



Middle East Technical University Northern Cyprus Campus
Computer Engineering Program

CNG491 Computer Engineering Design I

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Student Attendance System using Facial Recognition

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First Iteration

1. Introduction

1.1. *Motivation*

Nowadays It has become difficult for people to have close contact with each other due to the Covid – 19 Pandemic. As the world is ravaged by the pandemic, the development of systems to reduce its spread is getting more and more important every day. One of the important places for virus to spread is unfortunately the universities and schools. As the closure of the universities as part of the quarantine makes learning inefficient and difficult, solutions must be found to reduce the risk of spread.

Classrooms are the main place where the virus can easily spread between professors and students. One of the measures taken was to shorten the lesson times, which led to the emergence of new problems such as the inability to finish course topics in time. One of the ways to increase the time efficiency is to automate the attendance recording system by utilizing a face recognition, which is motivation of this project.

1.2. *Aim & Objectives*

We aim to implement automated attendance system using face recognition.

1.2.1 - Recognize the faces from a live video feed

1.2.2 - Process the class and the section information using time and date.

1.2.3 - Recognize and identify the face of the students to take attendance.

1.3. *Methodology*

How to detect a face from a photograph or a video feed?

Face detection can be done in a number of ways. Currently we are researching “Multi-Task Cascaded Convolutional Neural Network”. This method was introduced in an IEEE paper titled “Joint Face Detection & Alignment Using Multitask Cascaded Convolutional Networks”. A brief description of what MTCCNN is can be understood from the following: Pipeline of the cascaded framework includes three-stage multi-task deep convolutional networks. Firstly, candidate windows are produced through a fast Proposal Network (P-Net). After that, we refine these candidates in the next stage through a Refinement Network (R-Net). In the third stage, The Output Network (O-Net) produces final bounding box and facial landmarks position.

What are the factors to consider when recognizing a face?

Face direction. Face recognition works best when the face is pointed at the camera and both eyes are visible, but the face can be recognized (sideways) in the profile. size. The system

is less likely to detect smaller faces than larger ones, especially for low resolution images and images affected by compression and other artifacts. Media quality. The quality of the image or video sent to can have a significant impact on face detection performance. The face should not be sharp and blurry. Ideally, the image or video should be evenly illuminated, as dark shadows and bright highlights on the face reduce accuracy. The image or video should be immune to significant compression artifacts that may affect some formats (such as highly compressed JPEG images). Facial features. Face detectors can handle a relatively wide range of facial expressions, but neutral faces are always detected with the highest possible reliability. Especially abnormal facial expressions can cause face recognition to fail. In addition, glasses and large amounts of facial hair make it difficult to recognize the face. Glasses with dark lenses can fail to detect.

How to take attendance according to the recognized faces?

The attendance will be taken, after facial recognition has successfully occurred. Once the system recognizes the students in the image/video against the database, an excel file will be generated with the ones recognized marked as present and the others marked as absent. This excel file can then be linked with odtuclass attendance system, but that is out of the domain of this project.

According to our limited research KNN usually has a range of accuracy between 95% and 70% depending on the methods used and depending on the way how the methods and KNN actually interact with the given dataset. (Danades et al. 2017) On the other hand, SVM has varying accuracies between 97% and 85% depending on the methods used (eg FaceNet, Fisherface) and the dataset the algorithm is interacting with. (Parkhi et al. 2015) We will hopefully be targeting any accuracy above 95%.

2. Related Work

Lecturers may require technologies to assist them manage precious class hours efficiently in today's competitive environment, with less classroom time and longer working hours.

Instead of focusing on teaching, lecturers are tasked with doing a variety of official tasks, such as taking attendance, keeping track of each student's attendance, and so on.

Manual attendance taking takes up unnecessary classroom time, but smart attendance using facial recognition algorithms helps the lecturer save time in the classroom.

By recording the picture of the pupils in the classroom via the camera deployed, attendance marking by facial recognition may be suggested in the classroom.

Using the HAAR Cascade method and the KNN model, the facial region of each student is circumscribed by a bounding box, and ultimately, attendance may be registered into the database depending on their existence.

3. Requirements

3.1. Stakeholders

2.1.1 - Students

2.1.2 - Professors

2.1.3 - IT Administrators

3.2. Functional System Requirements

2.2.1 - Takes the attendance and records in an excel file. The reason that excel file format is used is because that format is used in universities a lot, including ours. Also the fact that linking excel with a database is more efficient.

2.2.2 - Supports recognizing students face with glasses and accessories. This is because we won't have people dress as in they are part of the control groups, so there would be people with no accessories as well as excess accessories, the system should be ready for that.

2.2.3 - Supports printing the generated excel file. This makes the job of the user easier so they wouldn't have to open excel select print options each time they get a report.

2.2.4 - Tracks the time to find the correct lecture and the students registered to that section. This is easier than making professors select the current lecture, classroom and section. Automating this process would make the system more reliable.

3.3. Non-functional Requirements

2.3.1 - Camera angle and quality should be sufficient.

2.3.2 – The student attendance system shall produce an .csv document inside 30 seconds after the user presses the “Start Taking Attendance”.

2.3.3 - It should store at least 5 different photos of each student.

2.3.4 - All the students' whom the system will be used on should be informed prior to the use of the software and should be asked for their consent as this is an ethical issue.

2.3.5 - Privacy is an issue so, all the users and people affected by the system should act accordingly as to keep the information secure.

2.3.6 - There should be no copies of the live video feeds that the system uses due to privacy issues.

