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REPORT

PROJECT TITLE
Face Recognition System for Homes

GROUP NUMBER
Group 7

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Without all of them that have mentioned, we would not be able to undergo our project successfully and meaningfully. All the experiences and knowledge that we have gained are their efforts and time spent.

ABSTRACT

Home security is an essential aspect in our daily life both at home or at work while exist numerous reports of burglars breaking into other people's home and steal valuable item. The Face Recognition System for Homes can be used to prevent burglary as the door is to be unlocked by authorized user. This implementation of face recognition system to unlock the door aims to ensure the security of our home by implementing image processing (Face Recognition) to lock and unlock doors for home and office. The implemented system is an intelligent system created to detect and authenticate the face of the house owner and unlock the house door. The system will detect and recognized human face and unlock the door when the face of the user matched with the system database. The system will unlock the door for authorized users and identify which user have just entering the house. It will ease human as for the keyless technology and avoid troublesome engagement involving loss of the key and left it inside the house. The system soar for keyless smart home technology.

ABSTRAK

Keselamatan rumah adalah aspek penting dalam kehidupan seharian sama ada di rumah atau di tempat kerja. Terdapat banyak laporan pencuri memecah masuk ke rumah orang lain dan mencuri item berharga. Sistem Pengenalan Wajah untuk Rumah boleh digunakan untuk mencegah pencurian kerana pintu hanya boleh dibuka oleh pengguna yang diberi kuasa. Pelaksanaan sistem pengenalan muka untuk membuka kunci pintu bertujuan untuk memastikan keselamatan rumah dengan menggunakan teknik pemprosesan gambar (*Face Recognition*) untuk mengunci dan membuka kunci untuk rumah dan pejabat. Sistem yang dilaksanakan adalah sistem pintar yang dibangunkan bagi mengesan serta mengesahkan wajah pemilik rumah dan membuka kunci pintu rumah. Sistem ini akan mengesan dan mengenali wajah manusia serta membuka pintu apabila wajah pengguna dipadankan dengan maklumat di dalam pangkalan data sistem. Sistem ini akan membuka pintu bagi pengguna yang diberi kuasa serta mengenalpasti pengguna mana yang baru saja memasuki rumah. Ini akan memudahkan manusia dan menyumbang kepada teknologi rumah tanpa kunci dan mengelakkan isu seperti kehilangan kunci atau tertinggal kunci di dalam rumah. Sistem ini juga menyumbang kepada teknologi rumah pintar (*Smart Home*) tanpa penggunaan kunci.

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CHAPTER I

INTRODUCTION

1.1 Introduction

Today, security is an essential aspect in our daily life whether at home or at work. There have been reports of burglars breaking into other people's home and steal valuable items. Most of this happened because the door of one's home might not be good enough to prevent such accidents.

Besides from that, people also tends to misplace their keys which might results in he or she to not being able to get inside of their own houses and offices before they found their key.

The Face Recognition System for Homes will detect and recognize the face of house owner and enable user to unlock the door of office or house by face recognition. For user, there is no worries of losing or misplacing the key.

Furthermore, the system will create keyless smart home for the residential and industrial area. The home security is also increased and at the same time reduce the criminal rates. The system authenticate and unlock the door for authorized user.

1.2 Business Process

First of all, the problem statement is identified and discussed among the group members. At the end of the discussion, the issue found is regarding the home security and the circumstances faced by house owner if they lost or misplaced their house key. So, we decided to implement face recognition in unlocking the door. Next, the objectives to be achieved from the successful implementation of this intelligent system are identified.

The resources to be used for the project are determined and the initial design or sketch are produced by using the provided resources and materials. The physical model of the project are built up based on the initial design. The modules is evaluated and synced with the built up physical model to ensure the project will meets the requirement specifications. The programming technique and languages to be used are determined and studied. The knowledge of the intelligence aspect which is the image processing for face recognition are also studied and learned.

In order to ensure the system are functioning according to the specification discussed earlier, we do testing and record the result of the testing. We are doing testing for the face recognition module and the motor movement module. We are repeating the testing process and improving the face recognition model as for a better result and higher accuracy for face recognition.

1.3 Problem Statement

Nowadays, home security is significant for the safety of an individual, family or even an organization. In this case, an intelligent device is could solve the problem. The device able to detect and authenticate user face and unlock the door keylessly for the authorized user.

1.4 Objectives

The objectives of the project are:

1. To increase home security by implementing face recognition system to lock and unlock the doors for home and office.
2. To create a keyless door lock system.
3. To unlock doors by face recognition.

1.5 Project Scope

1.5.1 Target User

The targeted user for this robot is for everyone especially for those who are aware of their home security.

The intelligent system has the capability to detect, recognize and unlock the door for authenticated user. It performs fast capability and efficiency for the users to access the house by face recognition.

1.5.2 Modules

The system function or modules are described as follows:

1. **User Face Detection and Recognition Management**
   The face recognition training model is used for classify and authenticate the new detected face. The system will detect and recognize the user's face for user authorization. Webcam is used to capture the faces.

2. **People Presence Sensor**

   The module is to check if a person present in front of the door. The result form the sensor is recorded and the reading will be sent to the motor for implementation of the next task. If the people are detected present in front of the door, the door will remain opened but if not the door will closed in 5 second.

