Help Finding Missing People

Graduation project is submitted to Computer Engineering Department in Partial Fulfillment of the requirements for the degree of Bachelor of Computer Engineering

BY

Muhammad Ahmed Ali

Marwah Saleh Ameen

Moaz Mohamed Mohamed

Maya Khaled Hammad

Momen Mohamed Nassar

SUPERVISED BY

Dr. Hadeer Ahmed

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Chapter 1: Introduction

1.1. Abstract

Every day, all around the world, thousands of people are getting lost. It is a global problem that every family may experience. So, we are contributing to solve this problem by applying modern computer and data sciences techniques – like face recognition, location detection, and real-time databases – to help returning missing people to their families. The project is about a handy mobile application named “Missing” and a web application made for government institutions. The purpose of the system is to help return the missing people – who can be lost in different situations – to their families. The application will mainly focus on children and dementia patients since they can easily get lost without having the ability to remember their relatives' information.

1.2. Definition of “Missing”

Anything is said to be missing if it is unable to be found because it is not in its expected place. For example, we say “two files are missing” when we cannot find them it their expected place. Similarly, we say “My glove has been missing for days” and “The burglars have been arrested but the jewelry is still missing”.

On the other hand, people are said to be missing when they are absent from a place – especially their home – and of unknown whereabouts. For example, we say “He has been reported as a missing person” when his family cannot

find him it their expected place. Similarly, we say “Her father has been missing since September 1992” and “Four soldiers had been wounded and one man was missing.”.

1.3. Statistics

1.3.1. Missing Children Statistics

The lack of a common definition of “Missing Child” and the common response to the issue, results in few reliable statistics on the scope of the problem around the world. But even with these challenges, we have collected some statistics of numbers of missing children in some countries, including:

In **Australia**, an estimated **25,000** young people are reported missing every year [1].

In **Canada**, there were **28,033** missing children reports in 2021 [2].

In **Germany**, there were **83,900** children reported as missing in 2021 [3].

In **South Korea**, there were **21,379** reports of missing children in 2021 [4].

In **India**, an estimated **59,262** children were reported missing in 2020 [5].

In **United Kingdom**, over **46,870** children were reported missing in 2020 [6].

In **Spain**, an estimated **1,978** children were still missing at the end of 2019 [7].

In **Russia**, an estimated **50,000** children were reported missing in 2019 [8].

1.3.2. National Crime Information Center Statistics

As shown in **Figure 1**, the National Crime Information Center (**NCIC**) has reported more than **1.6 million missing people's** cases, just in the past 3 years [9].

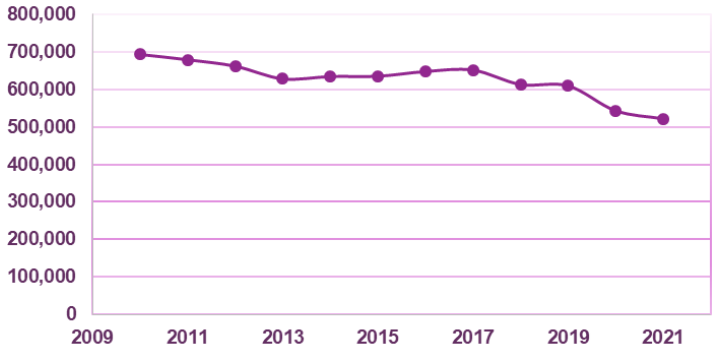


Figure 1 NCIC Missing People in United States

1.4. Reasons of Getting Lost

There are many different reasons why people are getting lost including dementia diseases such as Alzheimer and Lewy Body, transportation accidents such as airplanes, cars, and trains accidents, natural disasters such as tsunamis, floods, and earthquakes, crowded places such as shopping malls and Hajj, escaping from home or from a hospital, and finally kidnapping.

1.5. Problem Statement

Aiming at the social problem of frequent cases of missing people and the low rate of successful rescue operation, we are looking forward to providing the most convenient and efficient system of personally mutual tracing services for missing people. We can summarize the problems to be solved in the following points:

1. **Frequent Cases** of Missing People
2. Low Rate of Successful **Rescue Operations**
3. Lack of **Communication Means** with Families
4. Lack of **Efficient Rescue Methods**
5. It Takes **Long Time** to Find a Missing Person
6. Large Number of **Homeless People** with Dementia

Chapter 2: Related Work

2.1. Missing Children Mobile GIS Mutual Assistance System

The function of Missing Children Mobile GIS Mutual Assistance System is shown in **Figure 2**. When volunteers occasionally meet a suspected missing child on the street, they can take photos that will be uploaded to the suspected missing children database.

At the same time, the system will automatically get the time and location of the photo and will be stored in the database simultaneously. (Volunteers are able to voluntarily register their personal information – for instance, phone number – when upload photo)

When the photo is stored in the suspected missing children database, the photo will be compared to the registered missing children's photos in the database one by one through face recognition technology, and then it will output the similarity of the match results.

Relatives of missing children are able to register the information of the photo, name, location, parents name, address and other characteristics of missing children, then the information will be stored in the database of missing children. The photo will be compared with the suspected missing children database by face recognition technology to determine whether there is a similar match.

However, this system includes several disadvantages including no authentication procedure for registration process, cannot run on multiple user interfaces, and does not provide security.

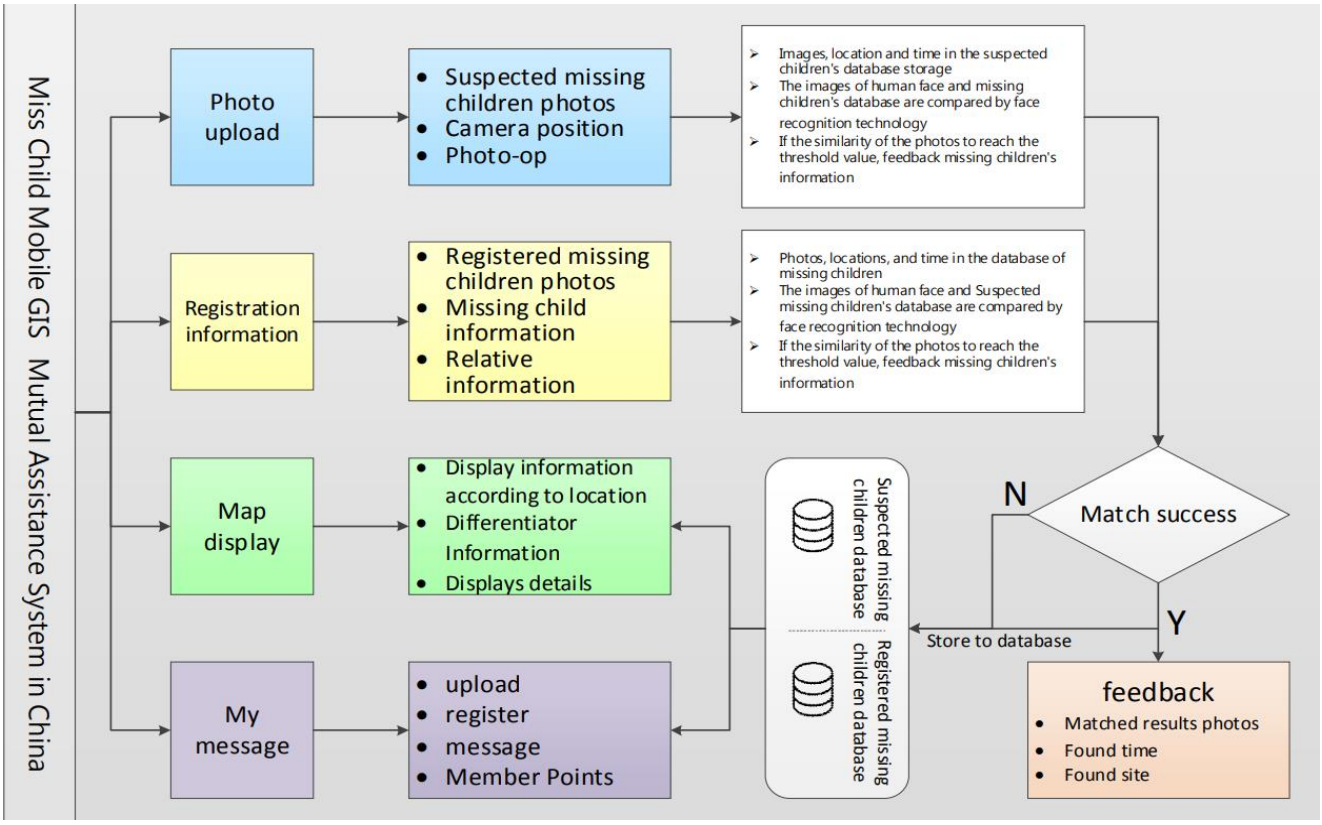


Figure2 The Function Modules of MCMAS

2.2. Finding Missing Child in Shopping Malls System

The procedure of Finding Missing Child in Shopping Malls System is shown in **Figure 3.** The parents approach the nearest security guard. The guard then logs into the system and gives the photograph of the child. The system finds the

location and the floor of the child. Then the system sends an alert message to the security on the floor where the child was found. The security on that floor hands over the child to the parents.

However, this system includes several disadvantages. For example, it covers small area only (The system can be applied in shopping malls only – not outside it), parents are not directly dealing with the system (The system is confined to be used by the security guard only), and it does not include civilians' participation in rescuing operation.

2.3. Intelligent Clothing for Preventing from Getting Lost

GPS and WiFi positioning systems, based on the positioning program of smart phone, can perform outdoor remote monitoring with one server and two mobile devices. For major clothing brands, the currently common way to adopt positioning function to clothing is to interface with the positioning device while connect with third-party devices and making the target clothing functional and intelligent. The device of Zigbee technology has advantages such as small size, low consumption of power and use in complex environments. However, it can only monitor the subject in a fixed range. Such positioning system is mainly suitable for younger children and children with difficulties in mobility to prevent them from leaving safe areas. Both GPS/Wi-Fi positioning processes is shown in **Figure 3**.

However, this system includes many disadvantages. For example, the used technology can only monitor the subject in a fixed range, the suit or the vest can be easily damaged by rain or get lost, not all people can afford buying this suit, and it does not include civilians' participation in rescuing operations.

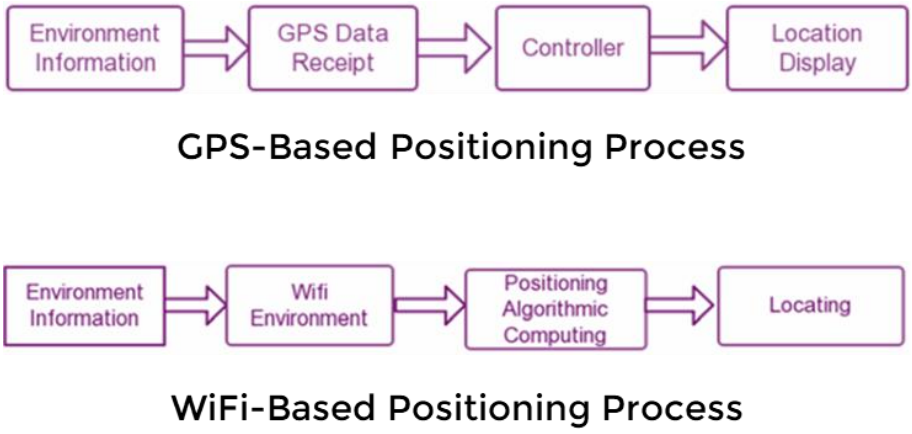


Figure 3 GPS/Wi-Fi Based Positioning Processes

2.4. IoT and GSM Based Child Rescue Device

The system presents a child monitoring and finding framework that uses GSM and GPS geolocation to detect holding-up behaviors and locate missing children. The project's ultimate goal is to develop an IoT-based smart security and safety system for women and children. This idea focuses on a security system that is entirely meant to provide protection and security to women in order for them to never feel powerless when confronted with societal issues. From **Figure 4**, we find that a microcontroller is used to interface with peripherals.

