**Automatic Door Opening using Quantitative Gait Algorithm**

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**Abstract**—Quantitative Gait algorithm provides a system to identify a person from a distance. This project identifies three types of systems: Detection, Recognition and Control to open the Door. The initial process is extracting the forefront facial (human) images are converted into ordinary binary silhouette, it is captured from each frame in burst mode. The images are converted into values and stored in the database. In the process at real time, the facial recognition is done by comparing with the database. From the results it can also be observed that the person identified by raspberry pi camera and is done mainly for security purpose. This proposed system is more efficacious, consistently good in quality, and it utilize very less amount of data and power that is compared to the other existing systems. This project indicates that very better sensitivity, specificity and also the execution time of Quantitative Gait algorithms which is implemented in ARM processor therefore the results are obtained using MATLAB software.

**Keywords**— Raspberry Pi 3, Raspberry pi Camera, Motor driver L298, Quantitative Gait algorithm, MATLAB.

1. **INTRODUCTION**

   The Automation technology is improving with time, internet and smart devices became more popular and reasonably priced, so the intension of this automation system is to develop an smart and secured way of automatic door access control system. People’s expectancy about a smart security has modernized productively. Modern smart security system is a combination various prevalent computing devices and wireless sensor networks. The new complicated products in electronics world brought new model of security challenges to automation systems. The intensive progress of automation security system has enhanced with time period, wireless sensors and required actuators are integrated to detect and prevent from intrusions.

   The facial image captured as an intruder image within a surrounding and accomplish by detecting the face with the help of Raspberry Pi camera and the further action will be executed. The Raspberry pi camera continuously captures the sequences of images instantly when the person appear near to door. The gain of this system is detection and recognition are performed by using Quantitative gait technique and the entire face recognition is concluded by comparing the values of face with the database which is already stored in the ARM Processor(Raspberry Pi 3).

2. **LITERATURE SURVEY**

   The work of Arun Cyril Jose and Reza Malekian [2016] proposes the stages of process of verification in smart home technology using fingerprints and also the login credentials which is use to verify the other user for accessing the device through internet. The additional system is to consider a device’s geographical location by using GPS and computing by fingerprint system. This system doesn’t concentrated on gestures for smart security.

   In their work SayidulMorsalin and A.M. Jahirul Islam [2016] developed a multi-layer home security system (HSS) is developed which maintains 5 to 6 levels of security and controls the performance against unwanted burglars and intruders. The security levels uses the Near Field Communication (NFC) tag, the other level uses a secured
password system and final level uses fingerprint system. This system makes secure and quality system gives strong work on fingerprint for security system.

Md. Raihaan Kamarudin et al [2013] developed a smart home automation system using voice recognition. The system uses home appliances from Graphical User Interface (GUI) using Microsoft Visual (MV) Basic software that use Microsoft Speech Recognition Engine (MSRE) as an input data and being controlled wirelessly. Atlast, the gesture based system analyzes to obtain better solution for the future enhancement.

Krishna Rathiet al [2017] proposed the Gesture Human-Machine Interface (GHMI) uses an accelerometer and flex sensor. GHMI mostly based on hand gesture recognition algorithm that uses flex sensor, Bluetooth model, raspberry pi and Arduino. The hand gestures are determined by the accelerometer & flex sensor. These signals are wirelessly transmitted to Bluetooth model HC-05. The Controller receives and process data send by the Bluetooth model. For the security reason unauthorized person photo is captured and send to owner via email. This paper succeeds in gesture based automation system.

Tejas Saraf and Ketan Shukla [2018] developed a system for door access system using a face recognition technique. This proposed system uses python language with cascade algorithm. And the another type of subsystem is used by Haar Cascade classifiers for better detection of object. The security device is developed by an Paul Viola and Michael Jones method. The disadvantage is that external battery supply is used for operating the system.

3. QUANTITATIVE GAIT ALGORITHM

Quantitative Gait Algorithm is a technique used to identify user behavior to be authenticated. This technique is an combination of Detecting and Recognizing the facial parts of the person. The aid of using this technique is that the fastest method applicable for detection of face parts. The improvement of simple and adequate classifier put together for figuring the active features for the selection of better extracted feature. In the enhancement of this algorithm, the location and size of the real time face in the input database is recycled for specific case of class detection. The prevailing case of localizing the face is to examine the face recognition. The preeminent responsibility is to find the face location and size for detection and to strengthen the image to give as an input.