3. **Motor Movement**

   The brick of EV3 robot will read the results of the face recognition and the motor will run according to the specified task. The medium motor will move to unlock the door for authorized user and the large motor will opens the door from the inside when the door is unlocked by the medium motor.

1.6 Project Significance

Today, many users are still using the old traditional method, which is using the key to unlock the door manually. These are few significant in developing the Face Recognition System for Homes. The system are able to increase the residential house security and reduce the criminal rate. Moreover, this keyless door unlocking system will increase the user's efficiency in carry out daily task and soar towards keyless smart home.

1.7 Hardware and Software

1.7.1 Hardware Requirement

For the hardware, our group uses both LEGO MINDSTORM EV3 and Tetrix Component set to build our project.

1.7.2 Software Requirement

As for the software, we uses Python programming language to implement the code for face recognition and EV3Dev operating system to be used for the current version of EV3 compatible platform.

1.8 Conclusion

As a conclusion, the Face Recognition System for Homes is inspired based on the problem faced by the house owner at which the home security becoming a threat to them. The system will ensure the home security and create efficiencies for unlocking the door by face recognition.

Last but not least, users can use the system and access the door at ease. The problem of misplacing or losing the key could be solved. It is convenience for either an individual or organization that concerned for their home security.

CHAPTER II

METHODOLOGY

2.1 Robot Development Methodology

We uses prototyping approach as a methodology for our project. Our project uses image processing, that is face recognition at which accuracy taken a very significant place. First of all, after identify the problem statement we have understand the functionality requirement of our Face Recognition System for Home.

We stick to the requirement specification and design the architecture of the robot. We build a simple robot with motor and brick used for controlling the motor. Then we build the training model of the face recognition system and integrate with the robot built up earlier. Accuracy test was run to ensure everything is smooth and the accuracy is studied. The prototype is improved and the model is improved and tested continuously.

We choose prototyping approach as for face recognition, we have to build and test the training model from time to time and continuously for obtaining the best result and accuracy.

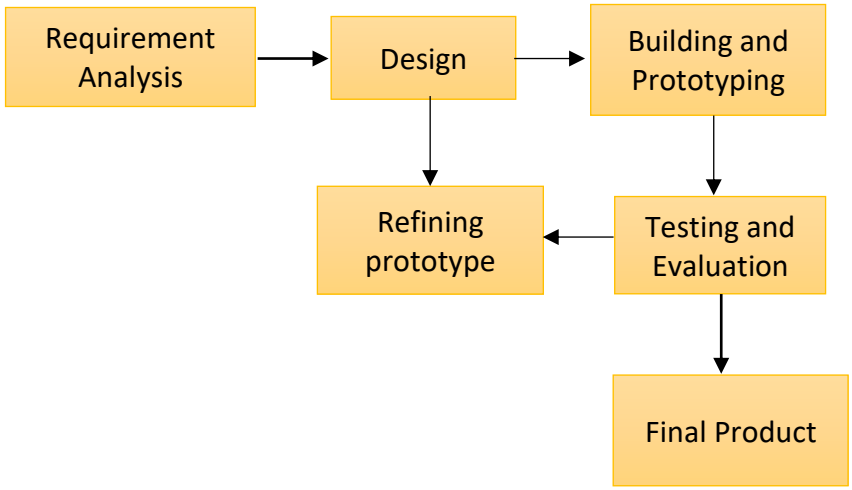

Figure 2.1.1 Prototype Model

In requirement analysis, we discussed the problem statement and determined the requirement specification with our supervisor and other group members. The functionality or modules are discussed.

The specification of the project requirement is then used to design the initial project architecture according to the specification which is a webcam used for face recognition and motor to move the door. The prototype is built according to the outcome of design analysis.