3.4. Domain Requirements

2.4.1 - The live video feed will not be recorded, and cameras shut down after class hours.

2.4.2 - The area that the cameras will be placed should be secure enough as in physical security, we wouldn't want anything happening to them such as vandalism.

2.4.3 – The placement area of the cameras should also be protected from weather events such as wind, rain, lightnings as that would probably lead to camera getting broken.

2.4.4 – Camera lenses should be cleaned weekly, considering the weather in Cyprus is dusty.

2.4.5 – The cameras should be elevated from the floor by at least 2 meters to avoid probable pranks from students.

2.4.6 – The lecture and the students should be in a classroom in order for the system to work properly.

2.4.7 – The classroom should have good-enough lighting for good footage.

3.5. *Assumptions and Justifications*

2.5.1 - Assuming the dedicated class room is always used during the designated timeslots.

2.5.2 - Assuming the students' faces are facing the camera while the attendance recording is ongoing.

2.5.3 - Assuming the program always has enough storage for storing students' photos.

2.5.4 – Assuming the cameras are working and intact.

2.5.5 – Assuming the database is working properly and connected.

2.5.6 – Assuming the students are not out of the camera's view angle.

2.5.7 – Assuming that the students aren't wearing any masks to cover their faces.

4. Graphical User Interface

Since our project is not necessarily need a complicated GUI, we are just providing a simple example.

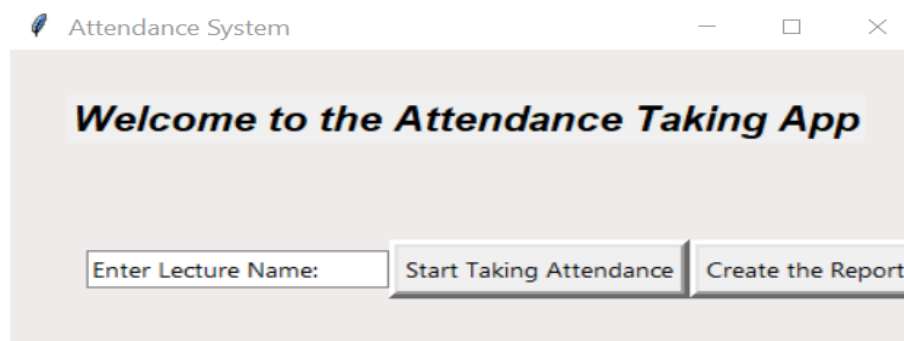


Figure 1.0

- “Start Taking Attendance” button will be responsible from turning on the attendance taking method.
 - “Create the Report” will be responsible from creating a .csv file after having taken the attendance.
 - “Enter Lecture Name:” box will be responsible from taking the lecture name as an input and putting in the name of the .csv file.
- This interface is just temporary for the time being. This feature will be improved.

5. System Modelling

5.1. Structured Use Case Diagram

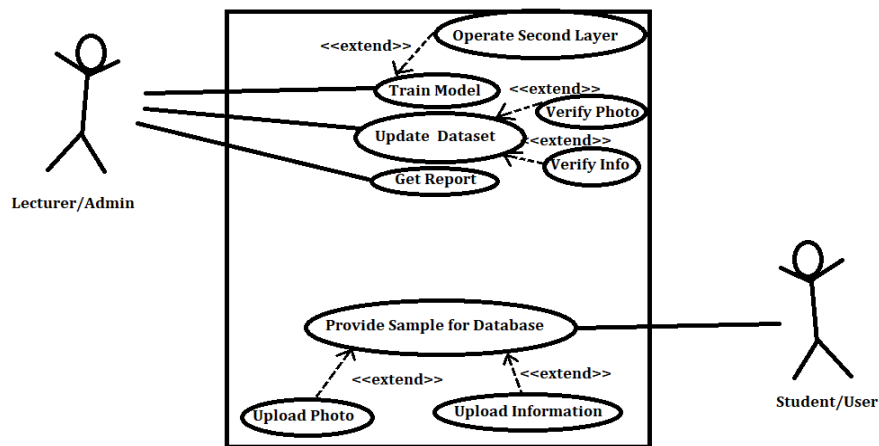


Figure 1.1

As you can see from the structure use case diagram, there is no direct interaction between the users. The student is only required for the database, while the admin is responsible for dealing with the software training and report.

