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DEVELOPMENT OF HUMAN MACHINE INTERFACE USING SMART MIRROR AND FACE RECOGNITION ALGORITHM

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ABSTRACT

The Human Machine Interface (HMI) based framework portrays the structure and advancement of a modern smart mirror that speaks to an unassuming interface for the surrounding home condition. The mirror permits characteristic methods between association through which the inhabitants can control the family unit savvy machines and access customized administrations. The smart mirror is competent to exhibit by extending home mechanization framework that gives a blend of family machines and different tweaked data administrations. In this paper, the HMI is developed using smart mirror framework that comprises of data related to climate expectation, date and time, clock, news channels and clients. These data can be taken from internet browser and utilizing python which give programming property and work show. The ARM Processor is associated with the cloud and gathered information from web to show the data on reflects. For security reason, we have planned the mirror with the assistance of face framework. The convolutional neural network based face recognition is employed and experimental result showed that 100 % accuracy of facial recognition is achieved.

Key words: ARM Processor, Convolutional Neural Network, Human Machine Interface, Raspberry Pi, Smart Mirror

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1. INTRODUCTION

Now-a-days, the science and innovation are more made a big deal about plotting and creating innovation that can carry help to human life and make it more agreeable. The HMI transforms ourselves by connecting us to the data and others to virtual world. Based on HMI, the framework known as "Smart Mirror" is proposed which comprises of detectable mirror, ARM processor, camera and LED screen. Such mirror has dual utility as reflect used as mirror and another as screen for displaying the appropriate modules to the users such as climate forecast, date and time, clock, locus data, news sources, client data, temperature, upcoming events etc. For security reason the smart mirror has been constrained by face recognition frameworks. The convolutional neural organization for face recognition is the validated frameworks used to recognize different users. This proposed framework advances to make homes brilliant to spare time.

In our proposed framework, the webcam is used to detect the faces for security purposes and after successful verification only give access for demonstrating the different modules on the mirror. Figure 1 shows various modules on the smart mirror.

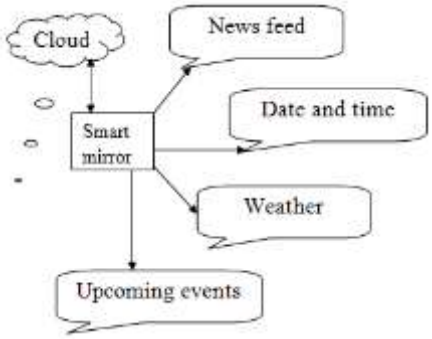

Figure 1 Modules on the Smart Mirror

The paper is organized as follows: Section 2 depicts the created procedures by various researchers that are pertinent to subject of exploration. Section 3 gives block diagram, circuit diagram; face recognition algorithm and flowchart of proposed framework. Section 4 described the hardware setup and implementation of HMI using Smart Mirror and its successive results. In the end, paper is concluded in Section 5.

2. RELATED WORKS

The related work on this proposed framework has striking number of advancements that takes client towards man-made brainpower.

Biljana Cvetkoska et al. in [1] proposed smart mirror to detect the posture problem of human being and guide user to stand properly using posture analyze algorithm. Kun Jin et al. studied the prototype of smart mirror using Raspberry Pi in [2]. S. Athira et al. implemented structure of an intelligent interactive media advanced Smart Mirror with man-made consciousness for the surrounding home condition just as for business utilizes in different enterprises in [3]. Vaibhav Khanna introduced a reciprocal interactive media smart mirror [4] with machine interface for the home condition just as for business utilized.

Njaka et al. implemented biometric authentication like voice and facial to access the smart mirror using Amazon web service, Alexa Voice Service and Google Speech to text conversion in [5]. Researchers in [6] planned completely computerized smart mirror show with human PC connection which utilizes cell phone through WLAN arrange for various capacities like home machine control, security checking, relaxation amusement and so forth. Sun Yong et al. in [7] developed smart mirror using STM32F030C8T6 microcontroller, plasma display and Raspberry Pi which is associated with Wi-Fi which acknowledges capacities like voice playback, room lightning control at far off area and face recognition. Nadaf and Bonal designed the smart mirror and used it as security system by using intruder detection using Yolo machine learning algorithm in [8]. Authors used Local Binary Pattern Histogram (LBPH) for face recognition with Raspberry Pi in [9], [10]. Most of the existing facial recognition algorithm used in smart mirror faces the issues of identification of authorized and unauthorized user to access the smart mirror. To overcome this issue, we have incorporated convolutional neural framework to detect correct face of authorized person and prevent unauthorized user to access the HMI Smart Mirror system.