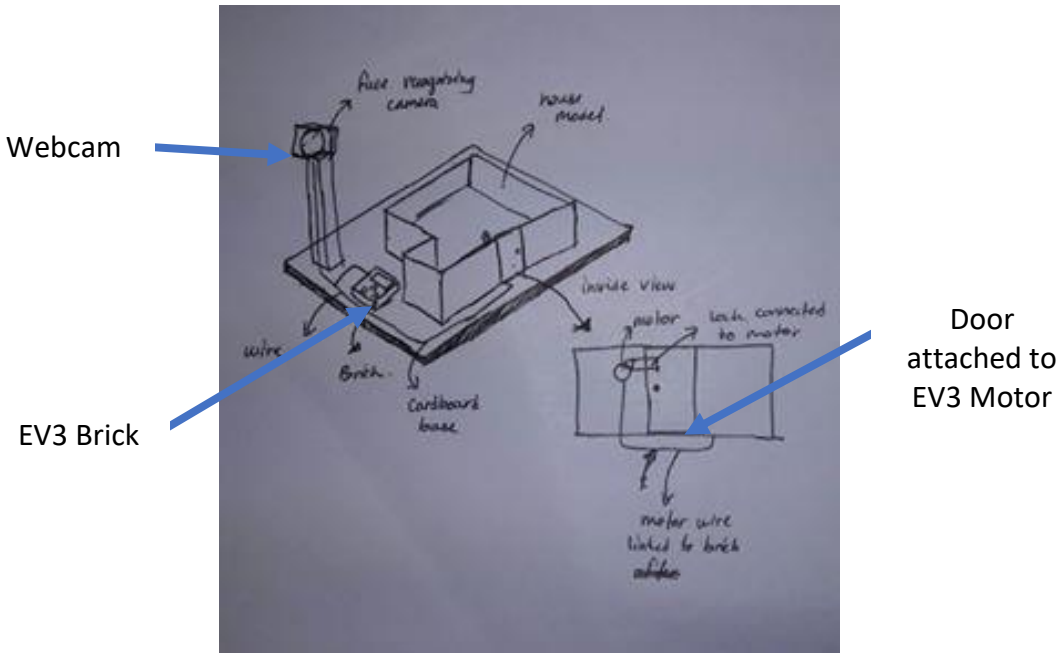

Figure 2.1.2 Initial Sketch of Face Recognition System for Homes

The figure above is the initial sketch and design for the house prototype of Face Recognition System for Homes. The initial design included the uses of webcam, EV3 motor and brick.

The movement of the motor is just for moving left and right, as for locking and unlocking the door according to the results from face recognition. The system is tested and its performance is improved from time to time. The evaluation process is to ensure the system and the motor movement can function well. Finally, a final product which fulfil the project requirement is produced.

2.2 Robot Development Technique

At the very first stage, the house prototype with a door attached with motor are implemented. The Debian Linux-based operating system, EV3Dev is integrated into the ev3 brick. EV3Dev are integrated with 8GB SD card and was inserted into the brick as to be run on EV3 LEGO MINDSTROMS compatible platforms.

In this project, OpenCv Library and Support Vector Algorithm (SVM) algorithm a used for the face recognition. The motor movement is done with EV3Dev operating system and Lego Mindstorms EV3 and Tetrix component set. The house prototype is built by using the Tetrix set and the Medium Motor from EV3 LEGO set are used to build the door with the motor.

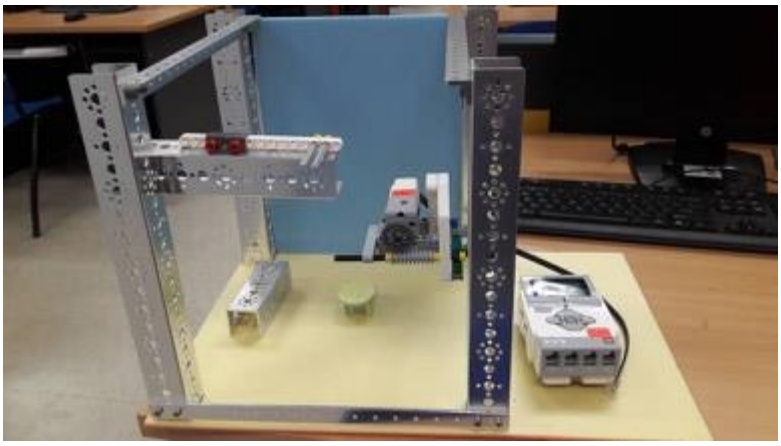

Figure 2.2.1 Initial Prototype of Face Recognition System for Homes

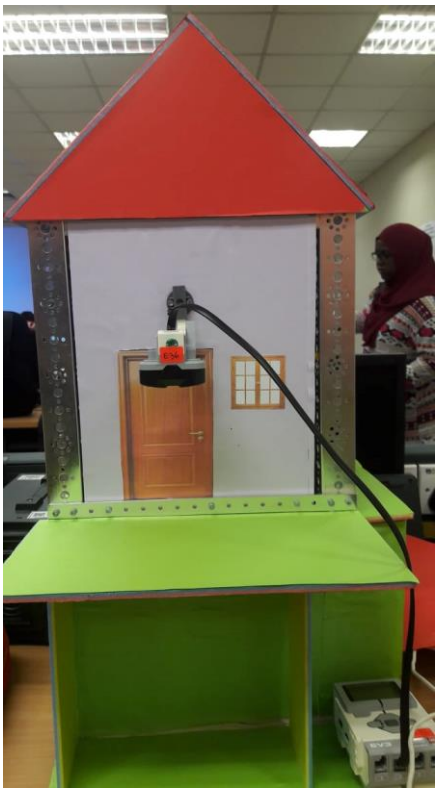

Figure 2.2.2 Final Product

2.3 Summary

In conclusion, this project used the prototyping methodology which the system is done based on the requirement specification. The processes of set up the robot included requirement analysis followed by design analysis, building and prototyping, testing and evaluation and finally a development of a final product. The built up prototype model enables our group to be flexible while accomplishing this project based on the objectives discussed earlier in the report.

CHAPTER III

ANALYSIS

3.1 Analysis of Current Application

In most houses and offices where user have to use some key to unlock the door, there are certain weaknesses or drawback that may cause some unwanted situation to happen:

1. The home security is threated as the criminal rate increases. It could be seen and noticed on the news where people broke into houses to steal valuable things. The burglary is not happening in houses only but also in the shop and in the bank.