The position is sent through SIM 900 GSM and GPS. She must push the button in the event of an emergency; the GPS application is used to track the child's whereabouts and communicate it to parents and the nearest police station using GSM technology. On the IOT server, the location of missing children will be updated.

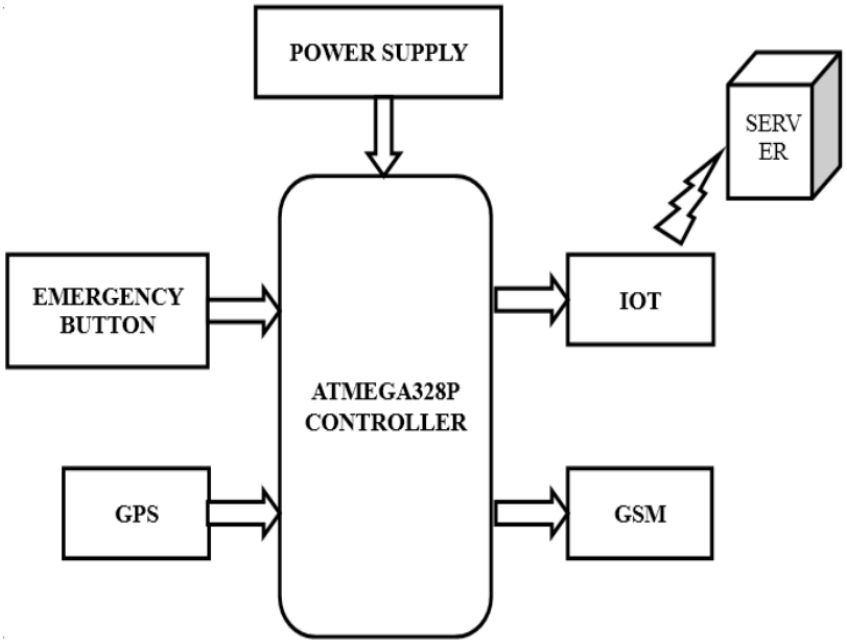


Figure 4 Child Rescue Device Block Diagram

This system also includes many advantages. For instance, not all people can afford buying this device, the device can be easily damaged by rain or get lost, kidnappers may notice the device and damage it or use it to distract the police, and people with dementia and babies are not aware of using these devices.

Chapter 3: Available Solution

3.1. Available Solutions

Nowadays, there are too many different methodologies to find missing people such as:

3.2. Police Centers

Calling the police station is the traditional way and we are always heading to it. It used to be our sole option for locating or simply looking for a missing member of our family but this is way has some issues. It is not always an effective solution because of Limited capabilities of police stations. They have many problems to solve, so they are not specific for this problem, causing slow rescuing operations due to other burdens (other crimes such as murder, theft, etc.)

3.3. Social Networks

Now, social media is one of the most important aspects of our life. People made an effective solution by creating Facebook pages and groups to help us find missing people like: "اطفال مفقودة" and "انا و ابن عمي بنساعد الغريب" but it also not an enough solution that it is very slow solution, people find their children after months and sometimes after years, depends on whether any one of the victim's relatives saw the post on Facebook, and not secure enough, posts are public for anyone.

3.4. Organizations

The “International Centre for Missing & Exploited Children” (ICMEC), “International Commission on Missing Persons” (ICMP) and “Missing Persons” are organizations for missing children but they are not responsible for finding people and returning them back to their families.

Figure 5 Some Organizations’ Logos

3.5. Applications

Many applications were created to find children or people generally but:

They don’t provide the location for missing person to his family where he is found like: “**Mising**” and “**DeEye**”

Mising App

DeEye App

Some of them are just applications for tracking not for finding their children when they get lost like: “**Life 360**” and “**Find My Kids**”

Life 360 App

Find My Kids App

Chapter 4: Purpose and Architecture

4.1. Purpose of the App

Our aim is to provide **High Speed** in returning a missing person to his family by adding effective features to our application to make it happen, **Provide Security** for user's data and registration, **Keep Data Organized** and keep records consistent and organized via an API, and **Provide High Accuracy** in face recognition and detection algorithms by training more data as we can.

4.2. System Users

4.2.1. Mobile Application Users

- Parents with children
- Families with mentally patients or elderly people
- Volunteers who find a missing person

4.2.2. Web Application Users

- Civil registry employees
- School employees – who register students at school
- Security guards at security centers

4.3. System Architecture

Anyone who owns a smartphone can use this application through some simple steps**.** The First Scenario is **Storing the Data** which is shown in the diagram in **Figure 6**. The user chooses to register as a parent. Then the parent registers his data such as name, phone number and national number to create his account, then he registers the data of his dependents such as name, age, home location, etc. After that, this data reaches the server, which holds the API files, and from there it is sent to the web application.

The civil registry employee determines whether this data is complete and untampered by the user or not.

If this data is complete, the civil registry employee approves for the registration process and saves it in the database. Otherwise, he rejects it so that the user re-registers again.

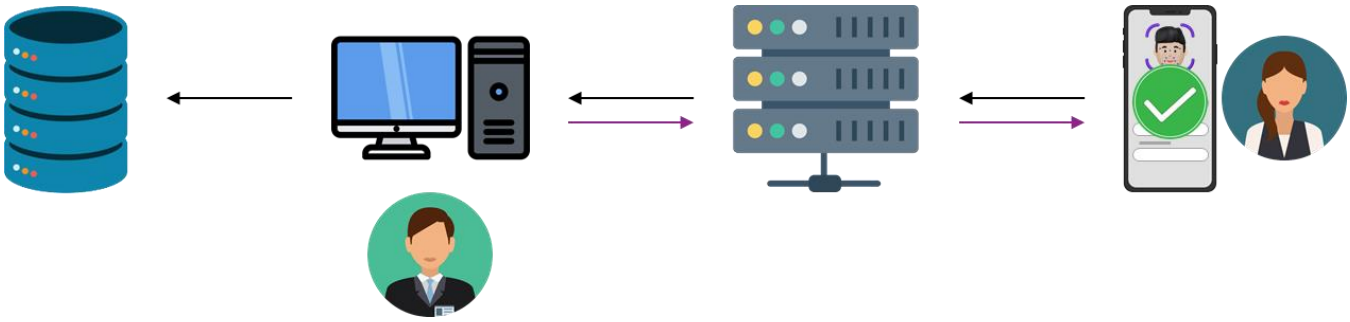


Figure 6 Storing Data Scenario

The Second Scenario is **Using Camera Search**, which is shown in the diagram in **Figure 7**. At the beginning, the volunteer opens the camera for the search then takes a picture of the missing person through the user interface.

When the image arrives at the server, which hosts the face recognition model. The image will then reach the artificial intelligence model to complete the process of face recognition to determine whether this person has pre-recorded data or not.

After detecting the image of the missing person, the data is extracted from the database and sent to the server. After that, the server displays this data to the user and also sends notifications to people who have reports of a missing person.

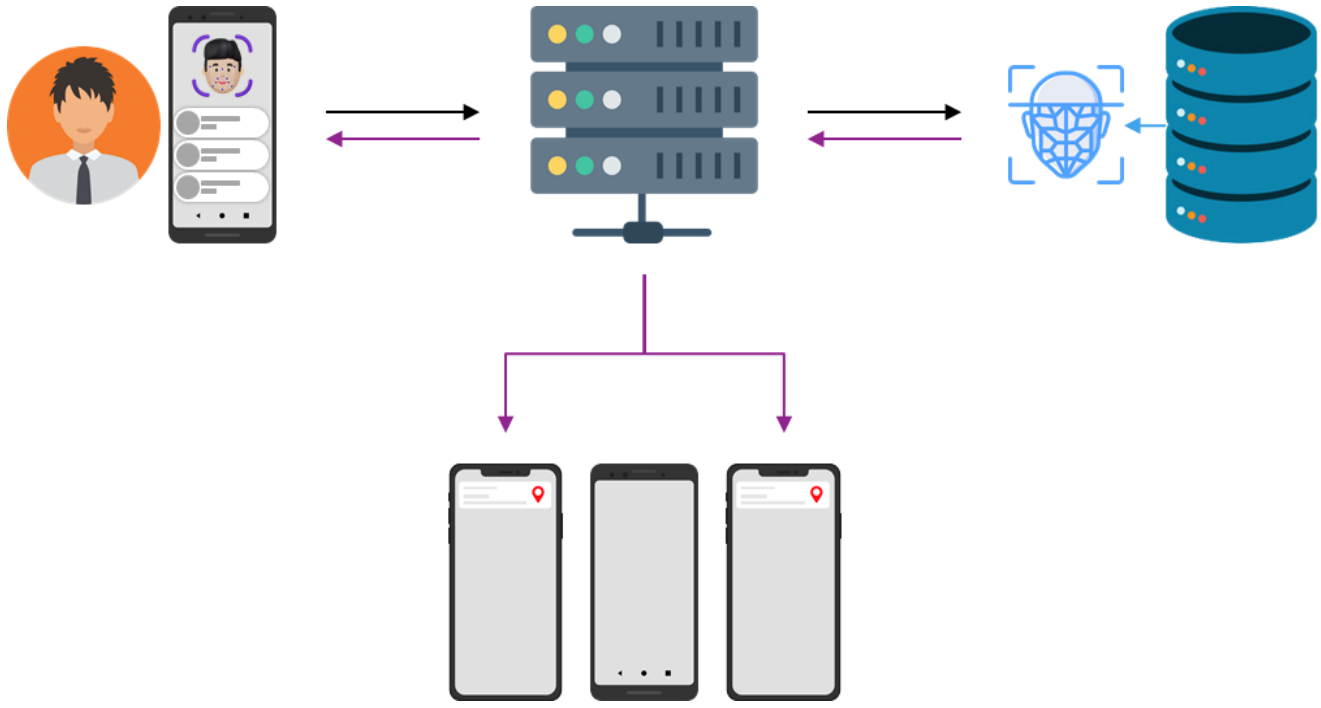


Figure 7 Search Using Camera Scenario

4.4. System Layers

The application has 4 layers as shown in Figure 8 which are:

1. **The presentation layer** which is on the top of the architecture containing the UI component, camera search to search for missing person, authentication function, and face detection to detect the human face only.
2. **The application layer** which contains the server of the application, functions itself (Full Name, Birth Date, Home Address, Home Location, etc...), and contains the data insert component which controls the data which the user can insert to the application to start synchronization.
3. **The service layer** which makes sure that the application is running well and performing its activities correctly (reliable). It contains service interface implementation and searching function to search in the database.
4. **The data access layer** controls the data itself (historical, and new data) also it is connected to the database which is the resource of the data needed to compile the algorithms and give a recommended location back to the application layer GUI. In this layer, the face is also recognized and compared to the images recorded in the database, thus obtaining the required data.