3. SYSTEM DEVELOPMENT

The proposed smart mirror is an assembly of ARM processor, two way mirror, LED monitor, camera and microphone. The block diagram of proposed system is shown in Figure 2.

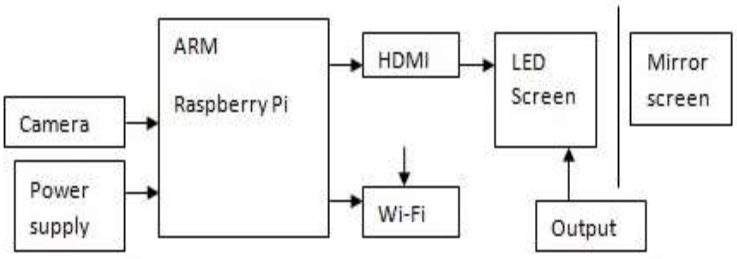

Figure 2 Block diagram of Proposed System

From Figure 2, the webcam is used behind the clear side of mirror with the objective that it can get and perceive faces for security purpose.

3.1. Hardware of Proposed System

A basic Webcam arrangement comprises of a computerized camera joined to Personal Computer, ordinarily through the USB port. The webcam has best CMOS sensor, sensor goal is 300k pixels, 5500 x 3640 pixels is greatest picture goal and 1600 x 1200 pixels is most extreme video goal.

The Smart mirror can function both as reflective mirror and TFT screen. This provides two major functionalities i.e. mimicking a normal mirror as well as working as a display for real time data updates. Personalized data and information using this mirror will be able to get real time updates of news and headlines, date, time, weather updates as well as other reports of our particular interests.

The Raspberry pi 3B [11], [12], [13] is used as controller which controls all functions of smart mirror. The Raspberry Pi 3B is all the more remarkable processor, multiple times quicker than the original raspberry pi. Remote LAN and Bluetooth network is utilized as able for amazing associated structures. The Raspberry Pi 3B flaunts a 64 piece quad-center Cortex-A53 processor running at 1.4 GHz and quicker Ethernet [14], [15] and [16]. It has three connector viz. GPIO, camera and display.

The interfacing circuit diagram between ARM Processor and different parts like camera, smart mirror and speaker is shown in Figure 3.

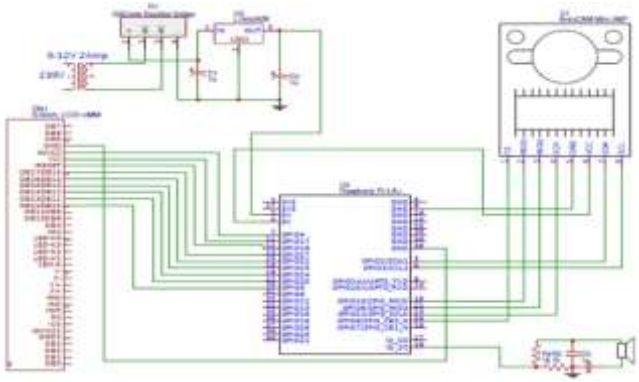

Figure 3 Circuit Diagram of Smart Mirror

The camera is attached to the Raspberry pi using the universal serial bus to detect user's face using Open CV. This will help in setting up the personalized profiles for different users and managing them afterwards. The user interface will be show the data on the mirror. A LCD was attached to display and connect the LCD display with the Raspberry Pi via HDMI cable. Finally, the power supply 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 smart mirror into the Raspberry Pi. It was updated and upgraded to increase the CPU speed.

The flowchart of proposed framework is shown in Figure 4.