2. User may loss or misplace their key which causes them unable to unlock the door for entering the room. The lost key may be found by other person instead of the family members of the house and this could be a threat to the family.

3.2 Analysis of Proposed Robotic Application

Face Recognition System for Homes is the project aimed to increase the home security as to unlock the house door with face recognition. The project consists of prototype house built up of the Tetrix set, EV3 brick, medium motor and the webcam for user face detection and recognition. For the face recognition, the training model is build up and tested.

During the testing, a webcam is used to detect the face of the user and the obtained data will be tested with the face recognition model for image identification and authentication. The brick will obtain the face recognition results and move the motors which will unlock and opens the door. An ultrasonic sensor is implemented in this project to detect the presence of people for which when no people is detected the door will be closed in 5 second.

3.3 Structure Chart of Proposed Robotic Application

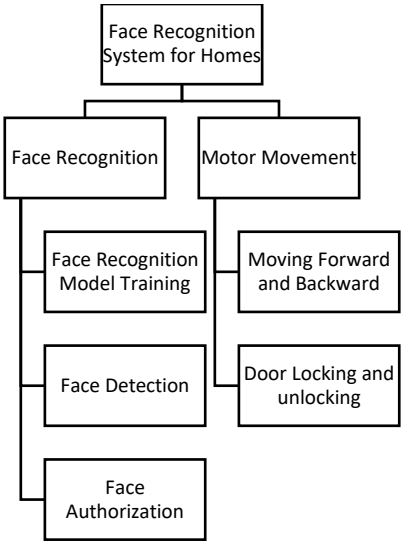

Figure 3.3.1 Structure Chart of Face Recognition System for Homes

Figure above has showed the modules included in the Face Recognition System for Homes including the face recognition and motor movement module.

3.4 Work Breakdown Structure

M: *Muhammad Asyraf bin Abd Razak*

L: *Lim Jiang Leong*

T: *Tea See Nai*

Table 3.3.1 Work Breakdown Structure

No	Module/ Task	Assigned to
1	**Discussion/Verification of Project Title and Synopsis with Supervisor**	
1.1	Discuss the project title and project scope with supervisor	**M, L, T**
2	**Final Proposal Submission**	
2.1	Submit the final proposal to supervisor for approval	**T**
3	**Methodology and Analysis Phase**	
3.1	Discuss the design of the robot - Face recognition door-unlocking robot - Webcam	**M, L**
3.2	Understand the requirement and methods of face recognition	**M, L, T**
3.3	Understand the limitation of the robot	**M, L, T**
3.4	Identify the artificial intelligence technique to be used	**M, L , T**
3.5	Design the architecture of the robot	**M**
3.6	Develop the architecture of the robot	**M**
4	**Module Design Phase**	
4.1	Discuss the programming language to be used and discuss the logic of the module	**M, L, T**
4.2	Develop the basic module in EV3	**M, L, T**
4.3	Program the robot by using Python programming language with image processing to perform the proposed task	**L**
5	**Module Implementation Phase**	
5.1	Develop the artificial intelligence model based on the module	**L**
6	**Module Integration Phase**	
6.1	Integrate the artificial intelligence model to EV3	**L**
7	**Testing Phase**	
7.1	Using authenticated face for recognition and unlock the door	**L,T**
7.2	Test run of the robot	**M, L, T**
7.3	Identify the drawbacks of the robot	**M, L , T**
8	**System Demonstration**	
8.1	Demonstrate the fully integrated robot and system to the supervisor	**M, L ,T**
9	**Video, Poster Design and Submission**	
9.1	Record and edit video of the project	**M, T**
9.2	Design the poster of the project	**M**
9.3	Submit the final poster to the supervisor for approval	**M**
10	**Project Exhibition and Evaluation**	
10.1	Demonstrate the robot project for evaluation during Workshop 2 showcase	**M, L, T**
11	**Logbook, CD, Peer Evaluation and Final report Submission**	
11.1	Write the report and documentation of the project	**T**
11.2	Submit final report and CD to the supervisor for final evaluation	**M, T**
11.3	Submit individual logbook, peer evaluation to the supervisor for final evaluation	**M, L, T**

3.5 Gantt Chart

No	Task	Week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Discussion / Verification of title and synopsis.														
2	Submission of proposal														
3	Discussion with supervisor on analysis and methodology														
4	Discussion with supervisor on design of module														
5	Project implementation														
6	Project Testing														
7	Submission of poster and CD														
8	Final presentation and submission of final report														

Figure 3.4.1 Gantt Chart

3.6 Summary

As a conclusion, the development of robot design and the implementation of code instruction of the Face Recognition System for Homes has to function properly in order to develop the system and complete the project successfully.

CHAPTER IV

DESIGN

4.1 Introduction

Face Recognition System for Homes used Lego Mindstorms EV3 components and Tetrix Component Set to complete the design and the architecture. Other materials such as boxes and cardboard are also used to build the body of the house.

4.2 Robot Architecture

As mentioned above, the project is built using the EV3 set together with the Tetrix set. The Tetrix components, Flat bar, Channel and Angle are used to build the body of the house prototype and the EV3 LEGO set components are used for the motor and door of the house prototype. Cardboard are used to build a more sturdy and attractive appearance of the house prototype.