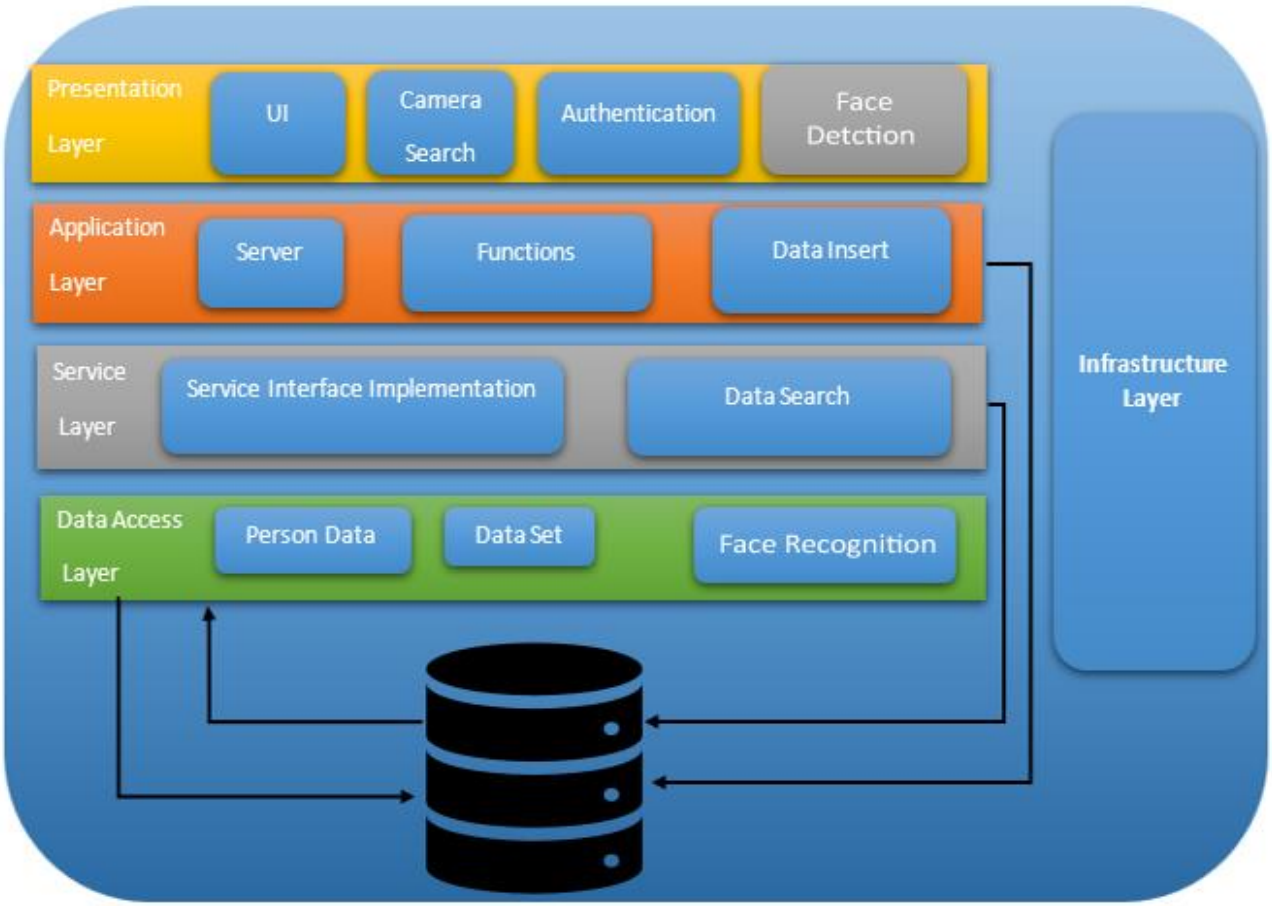


Figure 8 System Layers

4.5. Used Technology

4.5.1. Flutter

Flutter is an open-source framework by Google for building beautiful, natively compiled, multi-platform applications for Android, iOS, Linux, macOS, Windows, Google Fuchsia, and the web from a single codebase.

Why Flutter?

1. Single Codebase

Flutter is used to develop cross-platform applications for Android, iOS, Linux, macOS, Windows, Google Fuchsia, and the web from a single codebase.

2. Hot Reload

Hot reload means that while using Flutter to build applications, Flutter does not rebuild the system from scratch every time, but only updates the latest addition.

Flutter's hot reload feature helps you quickly and easily experiment, build UIs, add features, and fix bugs.

3. Open Source

Flutter is an open-source UI software development kit created by Google. Thus, the developer can reuse applications based on filters and thus add or remove their components.

4. Requires Less Testing

The more features your app has, the harder it is to test manually. Automated tests help ensure that your app performs correctly before you publish it, while retaining your feature and bug fix velocity.

4.5.2. Google Machine Learning Kit

Google Machine Learning Kit is an on-device processing kit, which makes it fast and suitable for real-time use cases like processing of camera input. It can be used for processing images and text that need to remain on the device.

4.5.3. Firebase Cloud Messaging

Firebase Cloud Messaging (FCM) provides a reliable and battery-efficient connection between your server and devices that allows you to deliver and receive messages and notifications on iOS, Android, and the web. FCM is a free service that allows you to send messages to your user's apps across a variety of platforms such as Android & iOS.

4.5.4. Microsoft ASP.NET core

ASP.NET Core is a cross-platform, high-performance, open-source framework for building web apps, services, Internet of Things (IoT) apps, and mobile backends.

It makes it easy to build services that reach a broad range of clients, including browsers and mobile devices. ASP.NET Core uses the same framework and patterns to build both web pages and services side-by-side in the same project.

ASP.NET API features:

1. **Simple serialization**

   Serialization is the process of converting an object into a stream of bytes to store the object or transmit it to memory, a database, or a file. Its main purpose is to save the state of an object in order to be able to recreate it when needed. The reverse process is called reserialization.

   ASP.NET was designed for modern web experiences. Endpoints automatically serialize your classes to properly formatted JSON out of the box. No special configuration is required.

2. **Authentication and authorization**

   Secure API endpoints with built-in support for industry standard JSON Web Tokens (JWT). Policy-based authorization gives you the flexibility to define powerful access control rules—all in code.

3. **Routing alongside your code**

   ASP.NET lets you define routes and verbs in line with your code, using attributes. Data from the request path, query string, and request body are automatically bound to method parameters.

4. **HTTPS by default**

   You don't deploy your apps without security, so why test them without security? ASP.NET provides first class support for HTTPS out of the box. Automatically generate a test certificate and easily import it to enable

local HTTPS so you run, and debug, your apps the way they are intended to be **secured**.

You can think of it as a waiter between UI and services! The following **Figure 9** will help you understand better the main job and main reason for using Microsoft ASP.NET API.

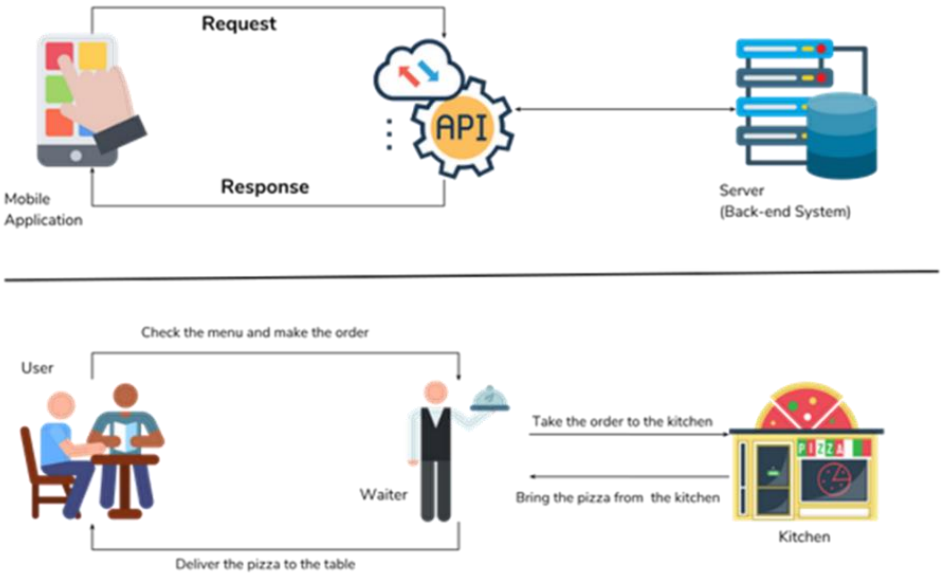


Figure 9 ASP.NET API Role

Why ASP.NET RESTful API?

1. High performance
2. Cross-platform support
3. Easy maintenance
4. Less code
5. Cloud-based application development support

RESTful API

REST stands for REpresentational State Transfer and API stands for Application Program Interface. REST is a software architectural style that defines the set of rules to be used for creating web services. Web services that follow the REST architectural style are known as RESTful web services. It allows requesting systems to access and manipulate web resources by using a uniform predefined set of rules. Interaction in REST based systems happen through the Internet's Hypertext Transfer Protocol (HTTP). A RESTful system consists of a:

- Clients who request for resources
- Server who has the resources

Architectural constraints of RESTful web API:

1. **Uniform Interface**

   It suggests that there should be a uniform way of interacting with a given server irrespective of device or type of application.

2. **Stateless**

   The necessary state to handle the request is contained within the request itself only.

3. **Cacheable**

   The client has the option to locally store certain pieces of data for a predetermined period of time.

4. **Client-Server**

   The client and the server must stay separate and independent.

5. **Layered**

   Multiple servers may potentially respond to a request.

MVC Architecture:

Model-View-Controller is a software architectural pattern commonly used for developing user interfaces that divide the related program logic into three interconnected elements. This is done to separate internal representation of information from the ways information is presented to and accepted from the user.

- **Model:**

  The central component of the pattern. It is the application's dynamic data structure, independent of the user interface. It directly manages the data, logic and rules of the application.

- **View:**

  Any representation of information. Multiple views of the same information are possible, such as a bar chart for management and a tabular view of accounts.

- **Controller:**

  Requests arriving at the on-server application are sent to a “router”, which maps the request to a specific controller. Within that method, the controller interacts within the request data and any relevant object to prepare the response using a view.

4.5.5. AI Part

In today's world, where countless people go missing every year, technological advancements offer new opportunities to expedite search efforts and increase the chances of reuniting families. The AI component of the app focuses specifically on facial recognition and face deaging systems, which play a pivotal role in identifying and locating missing persons.

Facial recognition technology, a subfield of artificial intelligence, has gained considerable attention and application in recent years. It involves analyzing facial patterns and structures to match them with known faces in a database, enabling the identification or verification of individuals. In the context of our Missing Person Finder App, facial recognition becomes a valuable tool for comparing the facial features of missing persons with existing images in a comprehensive database.

Moreover, we have integrated a face deaging algorithm into the app to enhance the accuracy of our system, particularly for individuals who have been missing

for over 20 years. Face deaging is a technique that artificially modifies a person's appearance to make them appear younger. By considering factors such as skin texture, wrinkles, and hairline changes, the face deaging system generates a younger version of the individual's face, which can significantly aid in matching them with current images or recognizable features.

This AI component holds immense potential in locating missing persons and providing critical leads to law enforcement agencies and concerned families. It has the capacity to overcome the challenges posed by long-term disappearances and changes in physical appearance. However, it is important to acknowledge the limitations and ethical considerations surrounding these technologies, ensuring privacy, consent, and fairness in their application.

4.5.6. Facial Recognition

The face recognition algorithm leverages a combination of margin-based loss and Inter-Prototype loss to improve recognition accuracy, with a specific focus on child-adult pairs.

The algorithm incorporates a margin-based loss function known as ArcFace loss. This loss function aims to maximize the cosine similarity between feature vectors and their corresponding prototype vectors by penalizing the angles between them. By enhancing the intra-class similarity, the algorithm ensures that feature vectors from the same identity are closer to their prototype vectors, improving the accuracy of recognition.

Additionally, the algorithm introduces an Inter-Prototype loss that minimizes the inter-class similarity, specifically for identities that include child images. This loss is imposed on the prototype vectors, enhancing the discrimination between different child images and improving the overall representation of child faces. By explicitly minimizing inter-class similarity, the algorithm strengthens the recognition capabilities for child-adult pairs.