5.2. Sequence Diagrams of the Major Use Cases

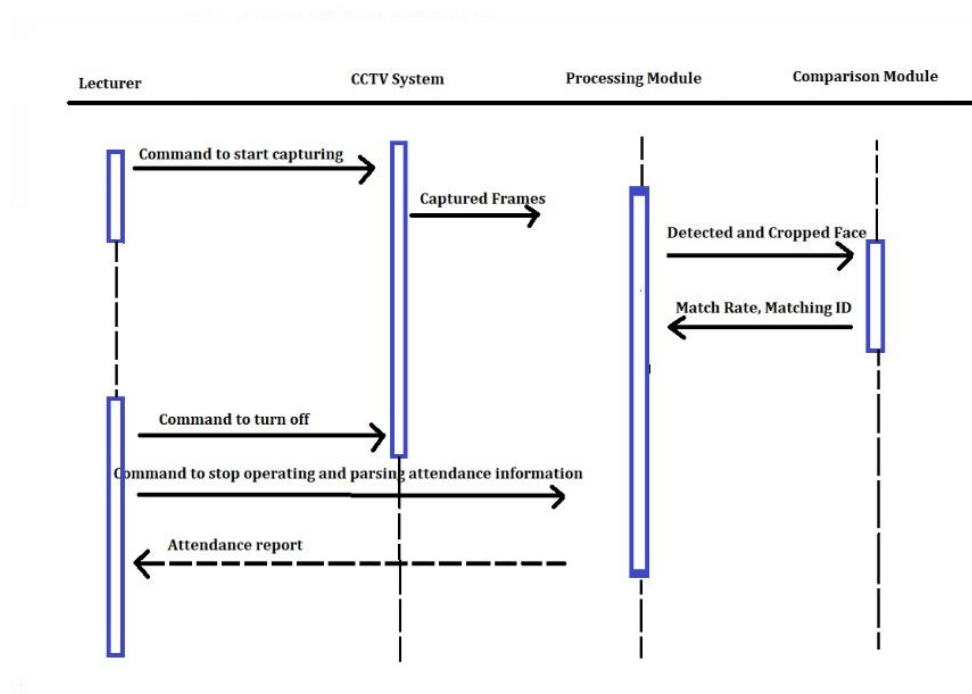


Figure 1.2

As seen in the chart, the Lecturer object starts the live CCTV System and this system sends captured images, video stream in our case, to the brain, Processing Module. In this module, we process the input frame by frame and detect faces, crop these faces, and send it to the pre-trained Comparison Module to see if there is an accurate match between this face and our dataset. Comparison Module warns the Processing Module should there is a match. The Processing Module processes this information and stores it temporarily to save it at the end of the process. To finalize the process, the Lecturer turns off the CCTV System and also sends a warning to Processing Module to stop processing and start saving the attendance information. Finally, the Processing Module sends the attendance report as an answer to the Lecturer.

5.3. Context Model

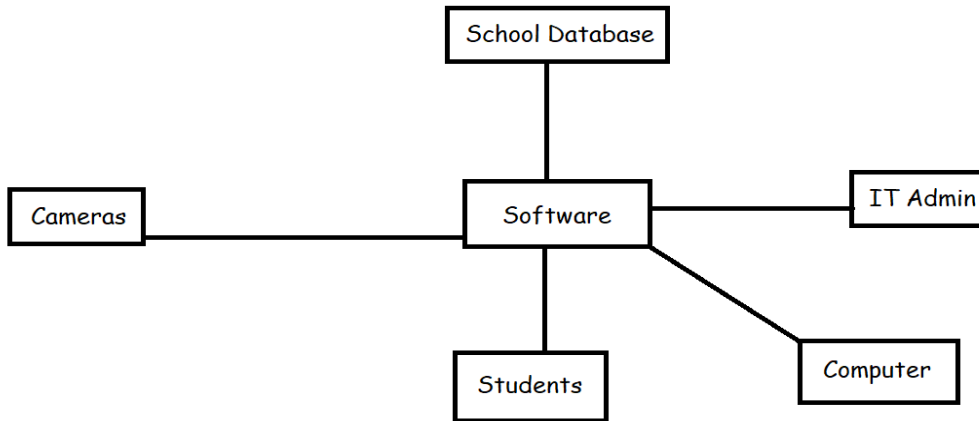


Figure 1.3

This is the context model for our system. As you can see, the software requires the use of cameras, the student data base, students, computer and administrator.

5.4. Architectural Model

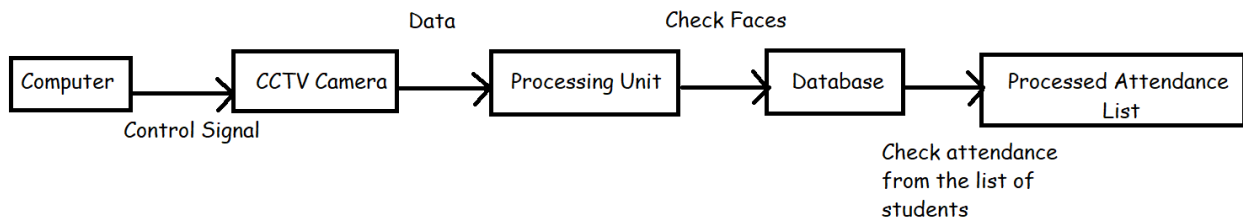


Figure 1.4

The architectural model shows how the system will perform. The camera will record the students, send the data to the processing unit where the processing will happen, which will be then checked against the database. After this, an attendance list will be generated.