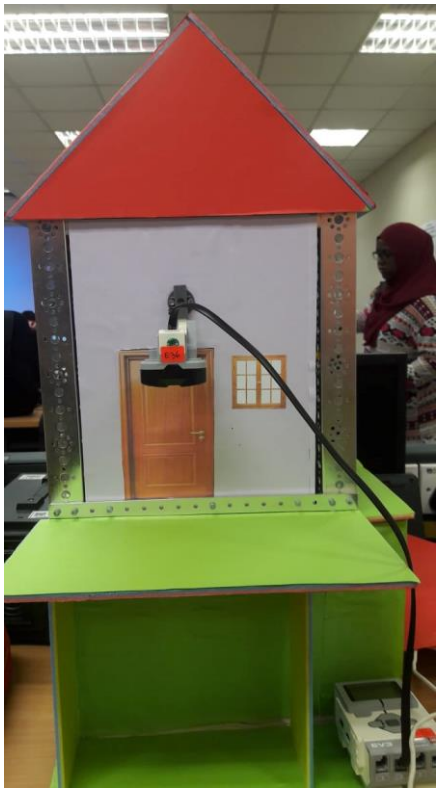

Figure 4.2.1 Final design of Face Recognition System for Homes

Above is the final design of Face Recognition System for Homes. The structure of the design is a house prototype with Tetrix and EV3 based which consist of an EV3 brick, Door with motor (EV3 Medium motor), face detector (a webcam). The Tetrix components are used to build up the house body that are made to be more stable and sturdier for accomplishing the task steadily.

4.3 Movement Module

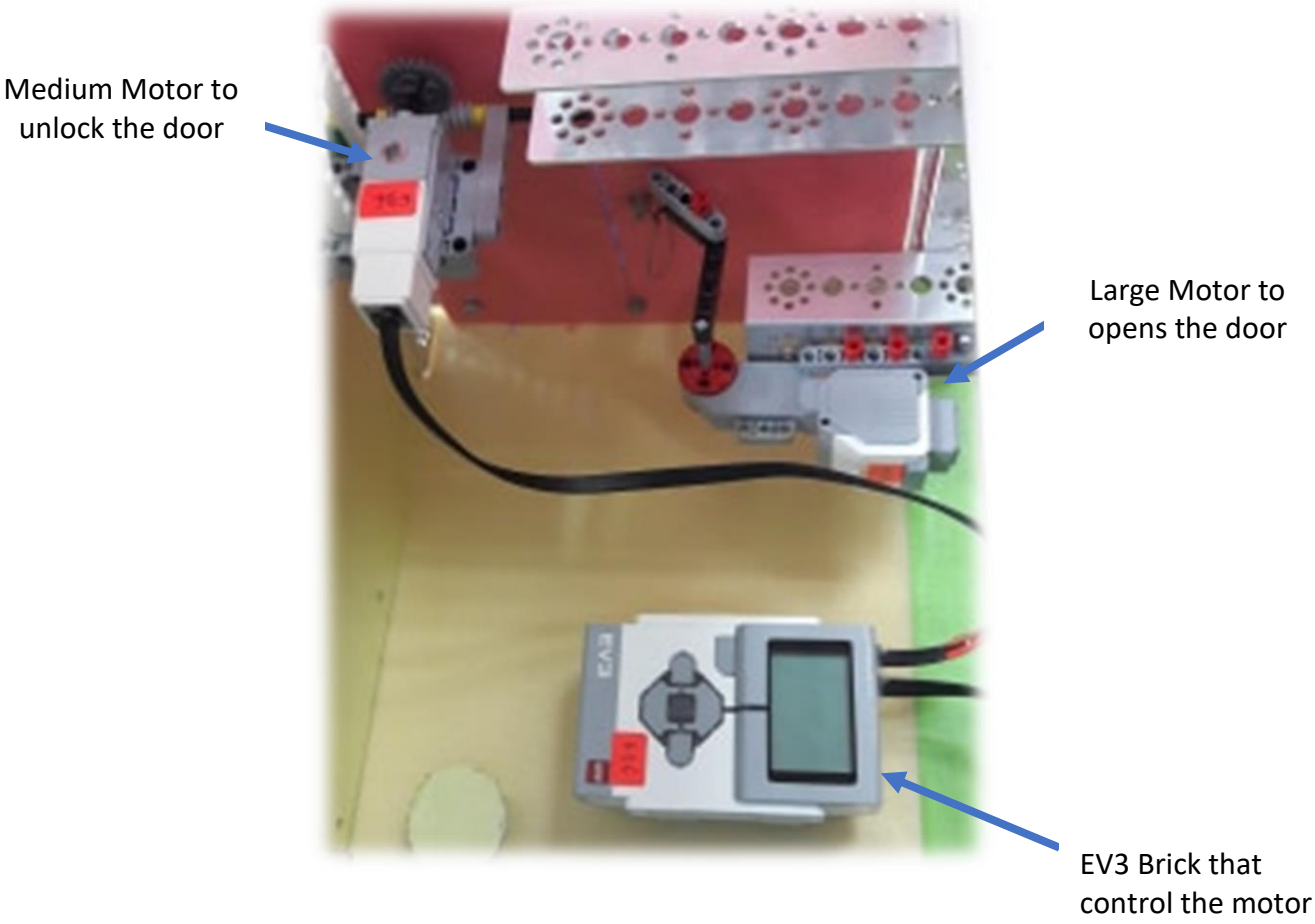

Figure 4.3.1 House Prototype with Door Attached with Motors

The figure above shows the built up house model with door connected to a medium motor and a large motor. Both motor is connected to EV3 brick. The medium motor is for unlocking the door while the large motor is for door opening.

