International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-4, November 2019

Physiological Traits (Face Recognition) Based Door Lock

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Abstract:Security is now a prime concern for any individual in modern days. Theever-increasing graph of technological advancement in the field of Internet of things and other arenas have paved way for new development of smart web-based locking system which is based on face recognition for authentication. The proposed system uses a feature similar to Haar for the purpose of face detection and also Local Binary Pattern Histogram (LBPH). The project also extends its usability by sending live image of the guest which arrives and can even send a notification on the phone to the owner. The proposed system can be embedded along with other technologies to form a smart housing. The implementation of the project is done using Arduino board, python for programming, Open CV library is also included, and the hardware component also includes camera module for face recognition.

Keywords:Haar, Image, Interaction, Pattern, Security

I. INTRODUCTION

Human Computer Interaction is used to enhance communication between user and the system.Basic of the project includes sensors to collaborate and provide function to user.Home security forms an essential part of modern need however the concept of facial recognition [1] is not used widely along with the other smart technologies of recent days. This can be embedded along with the existing technology to provide a more secure option for the user.

In the system proposed in this paper the facial recognition system works by scanning the person image using a camera module [2]. If the image captured matches with the database that is maintained the lock of the door will open. In case someone tries to open the lock, a message is sent immediately to the owner alerting him of the intrusion in his home. The facial recognition system works by identifying the facial components of the person.

The main advantage of this system over the traditional security systems which involves fingerprint is that there is no physical contact between the guest that enters and the system in place.'

Manuscript published on November 30, 2019.

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The system proposed in this paper maps the behavioural characteristic with psychological analysis. The various psychological analysis can result in expression like sad, elated, angry etc [3]. The behavioural aspects are related to the attitude behind different property base. The training of gene data and its analysis enhances the security to a better context.

II. PROPOSED SYSTEM

One of the most popular ways to recognize human faces captured in images is through the use of face detection and identification algorithms [4]. This technology finds various applications and acts as backbone of the psychological mechanism by which a human identifies other faces in real life.

The proposed system will be used as an automation tool for security systems across various fields. A camera needs to be installed which will capture images from its surroundings and use it as a visual input to our system. Faces of individuals who will have access to a restricted area will be fed to our system which will extract the key features [5] of each individual and store it for identification purpose. Based on this dataset, the algorithm will decide whether access has to be granted and the gate opened in our prototype model or not. If any unauthorized user tries to break in i.e. any intrusion is detected, an alarm will be triggered alerting the owner. The entire process will be automated and not require any human intervention. This model can effectively be used in various places such as schools, banks, industries and ATMs.

Face detection [6] can be considered as nothing but a special case of object-class detection. This is because of the similarity of the complexity of the problem. The latter tries to identify the position and sizes of all the visible objects in a given image such as car, pedestrian, torso etc. while the former tries to locate frontal human faces in the image. Once a face is identified, the image of the individual is matched bit by bit with the dataset stored in the database to check whether to validate or not. If any facial features do not match the process of matching will halt and the face will be invalidated.

Firstly, a grey-level image of the original picture is generated [7]. All the valley regions in the image are tested to uncover all the probable human eye regions. In order to produce other facial features including the nose, eyebrows and lips genetic algorithm will be used. However there are certain obstacles which need to be addressed. Due to uneven illumination, lighting effects and shadows often lead to unclear images. Head movements and blurred images causes shirring effects. These issues can be fixed by normalizing the candidate's face.

For each individual the fitness value will be calculated by projecting it on the eigen-face [8]. This process will be repeated a number of times to form a list of probable candidates who have acquired a high fitness value and needs future investigation. Once this process is over, different facial features such as face symmetry and existence of other traits will be measured for each candidate.

Step by step implementation:

The project was made in the following way

1. Making the face detection module:

- In order to setup the environment variables we had to link the directories and paths which were been accessed during the execution of the program so that the libraries we call later can work together smoothly.
- Next, we integrate openCV with python
- We rebuilt it to include face sub module. We used a rebuilt version of openCV with face sub module because it included the LBPH classifier which was to be used for face detection [9].
- We install the latest version of numpy and include it
- Finally we get the classifier ready.

2. Facial Recognition and Classification

- We start off by capturing the video from the web cam of our computer
- The algorithm to be used and the data structures to be implemented were decided. The codes for detection were written.
- Identify the faces in it. After this process face detection is complete
- Make a training data set out of the captured faces
- Next we use LBPH classifier [10] to produce a yml file
- Lastly the recognition of faces is performed

3. Hardware

Arduino actuator

Testing the faces required a serial module to be installed in the python code as it would facilitate the system to communicate directly with arduino board. Based on the results which will be procured from testing related action will be taken. Once this is done we need to interface the Arduino with the actuator and laptop. For this we connect the arduino to laptop. Once this is done we need to figure out the angles for opening and closing an artificial door using a motor. The system was configured so as to close the door when initialised and will allow the system to function correctly from the start.