5.5. Process Model

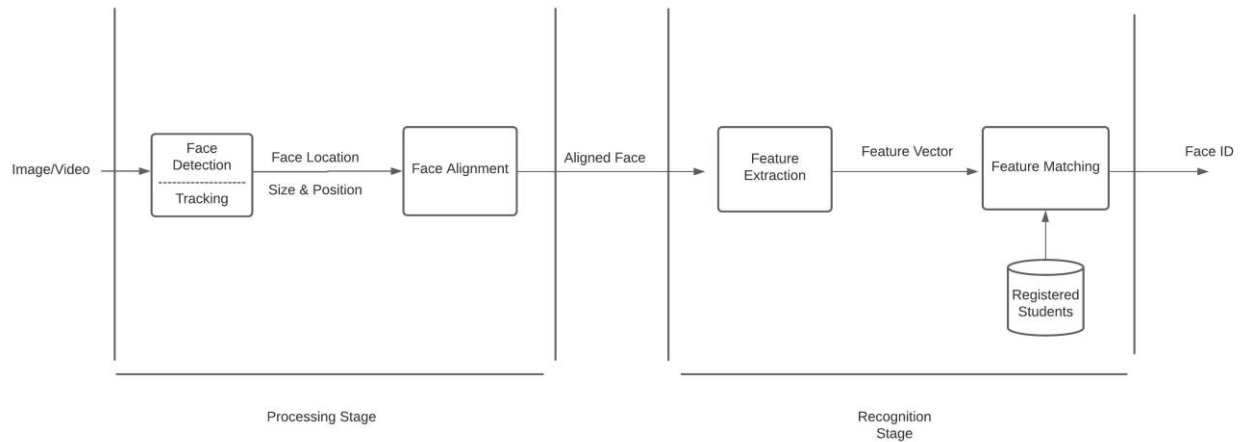


Figure 1.5

5.5.1 Detection / Tracking:

This part of the preprocessing phase is responsible for identifying and tracking faces in specific image or video files. When this process is complete, you can be sure that the input you entered contains a face and is ready for further processing. The tracking phase also allows you to track specific parts, special features, or facial expressions as needed.

5.5.2 Alignment:

Face detection problems are exacerbated by the fact that certain photo or video faces do not follow the guidelines. Face recognition issues are even more difficult because people can zoom in and out, peek from behind obstacles, and more. The placement of the face is important here. This will give you an idea of where the facial lines are in a particular image / video and what contours the facial features have.

5.5.3 Feature extraction:

As the name implies, in this phase of the process individual facial features such as eyes, nose, chin, and lips are used by the next stage of the algorithm. Again, features can be geometric or more complicated. At this point, the computer is collecting enough hard data to clearly distinguish the face.

5.5.4 Feature matching:

In this phase, the input received from the feature extraction is compared to a particular database to infer the identity of the person.

5.6 Data Flow Diagram

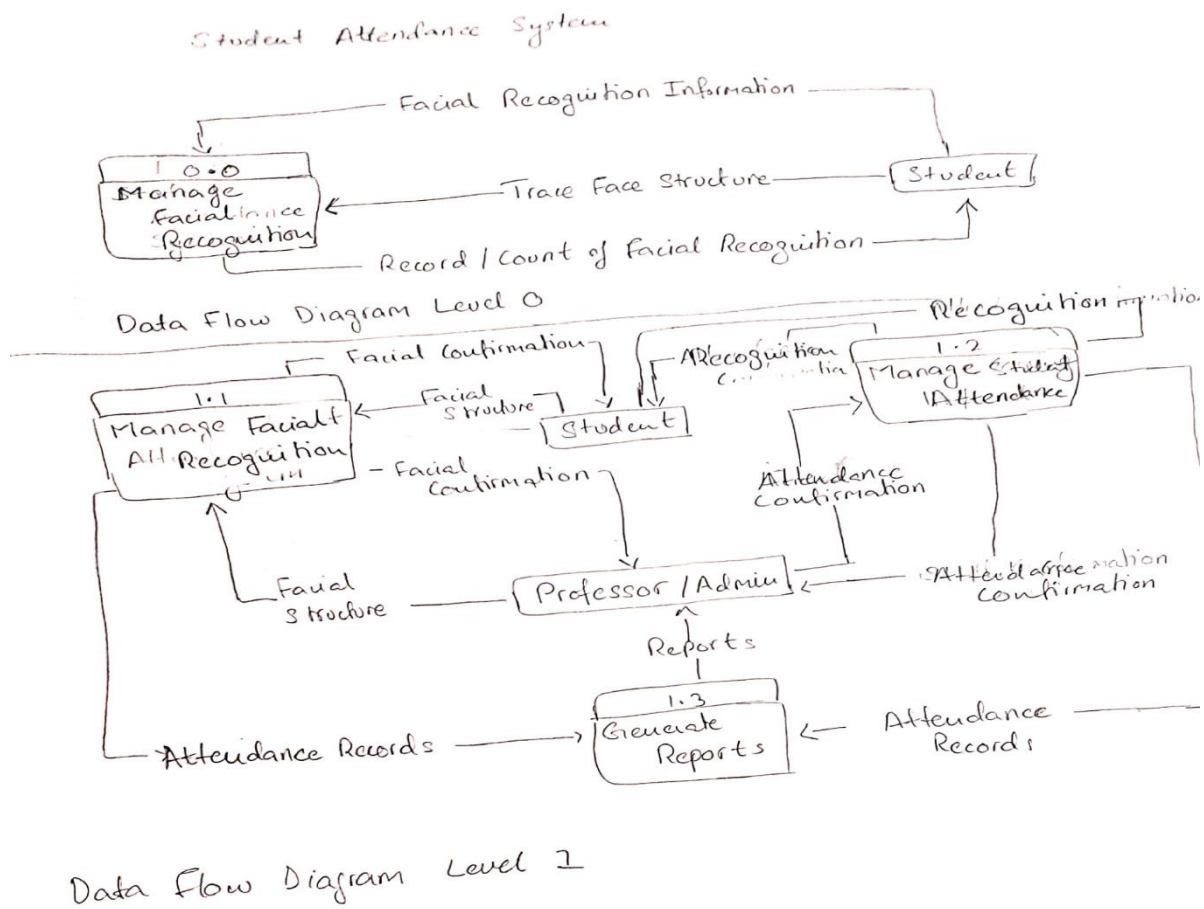


Figure 1.6

Since we're not making use of any databases there is no Level 2 Data Flow Diagram.