4.4 Sensors (Detection and Response) Module

The location of the sensors on the robot is as shown in the diagram in below section:

Figure 4.4.1 Locations of Sensors

As shown on the diagram above, two sensor is used in our project for interacting with the environment which is a webcam and an ultrasonic sensor.

i) Webcam (Face Detection)

The webcam is used for detecting faces that passed by the webcam and capturing the images for further task. The captured image is load into the face recognition training model for recognition purpose.

ii) Ultrasonic Sensor (People Presence detection)

The ultrasonic sensor is used to detect the presence of people in front of the door. The door will be closed in 5 second if the vertical distance reading of the ultrasonic sensor is below 13cm which indicates it does not sense or detect presence of people.

4.5 Intelligent Module

Image processing is used in the Face Recognition System for Homes.

i) Face Recognition

As for the face recognition, Support Vector Machine (SVM) algorithm is used in training the model. Python programming language is used when implementing the face recognition model.

4.6 Summary

As conclusion, the Face Recognition System for Homes is designed by using the components of EV3 Lego Mindstorms set which contains bricks, motors and sensors. Also, Tetrix set components is chosen to be base of the robot application so that the house prototype is more stable and accurate for performing the task.

CHAPTER V

IMPLEMENTATION

5.1 Introduction

Face Recognition System for homes is an intelligent system that are developed to unlock the door by using face recognition and increase the home security. The intelligent module that embedded in the application enables the user to unlock the door keyless and effectively.

Furthermore, the development of the system is done by using Python programming language with image processing technique and motor movement. The face recognition, programming code and modules was done in Visual Studio Code software before integrated to EV3 brick to enable the motor to run the proposed tasks.

The following section in this chapter provides an overview of the robot information included related information. The project used motor and webcam for face recognition and motor movement to unlock and lock the door.

5.2 Movement

a. Medium Motor Movement

The motor will move to unlock the door according to the results of image processing that is image recognition. Medium motor and other component from the EV3 LEGO set are used to build the door with moveable motor. The motor is programmed to move forward or backward based on the face recognition results.

b. Large Motor Movement

The motor will move to open the door when the medium motor unlocked the door. The large motor is used with other component of EV3 LEGO and Tetrix set to enables the door to be opened when it is unlocked by the medium motor.

5.3 Detection and Response to Environment

a. Image Detection and Recognition

A webcam is used to detect and capture user's face that passed by the webcam. The system will recognize the face and classify the new face either as authorized user or unknown user. The face recognition is implemented using OpenCv Library with Support Vector Machine (SVM) algorithm for face recognition.

b. People Presence Detection

An ultrasonic sensor is used to detect the presence of people in front of the door. The sensor will sense if people are present by comparing the initial and final distance as when people are present, the vertical distance is shorter as compared to the vertical distance when people is not present. The initial vertical distance is 13cm which indicates that the ultrasonic sensor does not detect or sense presence of people.

c. Large Motor

The large motor move in response to the results obtained from the system embedded with the face recognition. When the face detected is an authorized user, the motor will move to unlock the door and when the detected user is unknown, the motor move to lock the door.

d. Medium Motor

The medium motor move in response to the movement of medium motor which opens the door from inside of the house. It creates an automated door once the medium motor unlocks it.

5.4 Completing Task via Intelligence

Image Recognition

To implement the face recognition technique, a face recognition training model is used to train the data. The training model helps to recognize the new detected images either it is an authorized image or an unknown image. 50 datasets of authorized user and 50 datasets of unauthorized user are collected.

The datasets is used for embedding which is to extract 128d facial embeddings features for the usage in Support Vector Machine (SVM) algorithm in face recognition training model. The SVM model is imported from *scikit-learn,* a free software machine learning for Python programming language.

The webcam will capture the face of the user, analyse the image using the trained model that used OpenCv Library together with the Triplet Loss Function selected features and Support Vector Machine (SVM) algorithm mentioned above to train. The model is used to recognize the faces that passed by the webcam in video mode for every captures in every second.

In summary, the OpenCv library operates in 3 main parts which are Clustering, Similarity Detection and Classification. The SVM algorithm is used in advance with this library. Last but not least, the number of consecutive captures using the webcam are used to increase the accuracy and secureness of the owner face recognition

5.5 Summary

As conclusion, the intelligent application was successfully implemented and developed including the two modules. The modules of functions are triggered in response with the environment at which the webcam perceive the external environment for image detecting and capturing. The system will run when image is detected. Lastly, the intelligent model which is face recognition embedded in the application will make the program to run smartly.