Figure : 1 shows flow of face recognition detected by quantitative gait algorithm in MATLAB Software.

![Quantitative Gait Algorithm Flow Chart](image-url)
A. Face Detection

In this initial system process, the input facial images are grabbed from Raspberry Pi camera and are stored in database. Since accumulating the facial image it maintain the feature extraction and convert it into Feature-based Classifiers admit to the quantitative gait algorithm.

![Flow of Face Detection](#)

B. Face Recognition

In this segment of process, recognition of input facial images is done by comparing with database. This is the second process in identifying the person with database, where the image converted into binary values and Feature-based Classifiers matches with this feature extraction image to the database.

![Flow of Face Recognition](#)

C. Automatic Gait Algorithm

The proposed work for face recognition concept is to access the door opening system and it is implemented with Raspbian OS a popular computer vision library which can execute by Raspberry Pi 3 model B. The application of image processing is owing to important field called face recognition.

The system based on OpenCV is modeled for recognizing the facial images under best preference for overcoming the problems of biometrics in future life of the system. In the future consideration of the system is useful in identification, forensic sciences, authentication for banking system and security system also for authorized users like control for accessing the secured areas. Figure: 4 by face recognition system used here is from Quantitative gait algorithm (QGA) which is based on feature based classifiers in the project. The method used for face detection need a lot of negative and positive images to train the algorithm. This algorithm is like convolution method of matching the single value gained by subtracting the pixels under a required pixels of an image.
4. **Hardware Description**

The proposed Embedded system shows the internal module of door accessing system. Which have the Raspberry Pi board with ARM Cortex Processor for Face recognition using Quantitative Gait Algorithm, Motor driving circuit (L298 H-bridge), motor & Raspberry Pi camera of 8 Mega Pixel.

The block diagram of Automatic door opening using Quantitative Gait algorithm using Raspberry Pi 3 shown in the Figures: 5 is the controlling unit. The CD tray is driven using an servo motor which is used to open close. The Motor driver has two specific pins enabling or disabling which is connected to the GPIO pins of Raspberry pi. The authentication module which is used Hteik Htar Lwin, et al(2018) which will obtain the feature of face extraction using MATLAB.
The Raspberry Pi Camera will capture images in the burst mode in real time. The captured images is compared with the respective database already saved in the OS memory card which is interfaced to Raspberry pi. The conversion takes place in the controller the images will be shown in the screen. After the completion of the comparison, the Raspberry pi allow the access to enter the person to enter. Only if the person is authenticated the door opens automatically or else it will not open.

5. **Experimental Results**

A. **Experimental Setup**

Figure: 6 shows the Experimental setup of this project. Raspberry Pi 3 controller board with ARM Cortex processor is the main processing unit. Power supply to the Raspberry Pi 3 board is through the USB cable from PC. The board can also be powered from a DC adaptor. The algorithms are executed by the ARM Cortex processor and the images are processed and the performance measure values are displayed in the monitor. To design a Face identification from the databases by comparing where the frames are continuously sent at the time of recognition to the controlling unit for processing. The values of input image are then processed and compared with the trained database for the result.

The Raspberry Pi Camera is interfaced with the JTAG of the Raspberry Pi 3 where the camera captures the face and convert the frames and sent to the Raspberry Pi 3 as input. The output from the Raspberry Pi 3 is sent to the Servo motor interfaced with the door.

Power supply is for the Raspberry pi 3 to control the entire system. Raspberry pi camera V2 is an 8 megapixel camera capable of taking photographs of 3280 x 2464 pixels connected to J3 of Raspberry pi 3. Motor driver L298 is a high current and low voltage IC, the 2 specific pins enabling or disabling is connected to the controller. The motor is fixed in the CD tray to open close when the person is recognized. The output is displayed in the monitor.

B. **MATLAB and Open CV results**

A. **Template Algorithm**

The Template matching Algorithm compares the input images with stored patterns of faces or features in binary silhouette.