5.7 List of Special Algorithms:

1. **HAAR Cascade Algorithm** for object (face) detection in videos and photograph.
 2. **CNN Algorithm** for feature extraction.
 3. **KNN (K-Nearest Neighbour) Algorithm** for face classification and recognition.
-

5.8 List of Special Data Structures & Data Types:

1. Dictionaries.
2. Arrays.
3. Numpy Arrays.

6. Agile Development with Scrum

6.1.1 Sprint Backlog

	Member	Estimated Hours					
		W1	W2	W3	W4	W5	W6
Reading Related Work	All	2	2	2	1	0	0
Image Processing Alg. Research	All	3	3	3	2	2	2
Datasets Research	Abdullah	3	3	2	2	2	0
Face Detection Met. Research	Alpsen	3	3	3	2	2	2
Face Recognition Met. Research	Sabawun	4	4	4	2	2	0
Introduction	Onur	2	2	2	2	1	1
Related Work	Onur	2	2	2	2	2	0
Requirements	Onur	0	2	2	2	2	0
System Modeling	Alpsen	5	5	5	2	2	2
Graphical User Interface	Sabawun	2	2	2	1	1	0
Agile Development with Scrum	Onur	2	2	2	2	1	0
Project Estimation	Abdullah	4	4	4	2	2	0

6.1.2 *Sprint Burndown Chart*

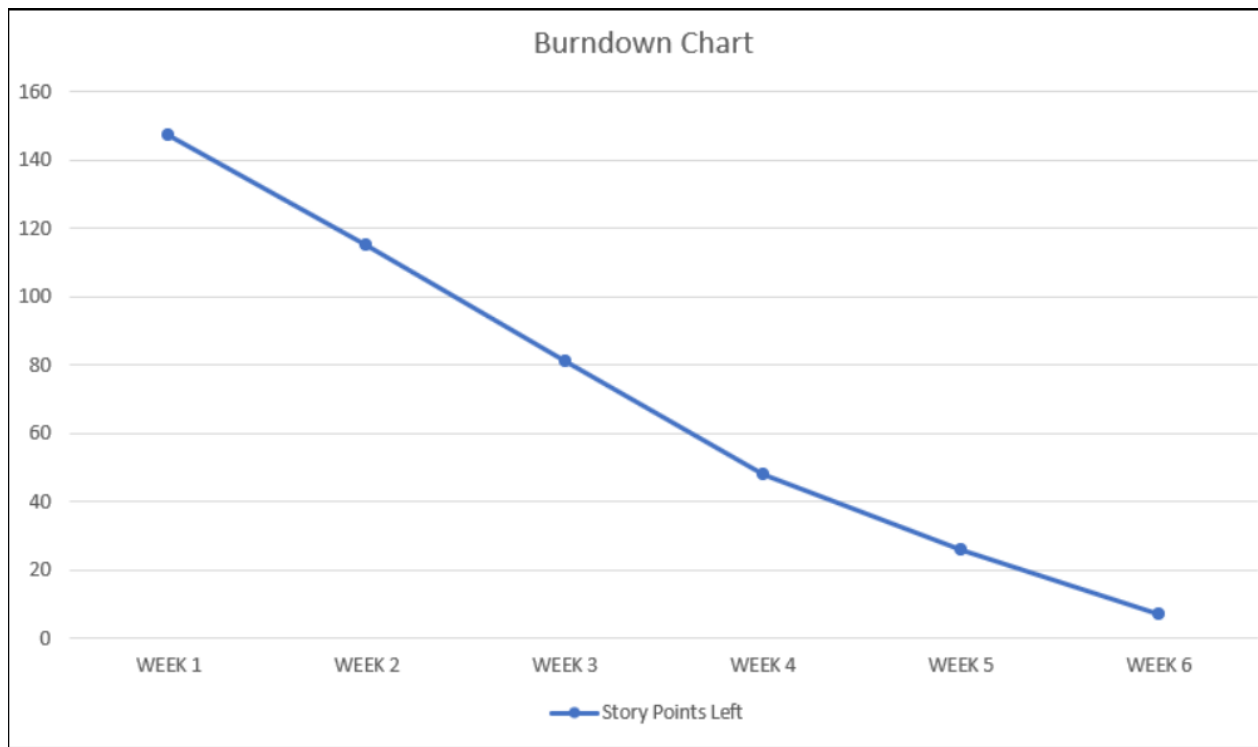


Figure 2

6.1.3 *Sprint Review*

We started by reading and researching related topics. The purpose of this is to understand the concept of face recognition and the algorithms that is related to it.

In week two, we started by talking about the First Iteration of Report. We started to talk about it before it is released to give us more time to research. Then we made work sharing between us. Everyone started searching and preparing their parts so that we can discuss it after First Iteration of Report is released.

In week four, we started to arrange our work for group discussion. Then we checked our work together and made necessary corrections and additions. After that, we prepared our report and submitted it for the feedback session on week 5.

To conclude, we didn't face any problems while doing our own researches and preparations. We encountered some schedule crashes, but other than that it was going as planned. We finished our first iteration before the time. However, we are not fully satisfied yet, so waiting feedback session to improve our report.

6.1.4 *Sprint Retrospective*

Because we were learning and executing the assignment at the same time, several of our tasks took longer than they should have. It would take less time if we knew the subjects. In certain cases, we might want to start with an outline. Including the communication issues we had, we estimate a ten -hour loss in overall time.

We have to focus more on learning details about the face recognition algorithms to choose the most efficient one for this implementation. It is also necessary to train it well so that our implementation will become successful at taking the attendance effectively.

As the concept requires high-level technical details, we should have spared more time to do the research and digest the information. Moreover, every team member should have included in that part more in order to reduce the time wasted spreading the word and having a debate on it later on. Every group member also should have taken a major part in the reporting process since it is designed solely for a group of 4-5, it is almost impossible to be completed by a lesser number due to its workhour weight. Finally, we should have acted more proactively at the beginning of the project. Instead of giving reactions, we could have directed the project's aim and details more instead of expecting our instructor to direct us.