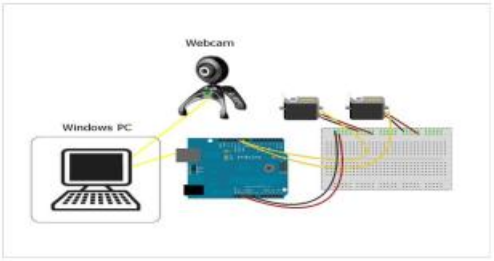

Fig1. Circuit diagram

III.WORKING CASE: IMPLEMENTATION

The proposed system works in the following way:

The first step is to feed in the dataset of the faces of the individuals who are authorized to access the area. This is done by taking their photographs by a webcam to prepare the dataset to be used for comparison in due course.

Now our proposed algorithm which has been used during the training phase generates an yml file for the LBPH classifier which will be used extensively while detecting faces. In order to be affirmative that only an actual person is being allowed, we also made a python script for detection of face i.e. the system recognises if an individual is standing in front of it or not.

The Arduino board was loaded with the code to control the servo motor with angle defined for door opening and closing. Based on the testing carried out it was found that the optimum angles are 0 degrees for closing the door and 130 degrees for opening the door based on the position of the servo motor.

Input: Images with the help of camera module, Database of authorized images,

Output: Unlocking System, Warning Alarm, Servo motor for rotation

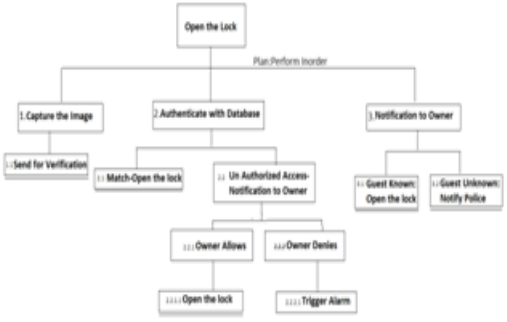

Fig 2. HTA for a proposed system

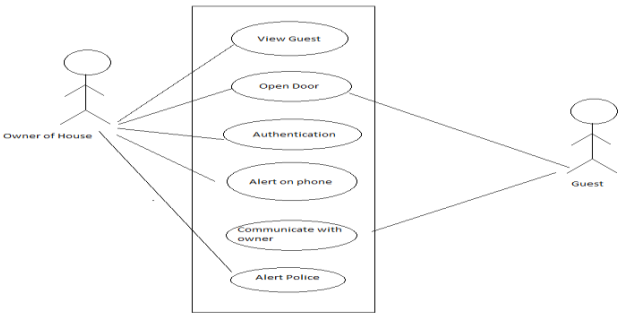

Fig 3. Use Case Diagram

IV. TEST CASES WITH ANALYSIS

Table 1. Test case 1

Test Number: 1	
Test Case Id: Test 1	Module Name: Face Detection
Test Priority : High	Description: To Detect The Presence Of A Face

Table 1.1 Case-1 results

Test Steps	Test Data	Expected Result	Actual Result	Status (Pass/Fail)
Run .Py File Show Face In Webcam Detection By Green Box	Py Files Human Face	The Green Box Should Appear	Green Box Around The Face Appears	Pass

Table 2. Test case 2

Test Number: 2	
Test Case Id: Test 2	Module Name: Data Storage
Test Priority:High	Description: Storing New Face

Table 2.1 Case- 2 results

Test Steps	Test Data	Expected Result	Actual Result	Status (Pass/Fail)
Run Python Run Storing Command	Face To be Authenticated	5 Images Should Be Taken from The Webcam and Stored	The Images Were Stored	Pass

Table 3. Test case 3

Test Number: 3	
Test Case Id: Test 3	Module Name: Face Recognition
Test Priority: High	Description: The Stored Face Should Be Authenticated

Table 3.1 Case-3 results

Test Steps	Test Data	Expected Result	Actual Result	Status (Pass/Fail)
Person With Authentication Place Head in Front Of Webcam	Py Files Authenticated Person	The Command To Open the Door Should Execute	Command Executes	Pass

V. EVALUATION USING GUIDELINES

Evaluate using Schneiderman's eight golden principles:

Using the Schneiderman's principles:

- **Consistency:**The system designed follows a consistent user interface for the various options to be selected by the user who will not face much difficulties in selecting the basic options namely:

Create_dataset, training, run_test

The display as well as the result of running the program follows a similar layout. The color, font and shape are similar for the system.

- **Cater to wide range and types of Users:** This system can be improved to cater to wide range of audience. People who are visually impaired and who cannot understand English language will be stuck using this system, they will not be able to navigate through the menus to utilise its full functionality.