CHAPTER VI

TESTING

6.1 Testing Method

For this chapter, we are going to test the performance of the Face Recognition System for Homes whether it fulfils the requirements specifications. As we mentioned earlier the accuracy are important, hence the testing part will cover the testing for face recognition and motor movement. We try to compare the results obtained from the system testing with the actual requirements.

For this project, we will be doing three type of testing, that is Unit testing, Integration testing and Repetitive testing. The testing helps in identify the bug and provide information and evidence for improvement and better performance of the system.

i. Unit Testing

Each part of the program is tested to ensure each every part are functioning well and fulfil with the requirements. In our project, the testing is run on the embedded image, image detection, image training model and the motor movement. The image embedded is tested in the program to make sure the image specification is correct and the image is then trained with the face recognition model. The motor is tested to ensure it can move both way forward and backward.

ii. Integration Testing

For integration testing, the various part is combined and run as an independent project and tested ensure the whole project can run smoothly and functioning well. The system containing the face recognition program is integrated with the EV3 brick. The system is connected to the EV3 brick with USB cable and is used to detect faces. The detected faces is then tested if it can be recognized correctly.

6.2 Test Result Analysis for Unit Testing

a. Face Recognition

Table 6.2.1 Testing for Face Recognition

Subject	Number of Consecutive Capture	Actual	First Test	Second Test	Third Test
Authorized User	20 captures	Acap	Unknown	Unknown	Acap
	15 captures	Acap	Unknown	Acap	Acap
Unauthorized User	15 captures	Unknown	Acap	Unknown	Unknown

b. People Presence Detection

Table 6.2.2 Testing for People Presence Detection

Subject	Actual	First Test	Second Test	Third Test
People present	The door does not close up.	False	False	True
People does not present	The door close up.	False	False	True

c. Medium Motor Movement

Table 6.2.3 Testing for Medium Motor Movement

Subject	Actual	First Test	Second Test	Third Test
Authorized User	Unlock the door.	True	False	True
Unauthorized user	Does not unlock the door.	False	True	True

d. Large Motor Movement

Table 6.2.4 Testing for Large Motor Movement

Subject	Actual	First Test	Second Test	Third Test
Medium Motor unlocks the door	**The door is opened from inside.**	**False**	**True**	**True**
Medium Motor does not unlocks the door	**The door remains closed.**	**True**	**False**	**True**

6.3 Robot Constraint

i) Face Recognition

The face recognition is done by training the model and use the model to predict or recognize the new faces. The accuracy of the face detection is the concern and the accuracy is still can be improved for better performance and higher confident level for the face recognition to work accordingly.

6.4 Summary

In conclusion, we were successfully tested the coding, motors and other robot components that are used to build our Face Recognition System for Homes. However there are some limitation for robot functions according to the system constraints. The limitations absolutely affect the performance and the functionality of the robot at which caused the result is not ideal enough.

CHAPTER VII

CONCLUSION

7.1 Robot Advantages and Commercial Values

Face Recognition System for Homes (Smart Lock Robot) will bring huge benefits to residential and industrial area. First of all, the implemented intelligent system uses face recognition to unlock the door and this will increase the security. It is suitable especially for an individual or organization that are aware and having great concern of home security.

7.2 Robot Weaknesses

In our project, the drawback of the Face Recognition System for Homes is the face recognition accuracy. The limited materials and sensors may affect the accuracy of the face recognition system and the smoothness of the motor movement. Weakness does not mean it is bad, but it indicates that there is improvement and learning space for the system.

7.3 Suggestion for Robot Improvement

The weaknesses of the Face Recognition System for Homes could be overcome by having a better face training model for face recognition. The hardware used could also be improved by using a better version hardware equipped. This could ensure the system could be functioning smoothly and accurately.

7.4 Summary

As the conclusion, this Face Recognition System for Homes is generally an intelligent system for increasing the home security and are able to create a keyless smart home for the residential and industrial area. The system enables user to unlock the door via face recognition without using any key. It does have a great methodology to make an intelligent and smart door lock robot.

The system that has been developed will provides benefits to our country at which besides increase the home security, it also contributes for creating a keyless smart home environment. The system still need to be improve with better software and hardware for higher effectiveness and performance of the system.

Lastly, the development of this whole project also able to increase our skills in performing brainstorming, leadership and task arrangement with team member contributions. The knowledge gains from the lectures and theory can be practically uses for this project and sharpen our skills and expertise.