During the training procedure, the algorithm detects faces. After alignment the images are resized to 112×112 pixels. The facenet serves as the backbone network to extract dimensional embedded feature vectors. The model is trained using the SGD optimizer with margin-based loss and Inter-Prototype loss for 50 epochs. **Figure 10** shows the architecture used to extract the feature vector.

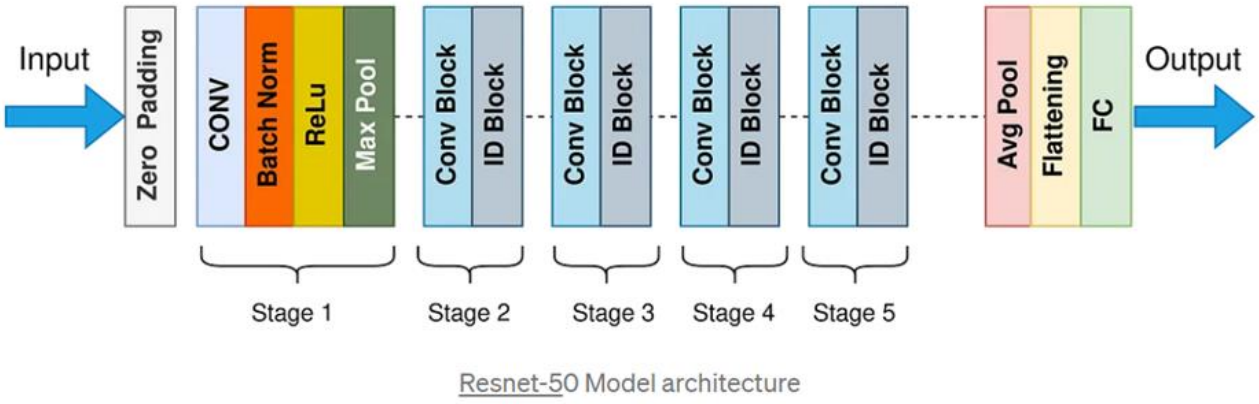


Figure 10 The Architecture Used to Extract the Feature Vector

The algorithm's performance is evaluated quantitatively on various test sets, particularly in face verification/identification scenarios with child-adult pairs. It consistently outperforms baseline approaches, demonstrating its effectiveness in handling age gaps. The evaluation highlights the algorithm's

simplicity, effectiveness, and its ability to achieve impressive results with fewer parameters and computational cost.

In summary, the face recognition algorithm combines margin-based loss and Inter-Prototype loss to enhance recognition accuracy, with a specific focus on child-adult pairs. By improving the discrimination between child images and strengthening their representation, the algorithm achieves impressive performance on both specific child-adult pairs and general face recognition tasks.

How does it work?

The face recognition process from an uploaded image to the end involves several steps. Here is an overview of the process:

1. Image Preprocessing: The uploaded image is pre-processed to prepare it for face recognition. This may involve resizing the image, adjusting the orientation, and converting it to a suitable format for further processing.

2. Face Detection: The pre-processed image is analyzed to detect the presence and location of human faces.

3. Facial Landmark Detection: Once the faces are detected, facial landmark detection is performed to identify key facial features like eyes, nose, and mouth corners. This step helps in aligning the face and normalizing its position for further analysis.

4. Face Alignment: The detected facial landmarks are used to align the face by applying geometric transformations. This process aims to bring the face into a standardized pose and reduce the effects of variations in facial orientation.

5. Feature Extraction: The aligned face is then processed to extract discriminative features that capture unique characteristics of the face. facenet is employed as a backbone network to extract high-dimensional feature vectors from the face image. **Figure 11** shows extracted features vector of a face.

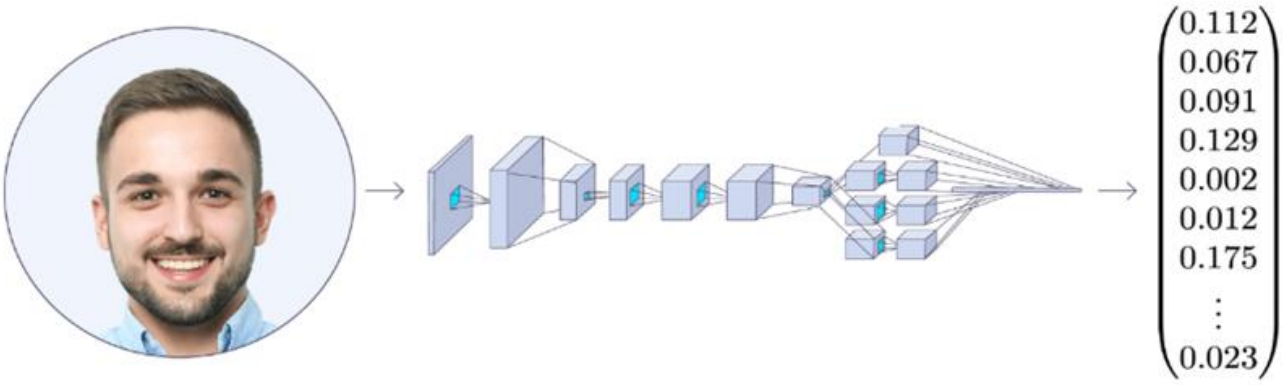


Figure 11 Extracted Features Vector of a Face

6. Similarity Calculation: The cosine similarity is calculated between the feature vector extracted from the uploaded image and the stored vectors of different persons. This similarity measurement helps determine the resemblance between the uploaded face and known identities in the database.

7. Evaluation and output: The recognition results are evaluated based on predefined criteria, such as a threshold similarity score. If the similarity exceeds the threshold and a match is confident, the system provides the recognized

identity. Otherwise, the system may indicate that the face is unrecognized or not present in the database**. Figure 12** represents the output.

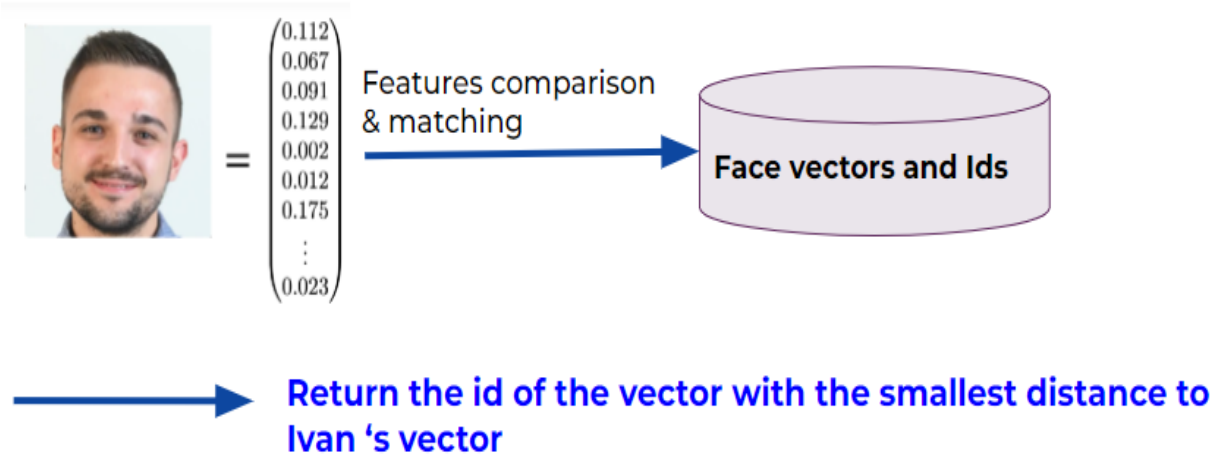


Figure 12 Output Face Vectors and Ids

4.5.7. Face De-Aging

If the child has been lost for many years, they will use face aging technique so we can generate a picture at a younger age of the real-time picture in the database and compare it with the picture in the database.

➤ As the age of a child increases, their facial features change, and it becomes much harder to identify them.

➤ face de-aging model can simulate a person's face at a specified age easily.

The goal is to transform a source facial image (x) at age αs into an image (x') representing the same identity at a desired target age αt.

Our approach utilizes a complete image-to-image translation architecture consisting of an encoder network and a fixed, pre-trained unconditional image generator. This architecture allows the direct encoding of the input image and the target age into style vectors that capture the desired age transformation. **Figure 13** shows the architecture of face de-aging model and **Figure 14** shows examples for de-aged face generation.

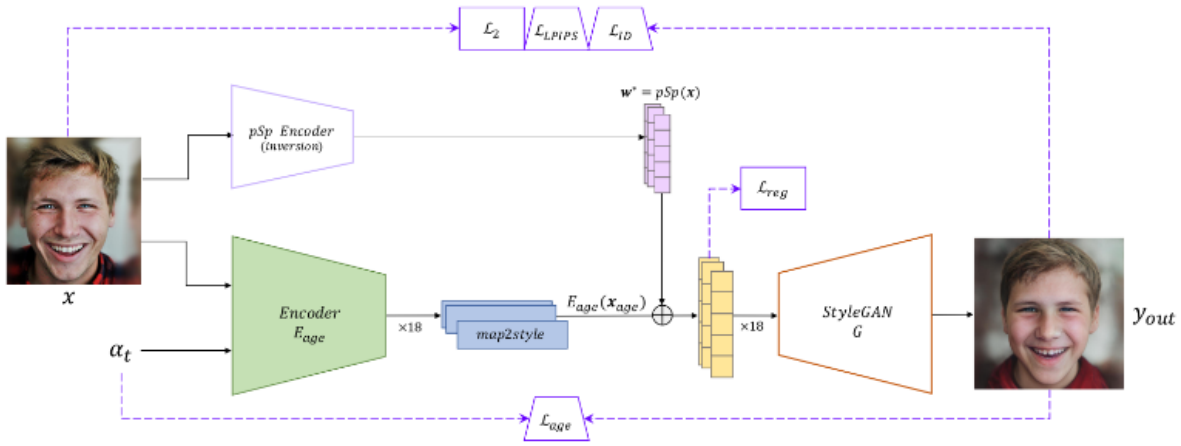
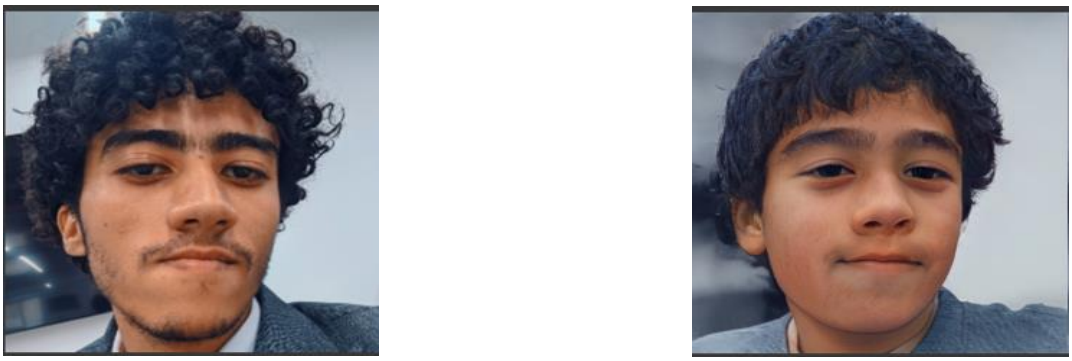


Figure 13 The Architecture of Face De-Aging Model



(a) *(b)*

Figure 14 De-Aged Face Generation (a) input image (b) output image

Components of the architecture:

1. Input and Target Age: The network takes an input face image and a desired target age (αt) as inputs.

2. Aging Encoder ($Eage$): The aging encoder is responsible for extracting feature maps at three different spatial scales from the input face image.

