected to each other [6].

At present, many more close to the life of intelligent products are emerging, smart TV, smart watches, and now its intelligent mirror. There are smart mirrors in 3D somatosensory fitting mirrors and hair salons, which are not in more use in public places. Because of its high cost, and the imaging effect is not good, and there is a phenomenon of picture delay.

Our lifestyle has evolved in such a way that managing time is the most important thing. Our work will be based on the idea that how we all look at the mirror, so why couldn't the mirror become smart [2].

According to the survey, we spend a minimum of 30 min it may be for washing, makeup, and wearing after getting up, and these 30 minutes are also the time for us to look in the mirror. To make full use of this time, at the same time we can effectively access the relevant information of the day, this project designed a kind of intelligent mirror can be used in the home [5].

The intelligent mirror works on the principle of a one-way perspective, the actual picture in the form of specular reflection transmitted to our vision. The picture displayed behind the mirror can also be transmitted to us through the mirror as if it is displaying in the mirror, to achieve the effect of showing the pattern on the mirror. Compared with the method of collecting pictures from the camera used in the 3D somatosensory fitting mirror, the picture is much smoother and the cost is reduced.

Raspberry Pi acts as the host chip, and the operating system is Linux. A smart mirror uses STM32F030C8T6 microcontroller card for retrieving information from the web and display it on the mirror. The proposed smart mirror displays information such as weather, date, time, calendar, capture picture from webcam for face recognition, and also multimedia information such as music, voice control, and local news from the web [10].

Many real-world applications exist for home automation like switching on and off of lights and fans automatically in the home, controlled from anywhere and anytime through the voice command [25].

Smart mirror reduces this problem of wasting time by providing the basic information like time, date, weather news update just by face recognition [30].

The Smart Mirror also lets people use their devices for less number of times, like clock, calendar, switches of fan and lights etc., and phone [8].

2. Problem Statement

The goal of a smart mirror is to provide access to receive all the information that could affect how they plan for the day. For weather and news update, a person will always have to stand in front of time which is more time-consuming. To get rid of these problems smart mirror is introduced. We can even switch on and off of lights through our voice commands. So this reduces the risk of accidentally electric shock especially for children.

3. Proposed Work

The aim is to build an interactive smart mirror prototype based on Raspberry Pi. That can recognize the face and display his mail, news update, and all the basic information like time, weather, calendar, and music play, and some home automation application (switching on and off of lights and fan).

4. Methodology

The goals are as follows:

1. To implement weather, calendar, date and time module in Raspberry Pi.
2. Face recognition using Raspberry Pi.
3. Voice recognition and interaction using Raspberry Pi.
4. Implementation of Home Automation in Raspberry Pi.

Objective-1:

Automation is the new oil in the IT industry, so we are trying to build a prototype for a smart mirror based on Raspberry Pi. A smart mirror is a two-way mirror that is 70% reflective and 30% transparent. And behind the mirror an LCD display is placed and it is connected to the Raspberry Pi.

Fig. 1. Smart mirror with LCD display at the backend

Raspberry Pi known as card type computer is a microcomputer mainboard based on ARM. Raspberry Pi is connected to the Wi-Fi and information is accessed with the help of an API network interface. This Raspberry Pi is connected with the STM32 microcomputer.

Here we are using different modules of date-time, calendar, news headlines and complimentary text to give real-time updates on the mirror.

Raspberry Pi is specifically used here because it performs multiple tasks, can be connected to the internet easily without external hardware devices, the processing is much faster than another version of Raspberry Pi. 1.2GHz, 64-bit quad-core v8 generation, 40 pins extended GPIO. Micro SD port for loading your operating system and storage data.

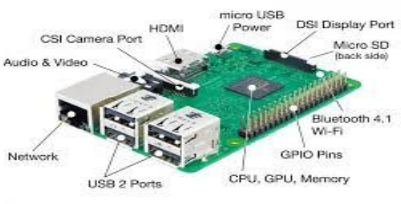

Fig. 2. Raspberry Pi 3B model

The wireless transceiver module: using the XL02232API module, half-duplex wireless transmission function UART interface, not only can work in the public frequency of 433MHz but also in the original cable connection based on upgrading wireless connectivity, and does not required additional programming, can be completely compatible with the cable of the serial communication protocol.