6.2.1 Sprint Backlog

	Member	Estimated Hours			
		29/11/2021	6/12/2021	13/12/2021	20/12/2021
Comparative Strategies	Abdullah	0	1	2	2
Image Processing Alg. Research	Alpsen	5	3	2	1
Dataset Finalization	Abdullah	0	1	1	2
Face Detection Met. Finalization	Alpsen	0	1	0	2
Face Recognition Met. Finalization	Sabawun	0	1	1	2
Related Work	Sabawun	0	2	1	2
Face Alignment Strategies	Onur	3	1	2	1
Agile Development with Scrum	Onur	1	1	1	1

6.2.2 Sprint Burndown Chart

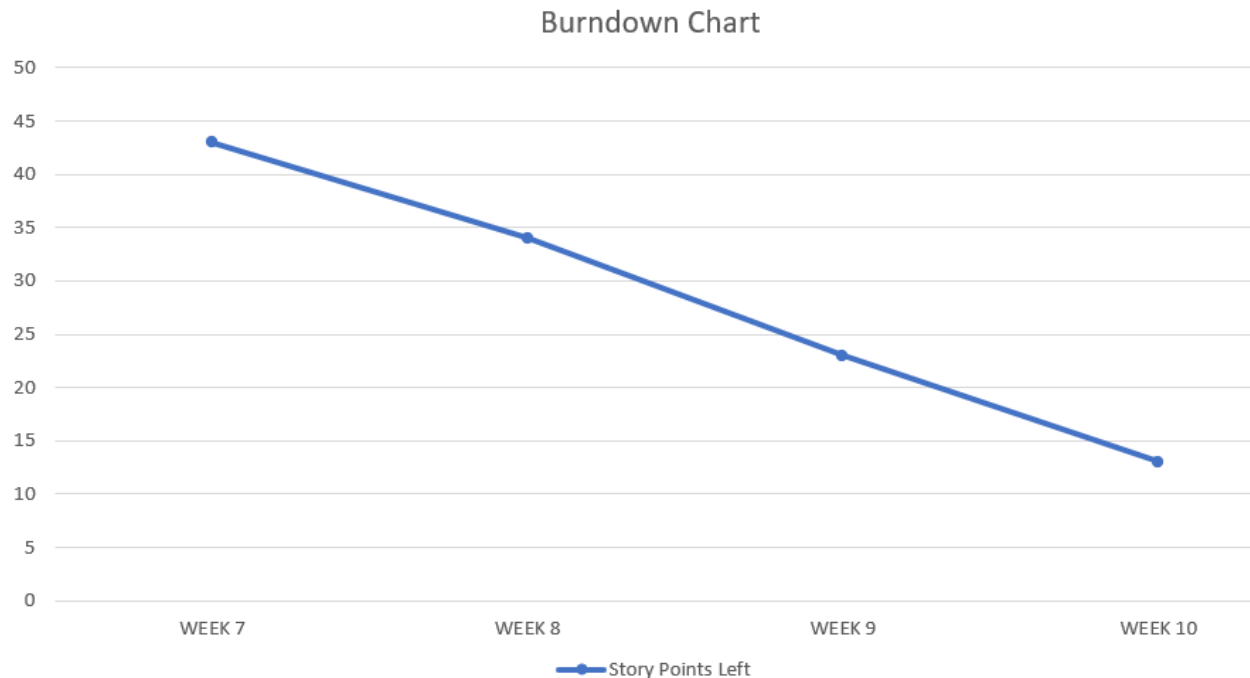


Figure 3

6.2.3 Sprint Review

We continued with our research and planning for the project. The main goal for our team since week 1 has been to fully understand the details and literature regarding the project

In week seven, we started by talking about the Second Iteration of Report. We started by sharing the work between us. We keep searching to find the most appropriate algorithm for our specific project topic. We also searched face alignment strategies for implementing the face detection.

In week eight and nine, we started finalizing our method researches and we started to think about how we can adapt these methods to our project.

Eventually, we are happy to conclude that we've understood the technicalities of the project fully, finalized our strategy of implementation which includes the algorithms that we would be using as well as the database for images.

6.2.4 Sprint Retrospective

After our first iteration, we have worked goal-oriented since we learned the group dynamics and what should be more worked towards. Nevertheless, we failed to arrange productive common study hours successfully with the varying schedules and deadlines. With the postponed meetings and personal issues, we have experienced some damages in the group motivation and the interpersonal relationships. We also neglected to recover from this dilemma soon enough. However, with the recent meetings, we pointed out that the project is taking damage with this attitude of ours, so we emphasized the priority of the project and the common good &

constructive intention over the project. We believe we have been motivated towards the projects more than before now with this new approach, and we all feel more satisfied with it. We commonly decided to take the initiative on the project's steps and began building our first ever prototype using our knowledge and research outcomes.