3. Map2Style Blocks: The network utilizes 18 map2style blocks, introduced in a previous work, to gradually down-sample the three feature maps and obtain 18 different 512-dimensional style vectors. These style vectors encode the input image into the W+ latent space of the StyleGAN model.

4. Pre-Trained pSp Encoder: A fixed, pre-trained pSp (perceptual space) encoder is employed to extract the W+ latent code (w∗) from the input image. This latent code captures the high-level style information of the image.

5. Combining Latent Codes: The extracted W+ latent code (w∗) is added to the age-transformed latent code ($Eage$ (xage)), resulting in an aggregated latent code that combines the age-specific features with the original image's style.

6. StyleGAN Image Generation: A pre-trained StyleGAN model is used to generate the desired age-transformed image using the aggregated latent code. StyleGAN is a generative adversarial network known for its ability to synthesize highly realistic images.

7. Training Process: During training, only the aging encoder and map2style blocks are trained. The other components, such as the pre-trained pSp encoder

and StyleGAN, are fixed. The loss functions (L_{LPIPS}, L_{ID}, L_{age}) are computed using these fixed, pre-trained networks.

In summary, the network utilizes an aging encoder, map2style blocks, and pre-trained components to transform the age of a face image. By combining style vectors, latent codes, and image generation, the network generates age-transformed images while preserving visual similarity, identity information, and age-specific features

Our Method:

Encoder and Generator: The encoder network takes the input image and target age as inputs and encodes them into style vectors. These style vectors are then used by the generator to produce the desired output image representing the source identity at the target age.

Cycle Consistency Loss: Since collecting pairs of corresponding images over many years is challenging, a cycle consistency loss is applied during training. This loss, commonly used in unpaired image-to-image translation tasks, helps ensure the consistency between the original image and the age-transformed image.

Encoder Guidance: To guide the encoder in generating appropriate style vectors, a pre-trained age regression network is utilized. This network serves as an additional loss constraint during the training process, providing guidance for the encoder to produce age-appropriate transformations.

Overall, the approach leverages an encoder-generator architecture and incorporates a cycle consistency loss and age regression network to model the age transformation process. By encoding the input image and target age into style vectors and utilizing a pre-trained generator, the network is able to generate age-transformed images while maintaining consistency and guidance from the provided constraints.

How is the model trained?

1. Age Estimation: A well-trained age classifier is used to estimate the age of a given facial image. During training, instead of specifying the target age, it is randomly generated between 5 and 100 using a uniform distribution, denoted as $\alpha t \sim$ U(5, 100).

2. Pre-processing: The input image (x) is augmented by adding a constant-valued channel representing the sampled target age. This results in an input tensor.

3. Pre-trained Encoders: This approach utilizes a pre-trained pixel2style2pixel encoder (pSp) that encodes real face images into the W+ latent space of a pre-trained StyleGAN2 generator. For a given input image (x), the encoder computes the latent code

4. Aging Encoder and Generator: The aging encoder ($Eage$) and StyleGAN generator (G) are the main components of the architecture. The aging encoder takes the augmented input image (xage) as input and generates a latent code

representing the age transformation, denoted as $Eage$(xage). The StyleGAN generator takes the aggregated latent code ($Eage$(xage) + w$*$) as input to generate the desired age-transformed image.

5. Training Passes: During training, two passes are performed. First, the model generates the age-transformed image (yout) from the augmented input image (xage). Then, another age transformation pass is performed on the previously generated image (yout) using the source age (αs) to create a cyclic transformation (y$cycle$).

6. Encoder Inversion and Residual Learning: Two encoders are employed in the training process. The pSp encoder is used to invert the given image and create the initial latent embedding. The aging encoder ($Eage$) is trained to learn the residual between the initial latent embedding and the latent embedding representing the age-transformed image. The pre-trained pSp encoder remains fixed throughout training, while $Eage$ is trained using the described loss objectives.

In summary, this architecture leverages pre-trained encoders, age estimation, and a cyclic training process to achieve age transformation of facial images. The encoder generates latent codes representing the age transformation, which are then used by the generator to produce age-transformed images. A sample of kids' dataset is shown in **Figure 15** and a sample of above age 20 dataset is shown is **Figure 16**.

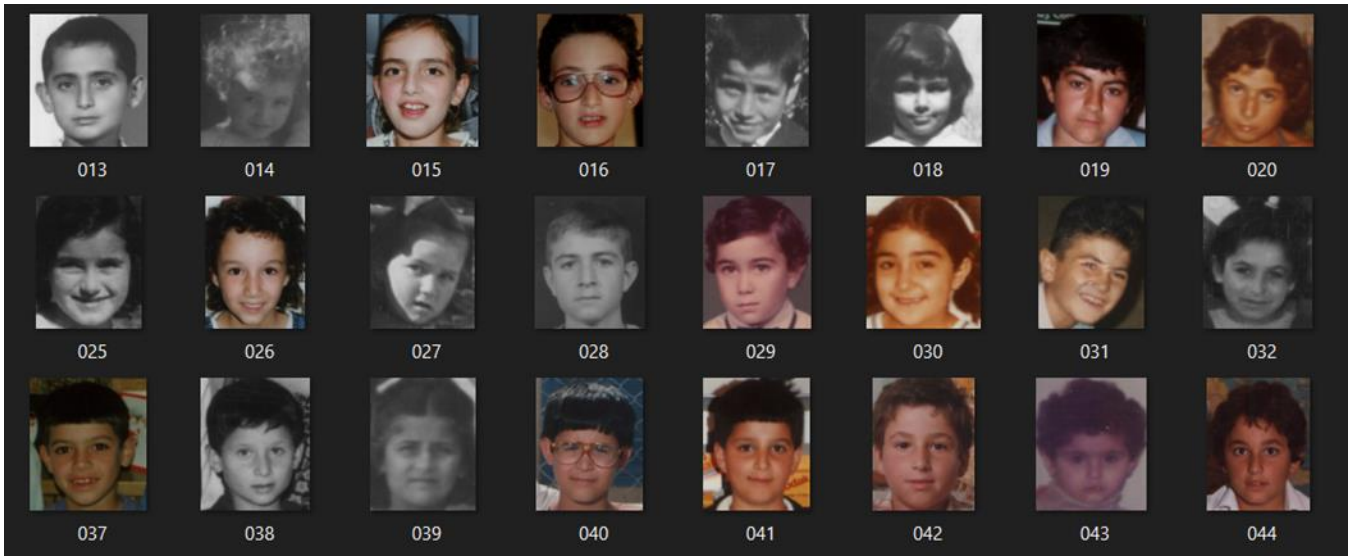


Figure 15 Sample of Kids' Dataset

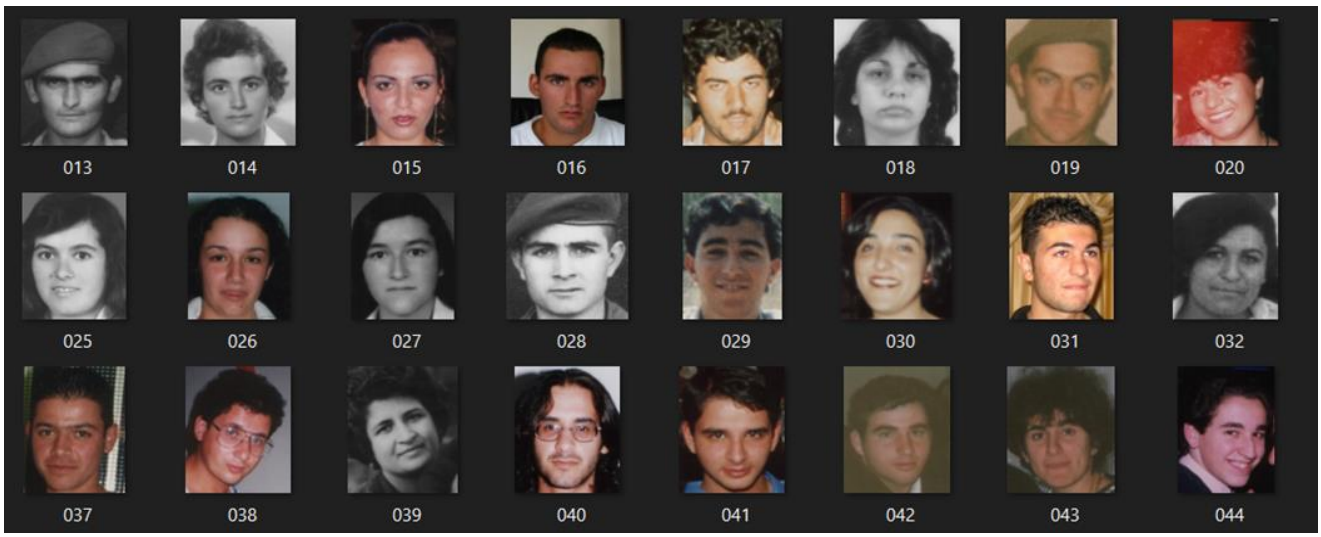


Figure 16 Sample of Above Age 20 Dataset

Results that show how facial aging can help in recognition

FGnet Dataset

L2 norm distance

Age gap	20>	20-40	40 <
Before Face aging	0.95	1.11	1.14
After Face aging	0.88	0.92	0.95

Cosine Similarity

Age gap	20>	20-40	40 <
Before Face aging	0.48	0.38	0.34
After Face aging	0.598	0.55	0.53

Large Age Gap Dataset

L2 norm distance

Before Face aging	1.11
After Face aging	0.977

Cosine Similarity

Before Face aging	0.39
After Face aging	0.59

Figures 17, **18**, and **19** shows the results on 1000 images:

```
776  133
number of persons successfully recognized: 776
number of persons showed in similar people: 133
total number of persons: 1000

Process finished with exit code 0
```