Appearance based method: A template matching method whose pattern database is learnt from a set of training images. This approach is simple to implement for face detection. It cannot achieve good results with variation in pose, scale and shape.
B. Quantitative Gait Algorithm

Quantitative Gait algorithm provides a way to automatic person identification at distance by monitor people without their cooperation. In this first step is extraction of foreground objects i.e. human’s image is captured in the sequence and the binary silhouette of a walking person is detected from each frame. The sequences of images are segmented by face detector algorithm. Then extracting the gray scale images of the person and tracking the value in predefined data bases.

Figure 7 Extraction of individual parts and segmenting the feature

Figure 8 Output of Authentication by detecting and opening the door

Figure 9 Output of Non-Authentication by detecting and opening the door

Figure: 7 shows the Authentication results in MATLAB using Quantitative gait algorithm. Where as figure: 8 shows the Output result of the authentication person by comparing with the databases (/home/pi/Desktop/mathu/db/student1.jpg) to (home/pi/Deskto p/mathu/db/student1.jpg) which is already trained before and attained the values. In real time, the face is recognized through Pi camera and compared with the array values and opens the door automatically for the authenticated person.
6. **Performance Measures**

Around 20 datasets for different stages of cancer cells [1][6] have been processed in the proposed work. The algorithms were implemented both in MATLAB and ARM processor. Various parameters have been measured and tabulated for five types of images.

A. **Accuracy**: The measure of closeness of trained data to testing data is termed as accuracy. It is expressed in terms of percentage.

\[
\text{Accuracy} = \frac{(TP + TN)}{(P + N)}
\]  

B. **Sensitivity**: Sensitivity is a proportion of positive samples which are correctly classified.

\[
\text{Sensitivity} = \frac{(TP)}{(TP + FN)}
\]  

C. **Specificity**: Specificity is a measure of the proportion of negative samples that are correctly classified.

\[
\text{Specificity} = \frac{(TN)}{(TN + FP)}
\]

Accuracy is used to find the exactness of facial images. Hence more accuracy means efficient in detecting the image at time. During the fourth image in Table 1 is a very good accuracy of 99% is obtained. Sensitivity finds the quality of datasets. Specificity finds the percentage of number of images captured in real time. So greater the sensitivity and specificity means there will be less error in distinguishing multiple facial images.

| Images | Accuracy | Specificity | Sensitivity | Execution Time |
|--------|----------|-------------|-------------|----------------|
| Image 1 | 88.8094  | 76.34       | 70.11       | 2.0019         |
| Image 2 | 91.0028  | 75.13       | 76.49       | 3.1013         |
| Image 3 | 90.2016  | 78.93       | 75.93       | 4.1911         |
| Image 4 | 91.5987  | 77.87       | 78.45       | 3.2387         |

| Images | Accuracy | Specificity | Sensitivity | Execution Time |
|--------|----------|-------------|-------------|----------------|
| Image 1 | 97.3452  | 92.253      | 87.34       | 0.783          |
| Image 2 | 98.9342  | 87.248      | 84.85       | 0.638          |
| Image 3 | 97.8036  | 93.254      | 92.90       | 0.638          |
| Image 4 | 100.1423 | 96.389      | 86.13       | 0.438          |
Table 1 shows the Performance measure values of the input images processed using MATLAB. Table 2 shows the Performance measure values of the input images processed using MATLAB. From the above tabulations, that the proposed algorithm implemented in ARM processor gives much better results than MATLAB results by producing higher Accuracy value with less error. This algorithm is more robust to changes than color histogram. This is because, instead of validating several features of image pixels at a time, the algorithm is made on all the features for several stages using quantitative gait during detection stage. Therefore it is computationnally simple and fast with higher detection rate. Also it is clear quantitative gait has shown the better result of performance for the images which also contain the complex background. The overall execution time is very much lesser when processed using ARM Processor than in MATLAB.

7. CONCLUSION

In this paper, design and implementation of quantitative gait algorithm based face recognition is identifying the role of multi view quantitative gait of facial images through normal Pi camera. The results shows that these features are more efficacious to identify people from distance. The result shows recognition rate of 97% with multiple databases trained in real time and recognized the results in real time manner.

This project also displays the low cost and the current used by the organization of multiple companies for security manner which can be monitored at any time. Quantitative gait algorithm can be combined with other biometrics system and this can be extended with multi modal system. So it can be used as one of the better way of authentication.

The future can be resulted in high computation and memory expandable system. The system can also be extend by fixing high quality web camera and by sending the information to cloud to convey about false intrusion and any of the changes in the environment.

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