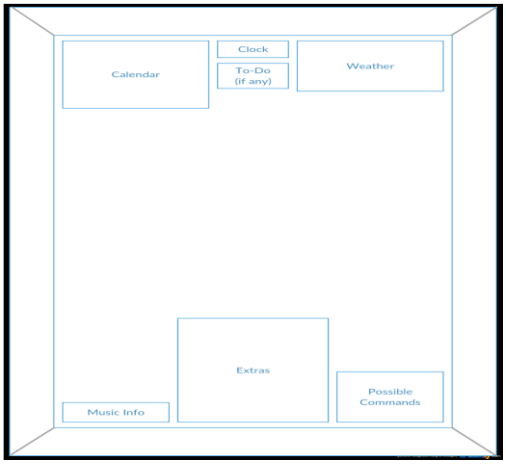

Fig. 3. Mirror display

Algorithm for information system

Step 1: Switch on the power supply.

Step 2: Initialize the SMT32 microcontroller.

Step 3: Get the date, time, and weather details from the pre-defined URL and get the news from the internet.

Step 4: Send the acquired data to Raspberry Pi through the serial port.

Step 5: Display it on the mirror via an LCD monitor.

Step 6: Switch off the power supply when it is of no use.

Step 7: End.

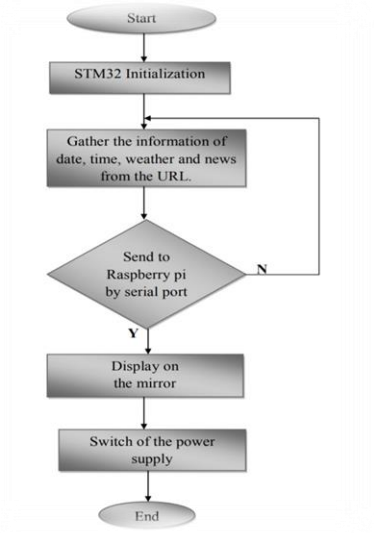

Fig. 4. Information system flow chart

Objective 2:

Face recognition is an add-on to the project. Initially the system is trained by adding data of the image. The software used here is Python. LBPH (Local Binary Pattern Histogram) algorithm is used in identification.

Fig. 5. Web camera

Initially the person face is captured by web camera several times depending on the need of the user, but approximately 100 pictures for better accuracy. And each picture is divided into n number of pixels. It is stored in the Raspberry Pi memory. Then when a person stands in from of the mirror his face will be compared with the stored images and if it matches then it will display the name of the user as stored in memory during the training process.

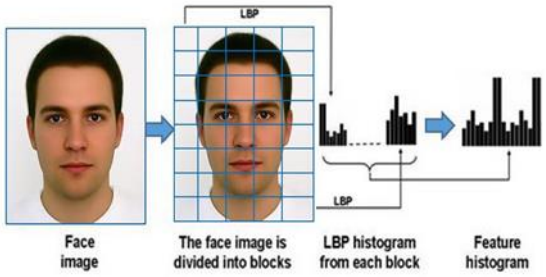

Fig. 6. Facial description using the LBPH algorithm

It displays email content if the person is registered. Else it just greets and accepts comment through Wireless Transceiver Module.

Haar-feature is used in face recognition. It is a sequence of rescaled square-shaped functions, similar to Fourier-analysis. There are two types of edge features and line features. It uses greyscale images 0-255 shades of black.

Algorithm for face recognition:

Step 1: Start.
Step 2: Initialize the Raspberry Pi.
Step 3: Getting the image from the dataset which is in the form of a grayscale image.
Step 4: Compare the live image with the captured image.
Step 5: If yes go to step 6 else go back to step 3.
Step 6: Alarm is initialized for 3-4 minutes until the face is recognized.
Step 7: If yes then play greeting else go back to step 6.
Step 8: End.