Figure 17 Number of Persons Successfully Recognized

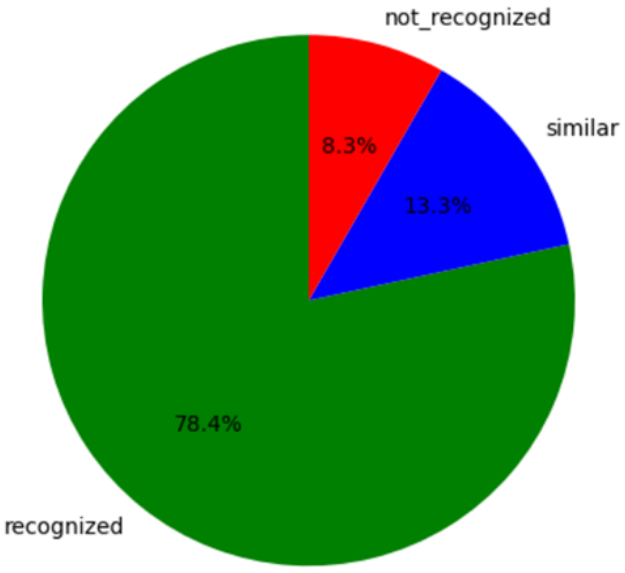


Figure 18 Statistics of Learning Model Efficiency

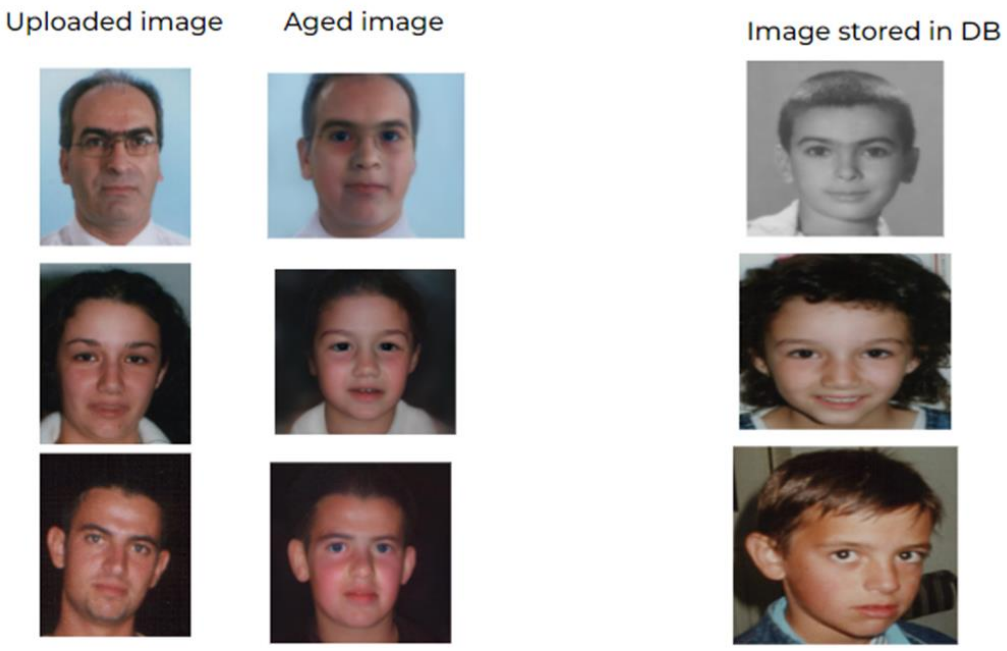


Figure 19 Samples of Successfully Recognized People

Chapter 5: Data Designing

5.1. Data Authentication

It includes user data to create an account through our application and it is well secured through the mobile phone number through a code that is sent to the user to ensure ownership.

5.2. Data Registration

It includes the data of the persons dependent on the user, such as a personal photo, name, address, etc.

5.3. Data Dictionary

This is the user's data, which is an explanation of the user's data in terms of the name, type, and size of the data, and whether this data is required to be registered or not.

Data Name	Data Type	Data Size	Required?
User_Full_Name	nvarchar	50	Y
User_Birth_Date	datetime	2(7)	Y
User_National_ID	nvarchar	14	Y
User_Phone_Number	nvarchar	17	Y
User_Birth_Certificate	nvarchar	70	Y
User_Photo	nvarchar	70	Y

Here is the data for the dependents, which is an illustration of the dependent data in terms of the name, type, and size of the data, and whether this data is

required to be registered or not, as this data is very critical in the case of giving details of the missing, so it must be completed as shown.

Data Name	Data Type	Data Size	Required?
Dependent_Full_Name	nvarchar	50	Y
Dependent_Birth_Date	datetime	2(7)	Y
Dependent_National_ID	nvarchar	14	Y
Dependent_Phone_Number	nvarchar	17	Y
Dependent_Birth_Certificate	nvarchar	70	Y
Dapendent_Photo	nvarchar	70	Y
Dependent_Gender	int	30	Y
Dependent_Home_Address	nvarchar	50	Y
Dependent_Home_Location	nvarchar	50	Y
Dependent_Secure_Code	nvarchar	4	Y
Dependent_Category	int	30	Y
Dependent_Blood_Type	nvarchar	3	N
Dependent_Birth_Certificate	nvarchar	70	Y
Dependent_Diseases_Medication	nvarchar	450	N
Dependent_Missing	bit		Y

This is the employee's data, which is an explanation of the employee's data in terms of the name, type, and size of the data, and whether this data is required to be registered or not.

Data Name	Data Type	Data Size	Required?
Employee_Name	nvarchar	50	Y
Employee_Position	datetime	2(7)	Y
Employee_Email	nvarchar	14	Y
Employee_Password	nvarchar	17	Y
Employee_Location	nvarchar	70	Y

Chapter 6: Proposed System and Result

6.1. Mobile Application

Our application initially consists of three main screens, and they are User Screen, Dependent Screen, and Search Screen.

Firstly, User Screen:

On the screen shown in **Figure 20**, the user attaches a photo and personal data such as full name, date of birth and national number, in order to match the user with his dependents, to ensure the credibility of the registration so that no one can register persons he does not depend on. Then, the user attaches a copy of the birth certificate so that it is matched with the user's national number.

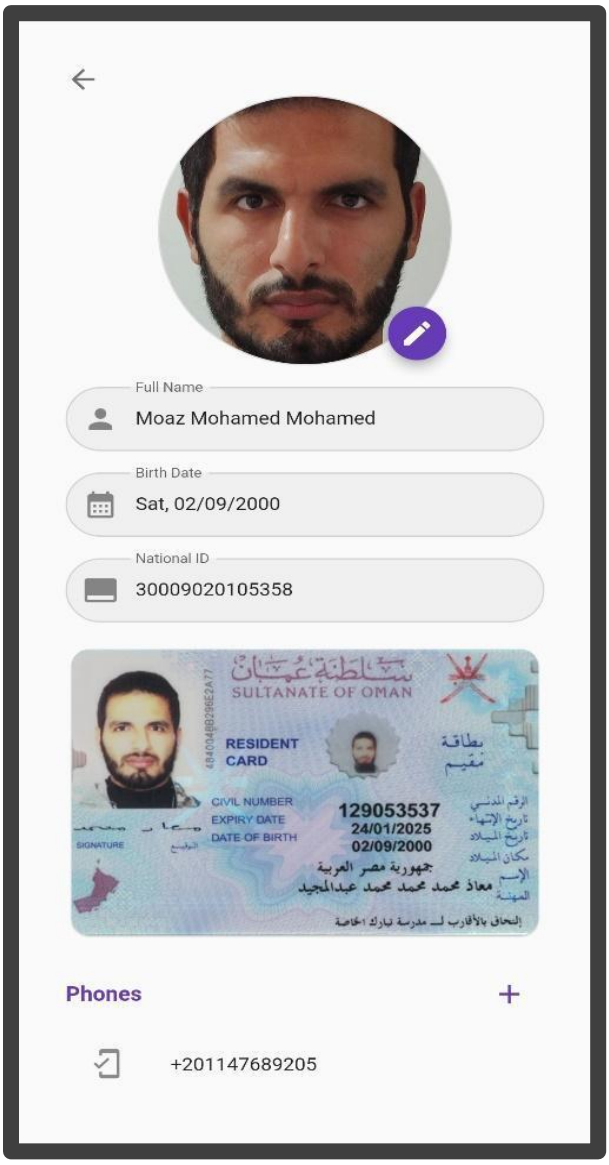


Figure 20 Mobile Application User Registration

Finally, the user registers with his phone number as shown in **Figure 21**, then the application sends a code as shown in **Figure 22** to the user to verify his identity, as shown in the figure below.

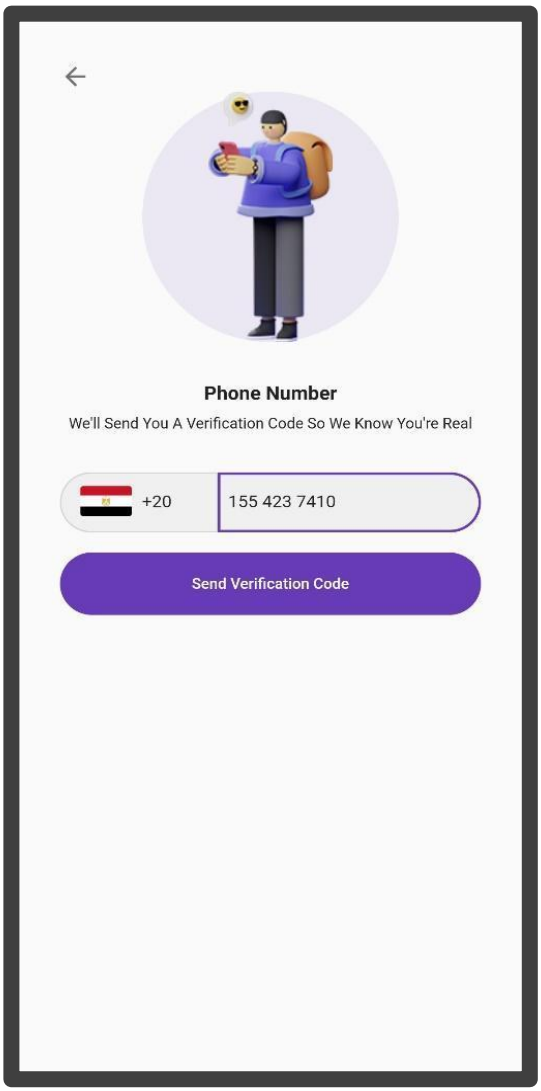


Figure 21 Registering with Phone Number

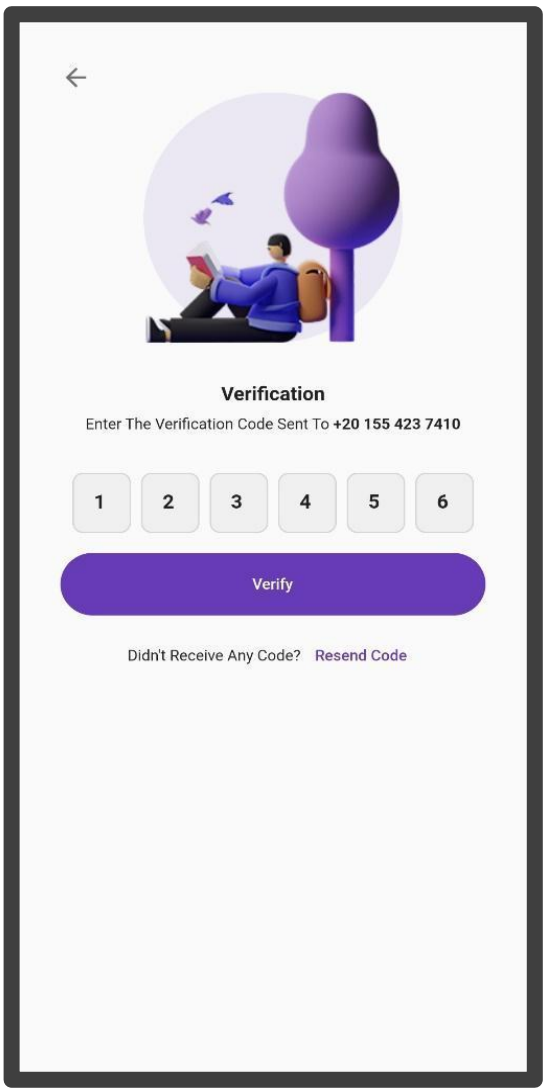


Figure 22 Entering Verification Code

Then the authentication takes place, and the user is able to log in at any time and register his dependents from the screen shown in **Figure 23**.