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APPENDICES

Main Code

```
# USAGE
# python recognize_video.py --detector face_detection_model \
#   --embedding-model openface_nn4.small2.v1.t7 \
#   --recognizer output/recognizer.pickle \
#   --le output/le.pickle

# import the necessary packages
from imutils.video import VideoStream
from imutils.video import FPS
import numpy as np
import argparse
import imutils
import pickle
import time
import cv2
import os
import rpyc

conn = rpyc.classic.connect('ev3dev')
ev3 = conn.modules['ev3dev.ev3']
x=0
m1 = ev3.MediumMotor('outA')
m2 = ev3.LargeMotor('outB')
us = ev3.UltrasonicSensor('in2')
# Put the US sensor into distance mode.
us.mode='US-DIST-CM'

# construct the argument parser and parse the arguments
ap = argparse.ArgumentParser()
ap.add_argument("-d", "--detector", required=True,
   help="path to OpenCV's deep learning face detector")
ap.add_argument("-m", "--embedding-model", required=True,
   help="path to OpenCV's deep learning face embedding model")
ap.add_argument("-r", "--recognizer", required=True,
   help="path to model trained to recognize faces")
ap.add_argument("-l", "--le", required=True,
   help="path to label encoder")
ap.add_argument("-c", "--confidence", type=float, default=0.5,
   help="minimum probability to filter weak detections")
args = vars(ap.parse_args())
```

```
# load our serialized face detector from disk
print("[INFO] loading face detector...")
protoPath = os.path.sep.join([args["detector"], "deploy.prototxt"])
modelPath = os.path.sep.join([args["detector"],
   "res10_300x300_ssd_iter_140000.caffemodel"])
detector = cv2.dnn.readNetFromCaffe(protoPath, modelPath)

# load our serialized face embedding model from disk
print("[INFO] loading face recognizer...")
embedder = cv2.dnn.readNetFromTorch(args["embedding_model"])

# load the actual face recognition model along with the label encoder
recognizer = pickle.loads(open(args["recognizer"], "rb").read())
le = pickle.loads(open(args["le"], "rb").read())

# initialize the video stream, then allow the camera sensor to warm up
print("[INFO] starting video stream...")
vs = VideoStream(src=0).start()
time.sleep(2.0)

# start the FPS throughput estimator
fps = FPS().start()

# loop over frames from the video file stream
while True:
   # grab the frame from the threaded video stream
   frame = vs.read()

   # resize the frame to have a width of 600 pixels (while
   # maintaining the aspect ratio), and then grab the image
   # dimensions
   frame = imutils.resize(frame, width=600)
   (h, w) = frame.shape[:2]

   # construct a blob from the image
   imageBlob = cv2.dnn.blobFromImage(
      cv2.resize(frame, (300, 300)), 1.0, (300, 300),
      (104.0, 177.0, 123.0), swapRB=False, crop=False)

   # apply OpenCV's deep learning-based face detector to localize
   # faces in the input image
   detector.setInput(imageBlob)
   detections = detector.forward()

   # loop over the detections
   for i in range(0, detections.shape[2]):
      # extract the confidence (i.e., probability) associated with
      # the prediction
      confidence = detections[0, 0, i, 2]

      # filter out weak detections
      if confidence > args["confidence"]:
         # compute the (x, y)-coordinates of the bounding box for
         # the face
         box = detections[0, 0, i, 3:7] * np.array([w, h, w, h])
         (startX, startY, endX, endY) = box.astype("int")
```

```
# extract the face ROI
face = frame[startY:endY, startX:endX]
(fH, fW) = face.shape[:2]

# ensure the face width and height are sufficiently large
if fW < 20 or fH < 20:
   continue

# construct a blob for the face ROI, then pass the blob
# through our face embedding model to obtain the 128-d
# quantification of the face
faceBlob = cv2.dnn.blobFromImage(face, 1.0 / 255,
   (96, 96), (0, 0, 0), swapRB=True, crop=False)
embedder.setInput(faceBlob)
vec = embedder.forward()

# perform classification to recognize the face
preds = recognizer.predict_proba(vec)[0]
j = np.argmax(preds)
proba = preds[j]
name = le.classes_[j]

print(name)

if(x==10):
   x=0

if(name!='unknown'):
   x=x+1
   if(x==10):
      distance = us.value()/10
      m1.run_timed(time_sp=600, speed_sp=-200)
      time.sleep(2)
      m2.run_to_rel_pos(position_sp=150, speed_sp=200, stop_action="hold")
      time.sleep(1)
      print(distance)
      while(distance<13):
         time.sleep(1)
         print(distance)
         distance = us.value()/10
      time.sleep(2)
      m2.run_to_rel_pos(position_sp=-150, speed_sp=200, stop_action="hold")
      time.sleep(2)
      m2.run_timed(time_sp=0, speed_sp=0)
      m1.run_timed(time_sp=600, speed_sp=200)
      time.sleep(1)
      m1.run_timed(time_sp=0, speed_sp=0)
else:
   x=0

# draw the bounding box of the face along with the
# associated probability
text = "{}: {:.2f}%".format(name, proba * 100)
y = startY - 10 if startY - 10 > 10 else startY + 10
cv2.rectangle(frame, (startX, startY), (endX, endY),
   (0, 0, 255), 2)
cv2.putText(frame, text, (startX, y),
```

```
            cv2.FONT_HERSHEY_SIMPLEX, 0.45, (0, 0, 255), 2)

    # update the FPS counter
    fps.update()

    # show the output frame
    cv2.imshow("Frame", frame)
    key = cv2.waitKey(1) & 0xFF

    # if the `q` key was pressed, break from the loop
    if key == ord("q"):
        break

# stop the timer and display FPS information
fps.stop()
print("[INFO] elasped time: {:.2f}".format(fps.elapsed()))
print("[INFO] approx. FPS: {:.2f}".format(fps.fps()))
# do a bit of cleanup
cv2.destroyAllWindows()
vs.stop()
```