  However, the interface will cater to the normal/ deaf users who can read English language, the system is specially biased for novice and intermediate users since it doesn't have many short keys except for closing the system.
- **Informative feedback:** The system is communicative in nature and it offers feedback in terms of entry of text and details to the user but a certain degree of familiarity with the computers is expected from the users.
- **Dialogs to yield closure:** the system can be improved to include dialogs. At some states the user is left uninformed of what lead him/her there.
- **Offer error handling:** The system offers error handling in terms of python diagnostic command statements, for that the user must be well versed with python. This part can be improved to include users who are not so well versed with python to be supported through the error handling functionality.
- **Permit easy reversal of actions:** The system allows the user to easily exit from any state and the steps involved to reach any intermediate are very simple allowing the user to reach any state from start very simply if something goes wrong (by restarting)
- **Support internal locus of control:** The system doesn't take any action on its own, It requires the user's support to take any action, thus the system gives the impression to the user that he/she is always in control.
- **Reduce short-term memory load:** The system only requires the user to supply the authorized personnel ID for security which the user is required to have stored somewhere to use the system successfully [necessary for security] other than this no other security privilege is required, user is not required to remember any other data.

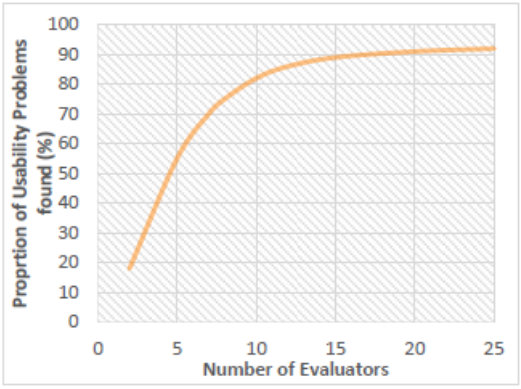

Fig 4. Usability problems vs evaluators

Evaluation Using Heuristics:

Steps:

GOAL-1: Feeding User Data/ Authorized Personnel Data

Step-1: Run the create dataset application

Step-1.1: Enter UserID
Step-2: Run the training application
GOAL-2: Matching User Input Image
Step-1: Run the testing application
Step-1.1: Move hands to mouse
Step-1.2: Face the camera
Step-1.3: Point to start capturing
If matches existing user, open gate
Else, Alert

GOMS Model:

Goal: Program execution
[Select Goal: Feeding Authorized Personnel Data
Operator: Move mouse to create dataset option
Operator: Click create dataset option
Operator: Enter UserID
Operator: Press Enter
Operator: Move mouse to training option
Operator: Click the training option
Goal: Match Input Image/ Lock Configuration
Operator: Move mouse to run test option
Operator: Click run test option
Operator: Move mouse to center
area on the screen while facing the camera.]

KLM Analysis:

- Feeding authorized personnel data

Step 1:
Step 1.1: Run the create
dataset option
Step 1.2: Enter the UserIDOperator level task sequence
Step 2: Run the training option

Table 4. Operator level task sequence

Description	Operator
Move hand to mouse	H
Point mouse to the create dataset option	P
Double click on the create dataset option	BB
Move hand to keyboard	H
Press key to enter UserID	K
Press 'Enter' to submit UserID	K

- Include the mental operator

Table 5. Task Execution time

Activities	Operator Sequence		Execution Time (in sec.)
Step 1	MHMPBBMHMKK	1.35 + 0.4 + 1.35 + 1.1 + 0.2 + 1.35 + 0.4 +1.35 + 1.2 +1.2	10.6s
Step 2	MHMPBB	1.35 + 0.4 + 1.35 + 1.1 + 0.2	4.4s

VI. RESULT AND DISCUSSION

An authentic, secure and reliable system toenhance the security and easily operatedsystem of locking has been proposed. Wehave used a continuous video feed toensure that people do not use the stillimages or print outs instead of a realperson to gain access. Only when a personcomes in front of the camera and thesystem recognises the person as belongingto the dataset that is, he/she is authorised,the system will send the signal to theArduino to open the gate. The Arduinowill actuate it by telling the motor tochange its angle and allow access.

One major obstacle we faced was duringfacial recognition. The algorithmimplemented here works correctly forsmall datasets. However, the issue is withthe confidence level of the system. Itsometimes classifies unauthorised peoplewith good confidence level as being part ofthe authorised dataset allowing themaccess when in reality it shouldn't havedone so. Note that it is easily affected bythe expressions of an individual and thesurrounding light and exposure, heightconditions of the camera when the imagesare taken.

VII. CONCLUSION AND FUTURE SCOPE

The proposed system can implement afully secure and authentic security systemwith fairly good precision. The OpenCVlibrary along with python is integratedwith the camera module to provide userexperience for the overall process.

Further the project can be extended toinclude a voice-based assistance for theguest to ease the process and assist them.The system can also be integrated alongwith the database of police to alert themand send them message in case of anyabsconding or missing person is seen inthe vicinity of the camera.

The use of recent technology likeWhatsApp to alert user rather than sendingmessages can also result in cost reductionof the overall process. The cloud basedsystem can be incorporated to keep a list ofpeople who visit the house as we know thecomplete recordings of the camera requiresa lot of space which eventually needs to becleared to make space for more datahowever if we keep only the image of thevisitor along with the timestamp it willsave a lot of space for the user and it canbe kept for a longer duration of time.

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