7. Project Estimation

7.1 UTFP

Inputs

(H) Video feed from camera for face detection & recognition

(H) Schedules of the lectures

Outputs

(H) Attendance Information

(H) Student Info

(L) Error Message

(L) Unwanted Student

Inquiries

(H) Face recognition operation

(H) Attendance marking operation

Logical Internal Files

(L) Student Information {Name, Surname, Student ID, Unique ID}

(H) Student Photos

(H) Trained model of the class

External Interface File

(H) .csv file

(H) KNN Algorithm

Inputs Total = $2 \times 6(H) = 12$

Outputs Total = $2 \times 7(H) + 2 \times 4(L) = 22$

Inquiries Total = $2 \times 6(H) = 12$

Logical Internal Files = $2 \times 15(H) + 1 \times 7(L) = 37$

External Interface Files = $2 \times 10(H) = 20$

Total UFTP = 103

7.2 VAF

General System Characteristics	Degree of Influence
Data communications	3
Distributed data Processing	3
Performance	2
Heavily used configuration	5
Transaction rates	1
On line data entry	3
End-user efficiency	4
Online updates	3
Complex processing	5
Reusability	5
Installation ease	0
Operational ease	3
Multiple sites	0
Facilitate change	4

Total TDI = 41

VAF = TDI * 0.01 + 0.65 = 1.06

7.3 ATFP

ATFP = UFTP * VAF = 103 * 1.06 = 109.18

7.4 Estimated LOC

LOC = ATFP * Language Unit Size = 109.18 x 20 = 2183.6 (Using Python)

7.5 COCOMO

Development Mode is Organic.

a = 2.4, b= 1.05, c = 0.38

KDSI = ATFP * Language Unit Size / 1000 = 2.1836 *We are using Python, which is 20

MM = a * (KDSI ^ b) = 5.44

TDEV = 2.5 * (5.44) ^ c = 4.76

7.6 Jones's First Order Schedule Estimation

Calculations for the average estimation:

Class Exponent = 0.45 (System Software)

Estimate Effort (Man-Month) = $((ATFP) ^ (3*Class\ Exponent))/27 = 20.90$

Rough Schedule Estimate = $(ATFP)^{class\ exponent} = 8.26$

Schedule in months = $3*man-months^{1/3} = 5.28\ months$

7.7 Shortest Possible Schedules

	Systems Products		Business Products		Shrink-Wrap Products	
System Size (lines of code)	Schedule (months)	Effort (man-months)	Schedule (months)	Effort (man-months)	Schedule (months)	Effort (man-months)
10,000	8	24	4.9	5	5.9	8

Figure 4

7.8 Estimated Team Size

Estimated Team Size = estimated schedule / estimated effort = MM / TDEV = 1.14

Estimated Team Size = 1.14

8. Project Management

8.1. Milestones and Tasks

Milestone 1: Detect Face

- Goal 1.1: Image Enhancement – 1 Day - Onur

- Goal 1.2: Successfully show a rectangle on any face in a frame – 3 Days - Everyone
- Goal 1.3: Image Alignment – 1 Day – Sabawun & Abdullah

Milestone 2: Recognize Face

- Goal 2.1: Split Faces into Test & Training – 1 Day - Alpsen
- Goal 2.2: Feature Extraction for Training Faces – 4 Days - Everyone
- Goal 2.3: Store Extracted Features in Database – 2 Days - Onur
- Goal 2.4: Find Minimum Distance B/w Test Face & Database of Faces (KNN, k=1) – 1 Day - Sabawun

Milestone 3: Record Attendance

- Goal 3.1: Record Name, Time of Recognized Face – 1 Day – Abdullah & Alpsen
- Goal 3.2: At end of session, print .xml file with all records – 1 Day – Abdullah & Alpsen

Milestone Dependencies: M1 -> M2 -> M3. Basically each milestone depends on it's predecessor.