Objective 3:

Smart mirror speech synthesis module using the SYN6288 speech synthesis chip. SYN6288 speech synthesis module converts text to speech. The text output on Raspberry Pi will be converted to speech and the speaker is connected as an out. Here speech input taken from the microphone will be converted to text and fed as input to Raspberry Pi. It has a standard 3.5mm standard audio interface. Input voltage can choose 3-5 arbitrary power input, serial communication operation is simple. Baud rate can be selected 3 communication level: 9600, 19200, 38400 bit/s. Transceiver module is also used which is composed of sending and receiving modules. The transmitting module is controlled by an external STM32 single-chip microcomputer, and the receiving module is controlled by the STM32 microcontroller inside the mirror.

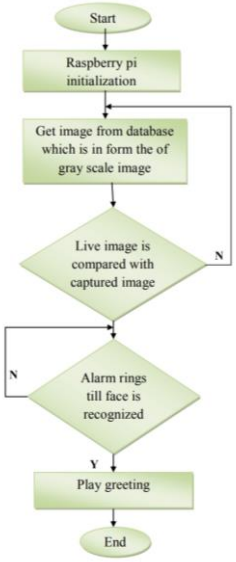

Fig. 7. Face recognition flow chart

Objective 4:

The main advantage is the interaction of the build prototype mirror with the user. The system as in the name itself indicates, SMART [to make the work easier and self-initiative] it accesses the “Voice-based home automation” it involves in planning the control of home applications through voice commands and Raspberry Pi as a server system. By using voice control access we can control the on and off of lights and fan control and customized alarm. With play music and news feed for entertainment purposes.

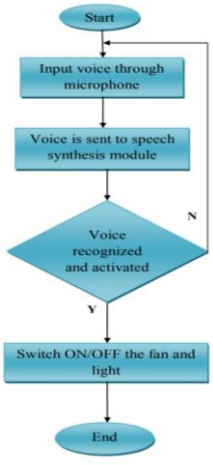

Fig. 8. Home automation flow chart

Algorithm for home automation:

Step 1: Start.

Step 2: Input voice through microphone.

Step 3: The voice command is sent to the speech synthesis module.

Step 4: If the voice is recognized then it activates fan and light based on the command.

Step 5: Else goes back to step 2.

Step 6: End.

5. Block Diagram

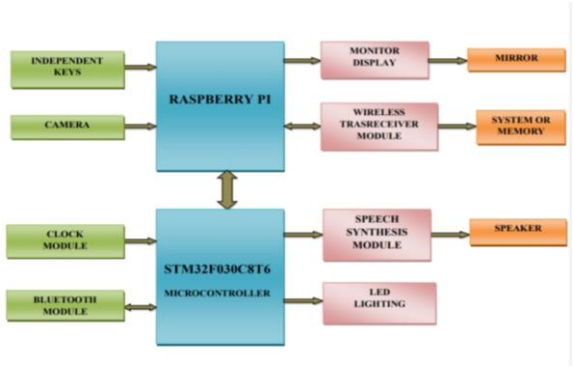

Fig. 9. Block diagram of system design

Connections are made as in the block diagram. LCD is placed at the backend of the mirror. This LCD is connected to the Raspberry Pi, which is interfaced with STM32 microcontrollers to access information. Camera, microphones are used as external inputs and speakers to access the output command, where the text is converted to speech with the help of a speech synthesis module.

6. Advantages and Application

- User friendly.
- Easy to communicate because of voice interaction. Helpful for physically challenged people.
- Home automation can be implemented so that children need not go to the switchboard to control electronic appliances.
- Easy to train multiple users.
- Low power consumption.
- Reducing time consumption because all the basic needs will be displayed in the mirror so that multiple work can be done at a time.

7. Conclusion

The Smart mirror is developed by Raspberry Pi as the host controller, and SMT32F030C8T6 microcontroller as the core control chip. Raspberry Pi is connected to the network via WIFI, and the weather information, clothing index, time, date, and other information are obtained by the API interface designated by the extranet. At the same time, the relevant information is displayed on the display. The user can interact with the mirror through the mobile APP, and can communicate with the mirror through the voice synthesis module SYN6288. The system realizes the functions of face recognition, speech recognition, voice playback, control of fan and room light.

Smart mirror has a small size, simple operation, low cost, high degree of user-friendly, personalized user interface, and other advantages, it also assists the user with news updates. It is suitable for families, and has broad application prospects.

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