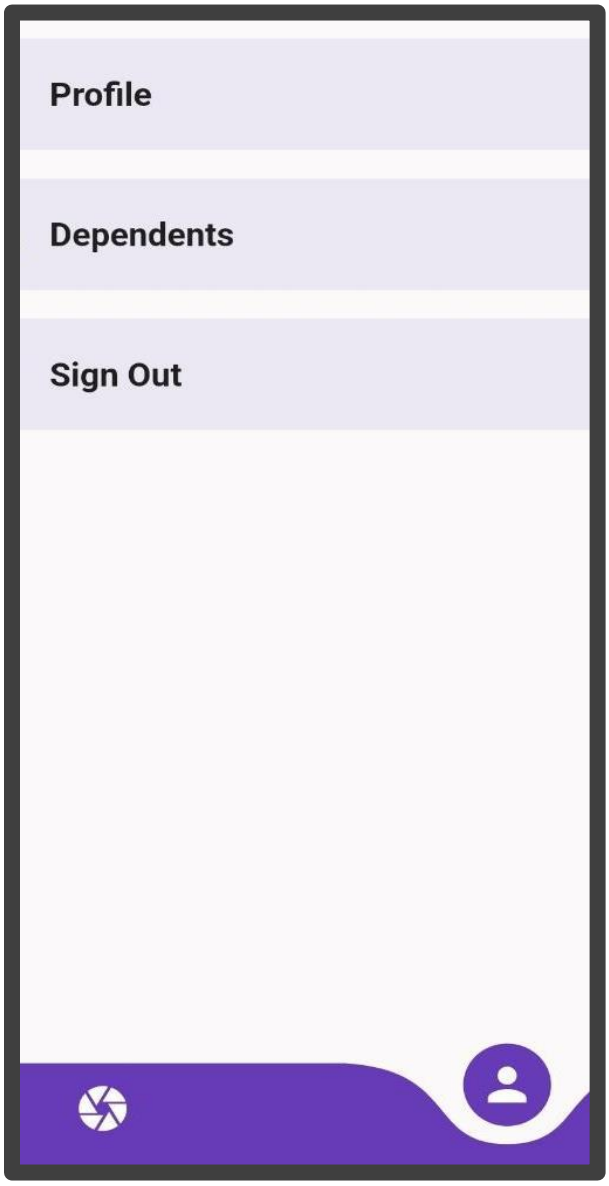


Figure 23 Principal Screen After Login

Now the user can move easily between these screens. Let's assume that the user wants to register his family members when he clicks on Dependents to show this screen.

Secondly, Dependent Screen:

On this screen shown in **Figure 24**, the user presses the Add button to be able to add his family members as follows.

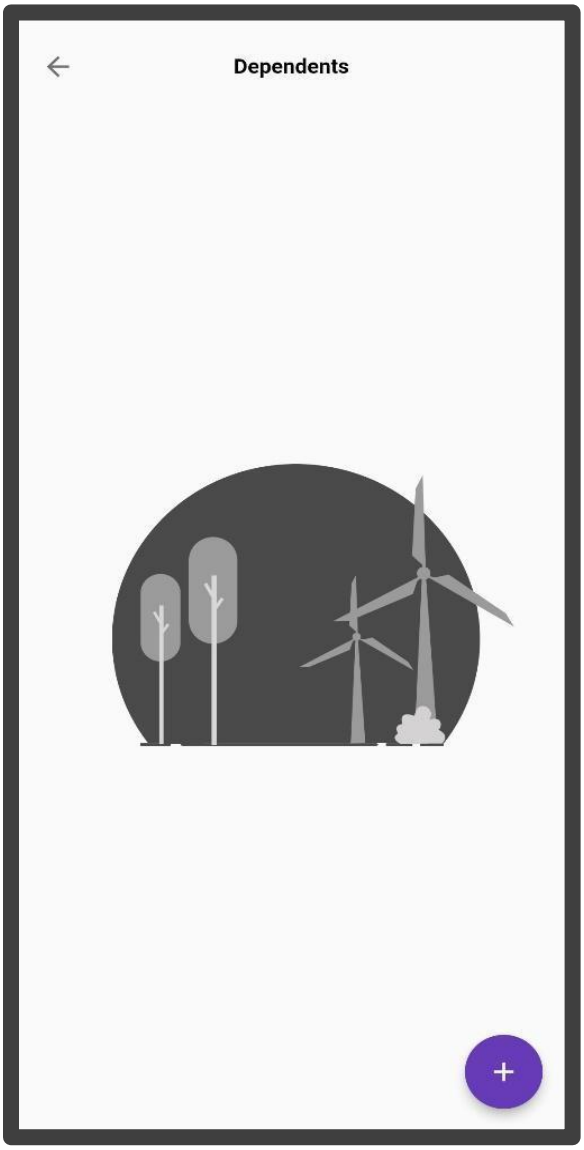


Figure 24 Principal Screen of Adding Dependents

The user then registers the data of his dependents, such as gender, full name, date of birth, and National ID as shown in **Figure 25**.

Here, he urges a match between the user's national number and the other person's National ID through the civil registry employee to ensure the validity of the kinship between the two persons.

After that, the user's location is placed as shown in **Figure 26**, as this location appears to the volunteer in case that the dependent is found, if he had been missing missing.

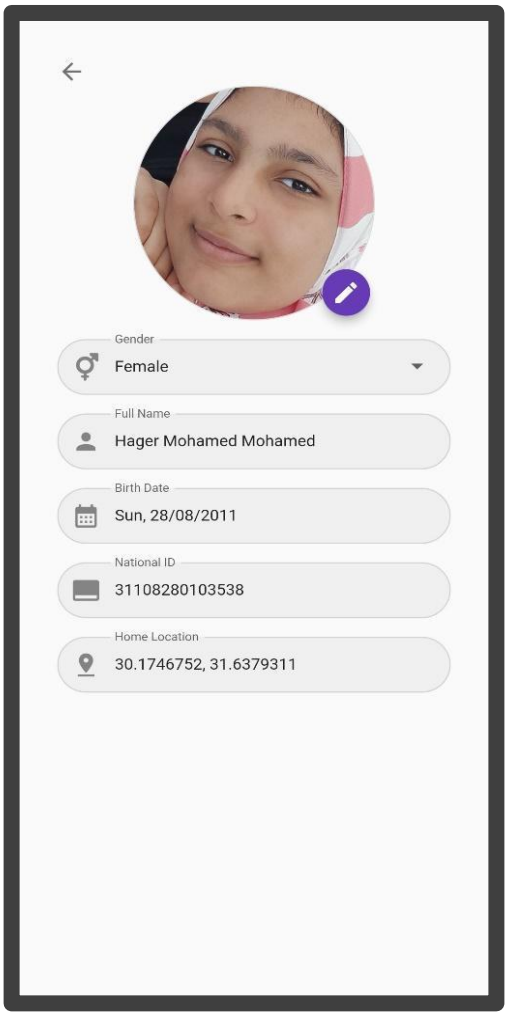


Figure 25 Registering a Dependent

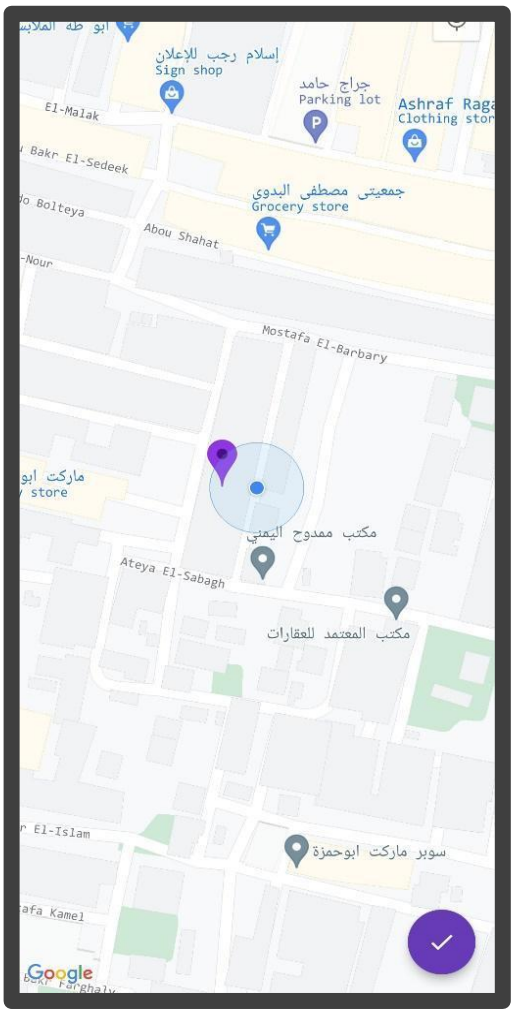


Figure 26 Locate Principals Home Location on Google Map

After that, it returns the home address as shown in **Figure 27**, which is one of the important data that is required to be recorded in details, such as the apartment number, street, city, etc., as shown in **Figure 28**.