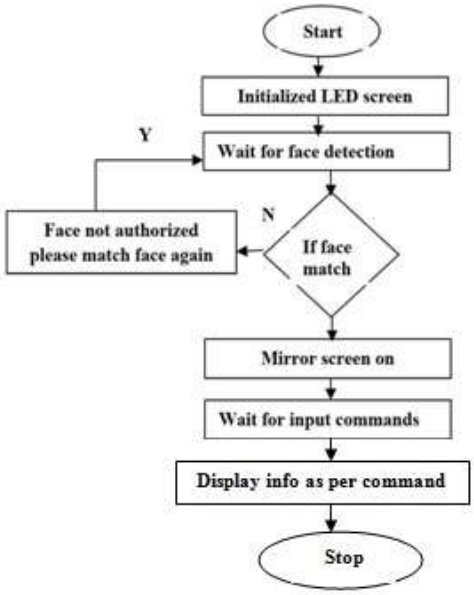

Figure 4 Flowchart of Proposed Work

The HMI smart mirror is constrained by face recognition framework for security reason. The LED screen on behind the mirror is ON just when the face is identified in any case screen is turn OFF. On the off chance that the face is coordinated, at that point the mirror screen is ON which gives the distinctive information like whether forecast, date and time, clock, news channel, client data, temperature, and so forth.

3.2. Development of Programming Framework

The Convolutional Neural Network (CNN) is developed to recognize faces of users to access the smart mirror based HMI for secured authentication. The CNN framework is shown in Figure 5.

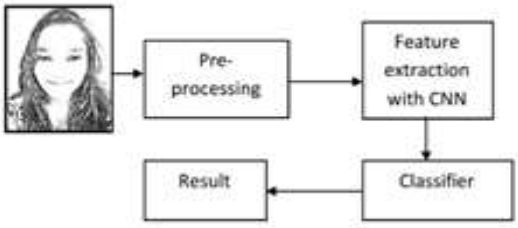

Figure 5 Face Recognition Framework using CNN

The CNN is a combination of two components: feature extraction and classification. The convolution pooling layers perform feature extraction. From Figure 5, the convolution layer detects features such as eyes, ears, nose, lips short and so on. Classification of CNN is the result of each when a special pattern is detected. By varying the size and shape of the kernels and their outputs, data comes from the input layer to the output layer. Each node performs an easy mathematical calculation and then it transmits its data as a classifier output.

4. IMPLEMENTATION OF PROPOSED SYSTEM

The hardware setup for our proposed system is shown in Figure 6 in which ARM Processor is connected to Smart mirror which has inbuilt camera and dual reflects.

Figure 6 Implementation of Smart Mirror with ARM Processor

After interfacing of Smart Mirror with processor then next stage is to recognize the face and compared it with customized datasets. The face recognition allows only grayscale so we captured images from live streaming and preprocess it. We saved nearly 100 images per user with separate identification number. Figure 7 shows the datasets used in training module.

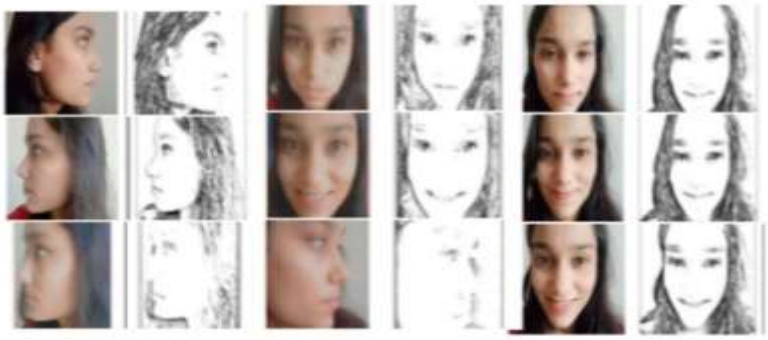

Figure 7 Customized Datasets for authentication access

The face recognition is carried out in 3 different parts: Firstly, creation of datasets for number of different viewpoints. Secondly, the training part of dataset in which all features is calculated from user with different viewpoints. In the end, images are captured through live streaming and matched the features set with training dataset. The accuracy of face recognition is obtained by using eq. (1):

$$\text{Accuracy} = \frac{\text{Number of identified images}}{\text{Total number of images}} \times 100 \quad (1)$$

The experimental result is shown in Figure 8 which indicates the authorized user with percentage accuracy.