8.2. Activity Diagram

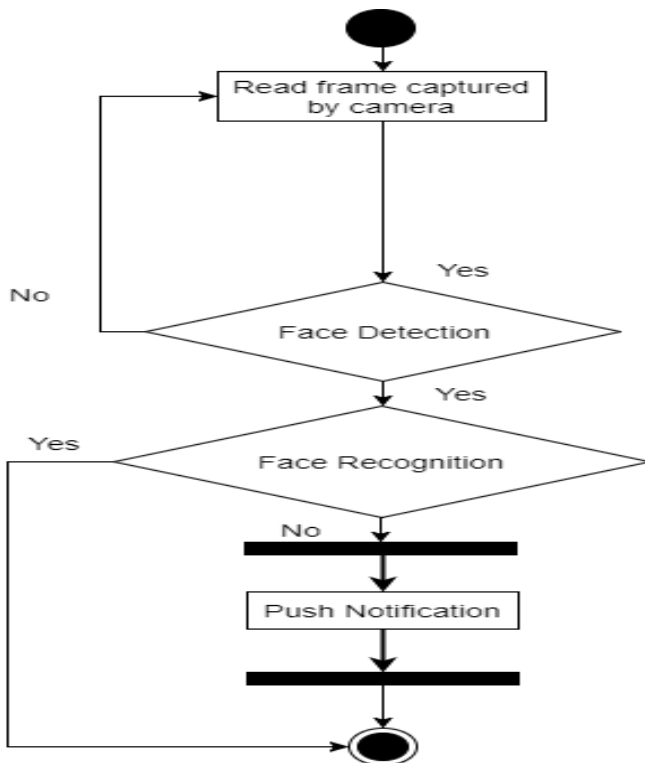


Figure 5

8.3. Gantt Chart

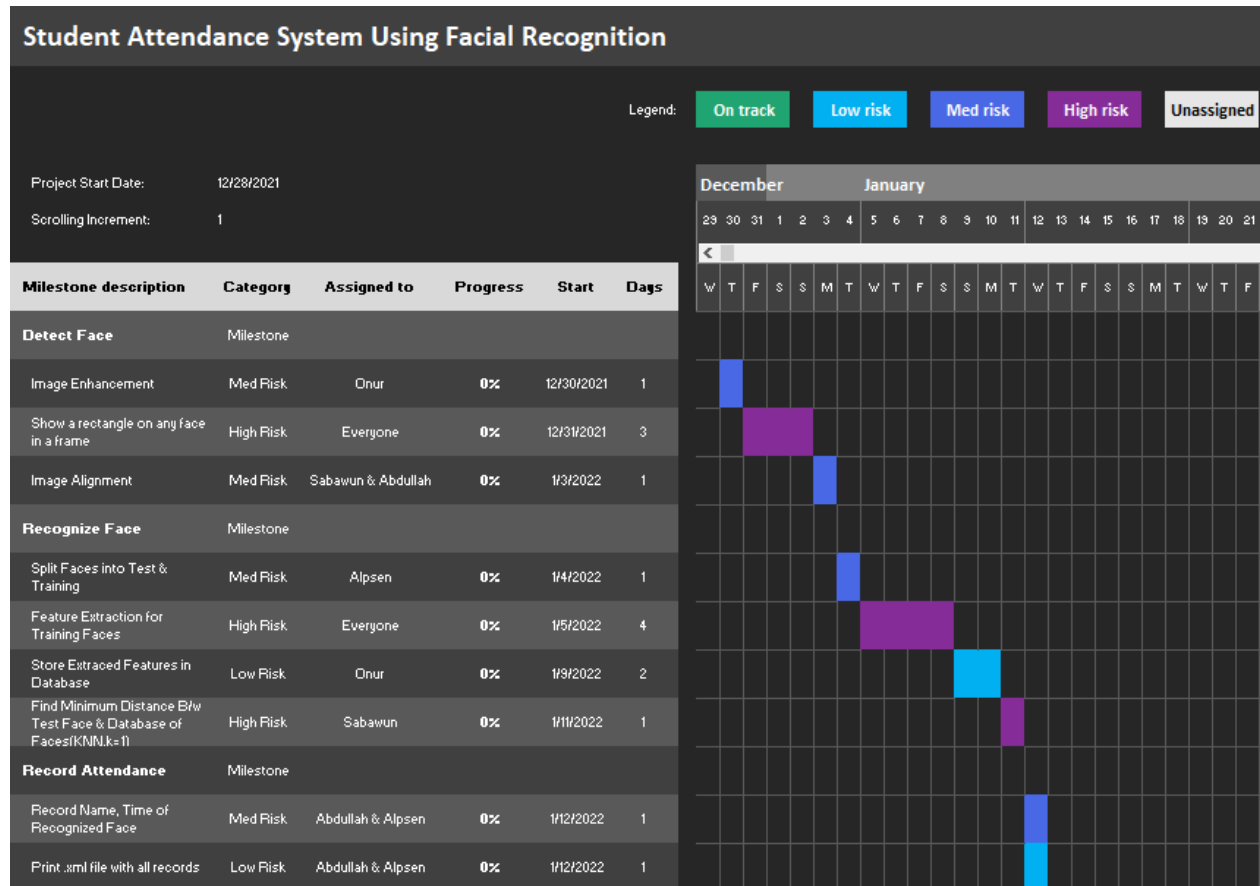


Figure 6

9. Concept

With the coronavirus pandemic's unexpected rise, priorities we need to consider have slightly changed in the classroom environment. We need to remove physical interactions and passings touched/used objects from one to another to prevent contamination via the item. Passing attendance-taking paper is also risky, considering the nature of it. To overcome this problem and eliminate a physical paper requirement for taking attendance, we wanted to develop a system that can take attendance over a CCTV camera system. We plan to use face detection and recognition algorithms besides multiple images of students to build this system and do a stand-alone project.

10. Conclusion

10.1 Critical Evaluation of the Project

Overall, the project was a success, it required more research than expected but after doing the related research and getting hands-on with the techniques to be used we've managed to reach our milestones. Our project can now train itself from a webcam, can be trained using a dataset folder. Further, we've managed to detect and classify faces, and the recognition part had around a 60% success rate in the prototype, which is quite good considering it's only the prototype and will be improved in the future.

10.2 Retrospective of the first semester

It was a long semester, with many ups and down within both group relationships and the project. It was more fluctuating than what we had expected in the first place due to unexpected deadlines of tasks of each group member and unstable interpersonal communication quality within the group members. The first half of the term has passed in a more relaxed environment for all of us, and we were slightly more motivated towards establishing some solid works. However, most of that time was consumed with the literature research and comparison of/debate over the alternative techniques. After finding ourselves in short of time because we were expected to submit reports and we were required to show some work, the understanding between the team members was put under stress. After experiencing such an environment, which we all have failed to prevent from happening beforehand, group members started to take important initiatives for the sake of completing the tasks, even if it damages the overall quality of the project or the communication between the team. It was a serious test for all of us. Nevertheless, as we approach the end of the semester, we can observe and analyze what could have been done better or what we should do to prevent finding ourselves in such a situation again. It is vital to plan to roadmap beforehand and include minor delays for the next semester. We will be prepared for these forecasted issues, and we expect them to affect the team's spirit less.

10.3 Future Work

- 1) Establishing a database which would be required to implement this in real life situation.
- 2) Running different tests on the system to find issues and vulnerabilities in the system.
- 3) Working on installing/upgrading hardware (camera) in classroom for the attendance system.
- 4) Improving the quality of the code
- 5) Establishing a direct link between the attendance system and "ODTUCLASS" for automatic attendance recording, which will replace the .csv files.

Reference List

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