Figure 8 Face recognition accuracy with authorized user

The facial recognition of proposed framework is tested for different number of trails (5, 10, 15 and 20) as appeared in Figure 8. It is observed that the proposed face recognition algorithm gives better percentage face recognition accuracy if numbers of trials are increased. The bar graph representation of the success rate of face recognition accuracy is shown in Figure 9.

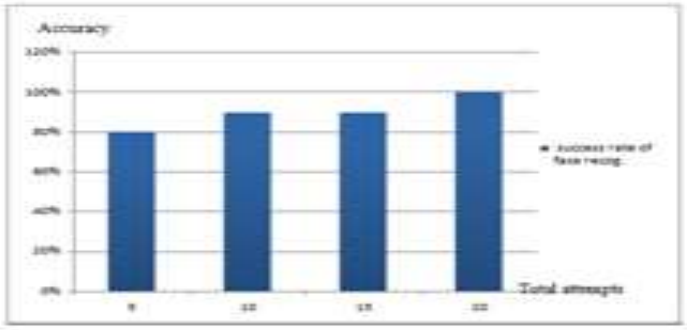

Figure 9 Face recognition success rate graph

From Figure 9, the framework has given 80%, 90%, 90% and 100% of genuine identification individually based on increased number of trials for different viewpoints.

When the user remains before the mirror, it initially distinguishes the face dependent on CNN based face recognition calculation. In face recognition detection the web camera captures 100 previews in 7 seconds of user in which any point of face is recognized and the screen is turned ON.

We showed the exhibition of AI for face recognition utilizing fractional countenances and different controls of the face, for example, turn and zooming which we used as preparing and recognition prompts. Our outcomes showed that individual pieces of the face, for example, the eyes, nose and the cheeks have low recognition rates however the pace of recognition rapidly goes up when individual pieces of the face in consolidated structure are introduced as tests.

If the face is not detected by the authorized user then mirror remains locked and the user sees the function same as a normal mirror shown in Figure 10. The proposed framework gives the best highlights of security.

Figure 10 Output of Smart Mirror if unauthorized user detected

If the face is detected by the authorized user at that point the savvy reflect with user and comparably the message is appeared on the screen which is shown in Figure 11. Also when the user is recognized the framework opened inside sure in each face edge.

Figure 11 Output of Smart Mirror if authorized user detected

In case demand of user, the framework attempts to react the user by utilizing face detection recognition calculation and availed some information about the calendar of the day, at that point reflect give the conspicuous exercises of the day to be experienced.

The ARM processor is interfaced with Wi-Fi module for internet connectivity and data is transfer through bidirectional mode and demand of user is fulfilled by accessing the information like climate expectation, date and time, clock, news channels, client details etc.

5. CONCLUSION

The HMI based smart mirror is developed with the help of convolutional neural network framework. Our system clearly identifies the authorized user to access the HMI and prevent unauthorized user by showing the HMI as normal mirror. The Raspberry Pi3B module is used which is has faster quad-center Cortex-A53 processor and easily communicated with remote devices through Ethernet. The HMI is set up by utilizing CNN based face recognition calculation. The experimental result showed that increased face recognition accuracy is achieved as number of trials is increased of authorized user at different viewpoints. In future, the authentication of user is increased by incorporating biometrics like voice recognition, fingerprint and posture recognition. Also, the plan of savvy reflects gives a game plan that can be reached out in future to enjoy considerably greater usefulness. We have plotted a smart mirror remembering the future development in the field of car framework just as business reason.

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REFERENCES

[1] B. Cvetkoska, N. Marina, D. C. Bogatinoska and Z. Mitreski. Smart mirror E-health assistant - Posture analyze algorithm proposed model for upright posture, *in Proc. 17th International Conference on Smart Technologies IEEE EUROCON*, Ohrid, Macedonia pp. 507-512, 6 - 8 July 2017.

[2] Kun Jin, Xibo Deng, Zhi Huang and Shaochang Chen. Design of Smart Mirror based on Raspberry Pi, *In Proc. 2nd IEEE Advanced Information Management, Communicates, Electronic and Automation Control Conference IMCEC 2018*, Xi'an, China pp. 1919-1923, 25-27 May 2018.

[3] S. Athira, F. Francis, R. Raphel, N. S. Sachin, S. Porinchu and S. Francis. Smart mirror: A novel framework for interactive display, *In Proc. International Conference on Circuit, Power and Computing Technologies (ICCPCT)*, Nagercoil, India, 18-19 March 2016.

[4] Vaibhav Khanna, Yash Vardhan, Dhruv Nair and Preeti Pannu. Design and Development of a Smart Mirror Using Raspberry PI, *International Journal of Electrical, Electronics and Data Communication (IJEEDC)*, Vol. 5, No. 1, pp. 63-65, January 2017.

[5] Adokiye Charles Njaka, Na Li, and Lin Li. Voice Controlled Smart Mirror with Multifactor Authentication, *In Proc. 2018 IEEE International Smart Cities Conference (ISC2)*, Kansas City, MO, USA, 16-19 Sept. 2018.

[6] Divyashree K. J., Dr. P. A. Vijaya and Nitin Awasthi. Design and implementation of Smart Mirror as a Personal Assistant using Raspberry Pi, *International Research Journal of Engineering and Technology (IRJET)*, Vol. 5, No. 5, pp. 438-441, May 2018.

[7] Sun Yong, Geng Liqing and Dan Ke. Design of Smart Mirror based on Raspberry Pi, *In Proc. IEEE International Conference on Intelligent Transportation, Big Data & Smart City*, Xiamen, China, pp. 77-80, 25-26 January, 2018.

[8] Raju Nadaf and Vasudha Bonal. Smart Mirror using Raspberry Pi as a Security and Vigilance System, *In Proc. Third International Conference on Trends in Electronics and Informatics (ICOEI 2019)*, Tirunelveli, India, pp. 360-365, 23-25 April 2019.

[9] Omkar S. Vaidya, Ravindra Patil, Gayatri M. Phade and Sanjay T. Gandhe. Embedded Vision Based Cost Effective Tele-operating Smart Robot, *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, Vol. 8, No. 7, pp. 1544-1550, May 2019.

[10] Ravindra R. Patil, Omkar S. Vaidya, Gayatri M. Phade and Sanjay T. Gandhe. Qualified Scrutiny for Real-Time Object Tracking Framework, *International Journal on Emerging Technologies*, Vol. 11, No. 3, pp. 313-319, June 2020.

[11] Abhishek Pathak, Amitkumar Mishra, Rohit Sarate, Swapnil Bhavsar and Nirav Patel. Smart Mirror using Raspberry Pi, *International Journal of Recent Trends in Engineering & Research (IJRTER)*, Vol. 4, No. 3, pp. 353-358, March 2018.

[12] Abdullahil Kafi, M. Shaikh Ashikul Alam and Sayeed Bin Hossain. Artificially Intelligent Smart Mirror using Raspberry Pi, *International Journal of Computer Applications (IJCA)*, Vol. 180, No. 16, pp. 15-18, February 2018.

[13] V. E. Pawar, Pooja Sisal and Neelam Satpute. Smart Mirror Using Raspberry Pi, *International Journal of Engineering and Techniques (IJET)*, Vol. 4, No. 2, pp. 554-557, March-April 2018.

[14] P. S. Tondewad, Harshada Parate, Poonam Awalkonde and Aishwarya Mule. Smart Mirror Based on Raspberry Pi, *International Journal of Research and Analytical Reviews (IJRAR)*, Vol. 6, No. 2, pp. 151-153, April-June 2019.

[15] Govinda K and Saravanaguru R.A.K. Review on smart mirror on IoT Technologies, *International Journal of Applied Engineering Research (IJAER)*, Vol. 11, No. 4, pp. 2848-2853, 2016.

[16] Roopa Sabri. K, Poornima Urala. A, Gayathri. P, Deepak. D, S. Pushpalatha and Neetha Natesh. Smart Mirror using Voice Interface, *International Research Journal of Engineering and Technology (IRJET)*, Vol. 6, No. 6, pp. 314-318, June 2019.