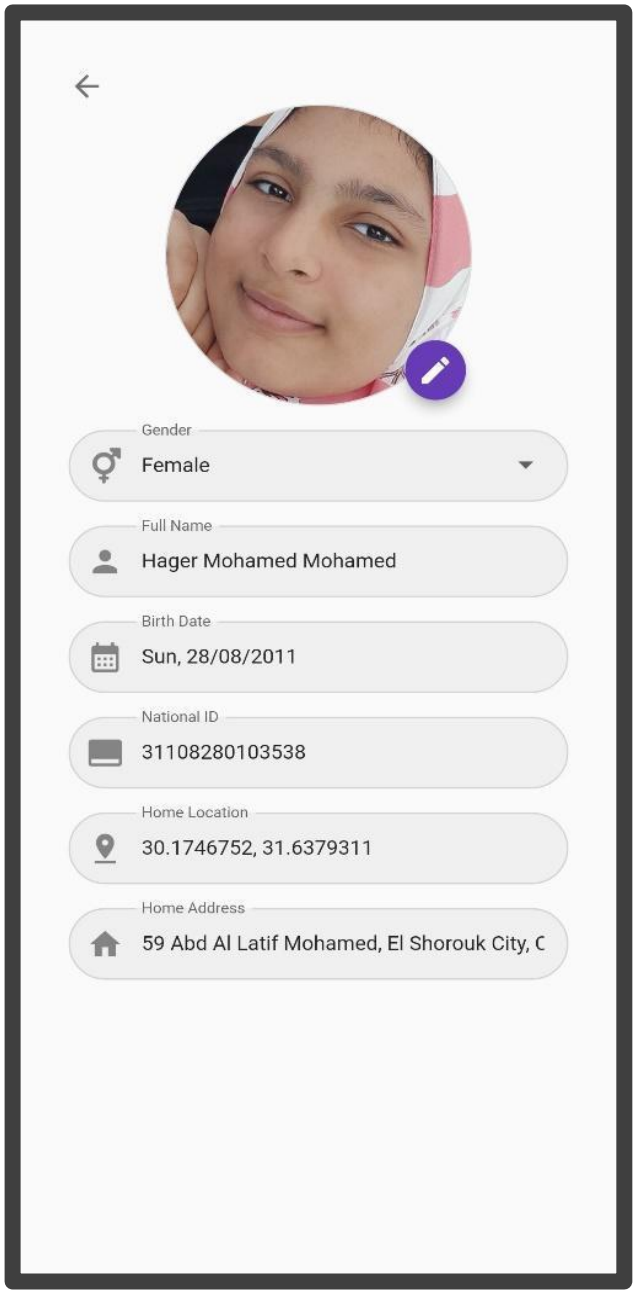


Figure 27 Retrieving Home Address

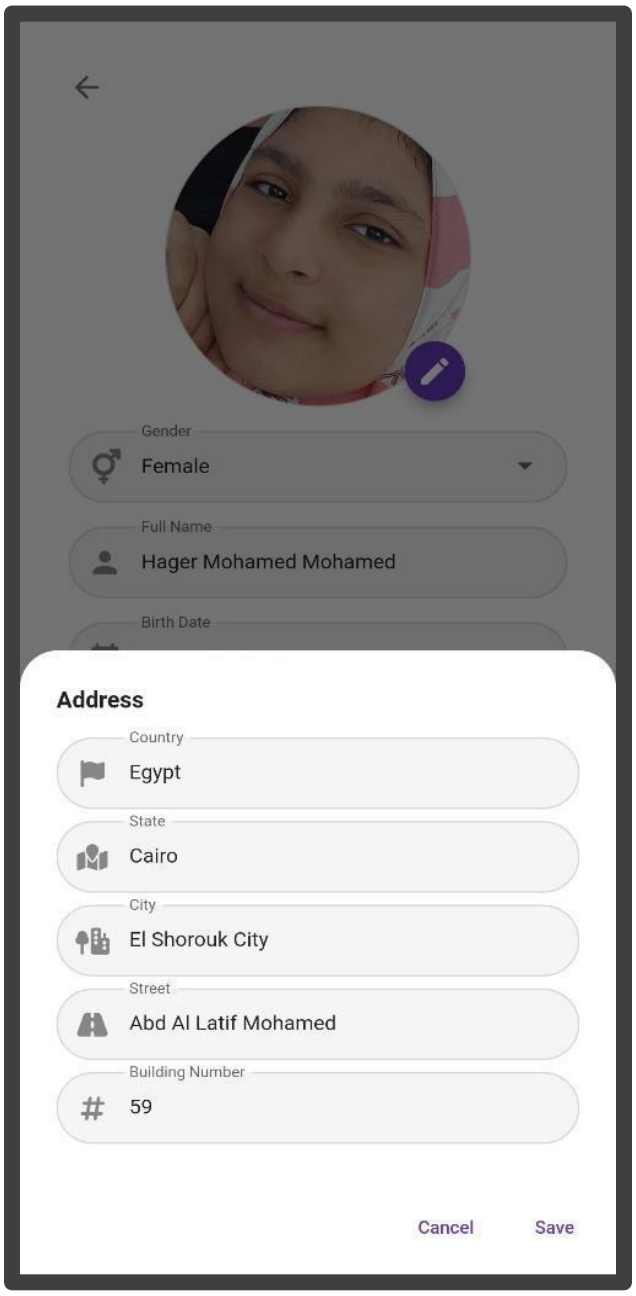


Figure 28 Home Address Details

The user completes the data attachment through his registration code, and then selects the category of the person, whether he is a child, the elderly, or the disabled as shown in **Figure 29**. In the event that the person is disabled, such as people with special needs and others, then the user writes the type of disability or disease, and along with it, he also writes how this person can be dealt with.

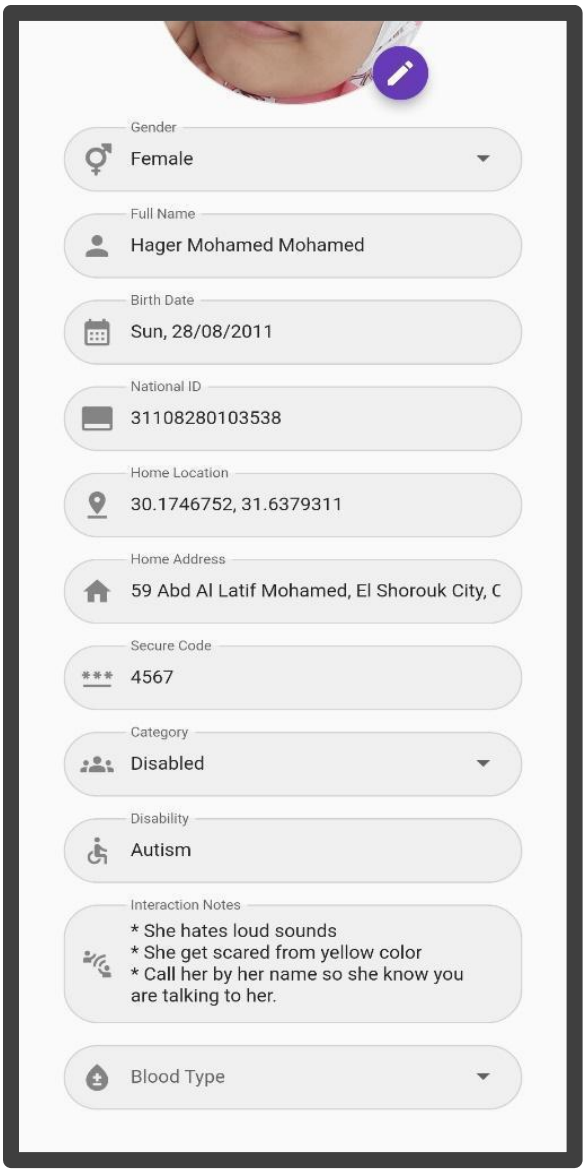


Figure 29 Options for Disabled Dependents

The user also selects the blood type in order to deal well with the missing person if he is sick, and this matter is optional and cannot be used in the event that the user does not know the blood type.

One of the important data also for the user is to attach a copy of the birth certificate of the dependent as shown in **Figure 30** so that the civil registry employee can match and thus accept or reject in case the data does not match.

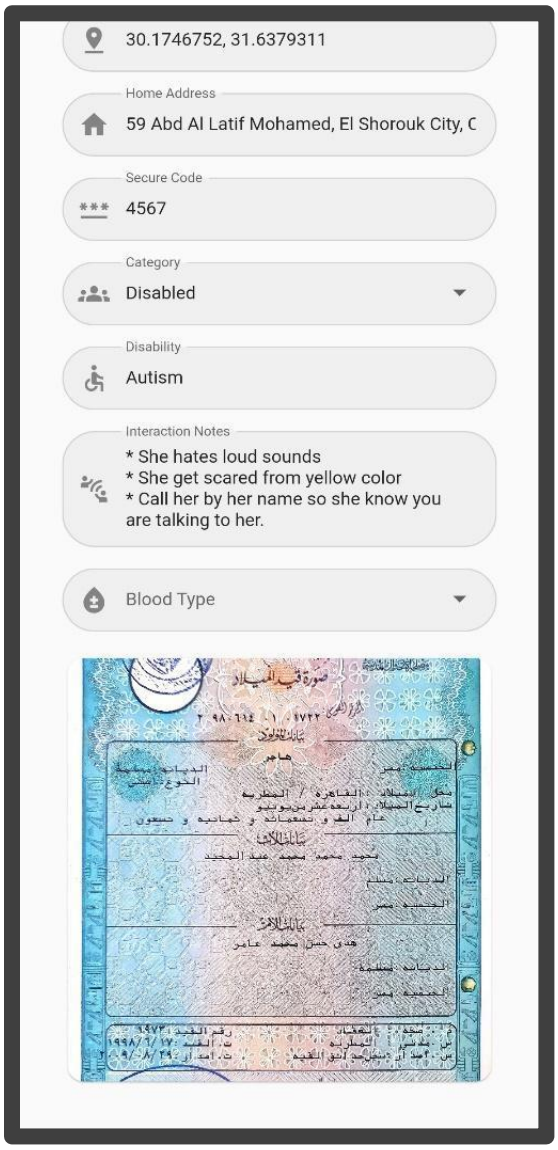


Figure 30 Attaching Birth Certificate Image

After that, important data about the disease and medicine for the person, if any, where the user writes the name of the disease and the medicine used as shown in **Figure 31** and **Figure 32**, as some cases need medicine at a specific time, such as diabetics, heart patients, and others. We found it necessary to put the disease and medicine so that there is no harm to the missing person Once it exists via volunteer users.

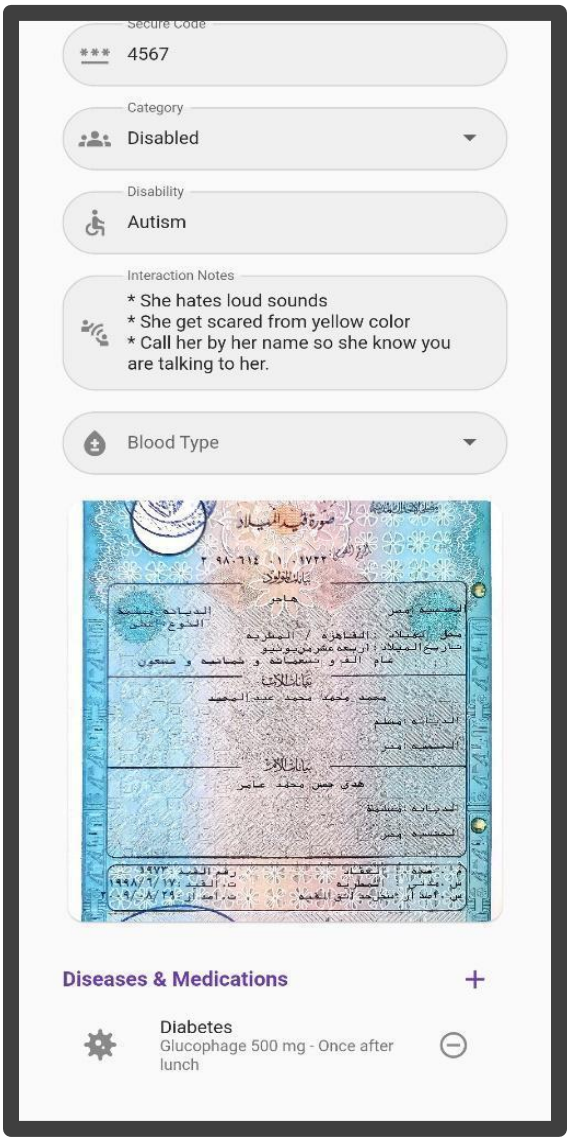


Figure 31 Assign any Diseases

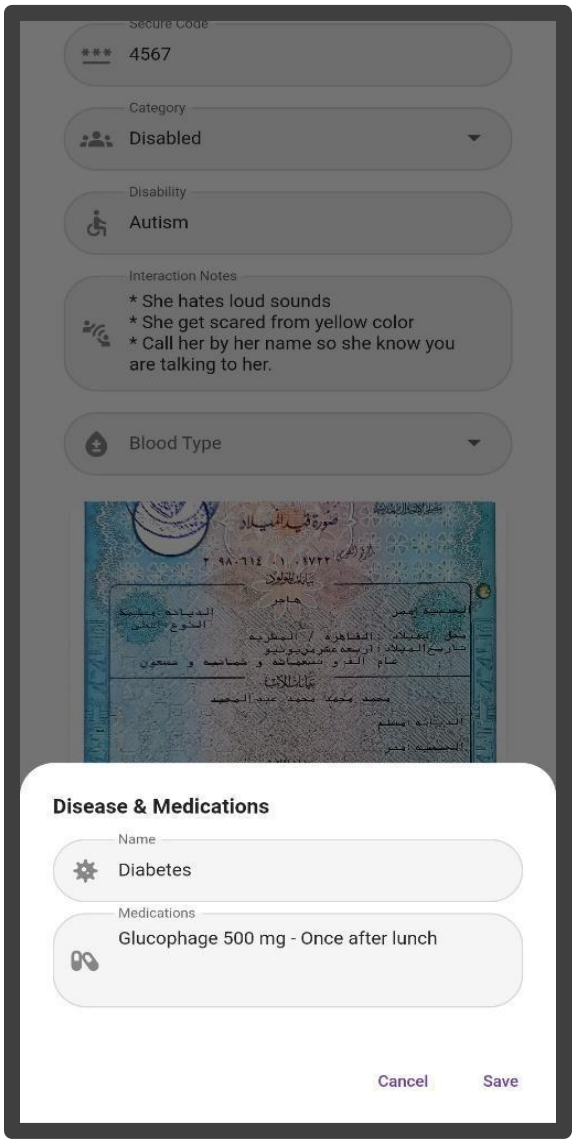


Figure 32 Assign Medicines of Diseases

Finally, the user determines whether the person is missing or not by pressing the Missing button as shown in **Figure 33**, and then saves the data to be displayed as shown in the screen in **Figure 34**, because the user was able to register the first person, and then he can add more family members with the same steps.

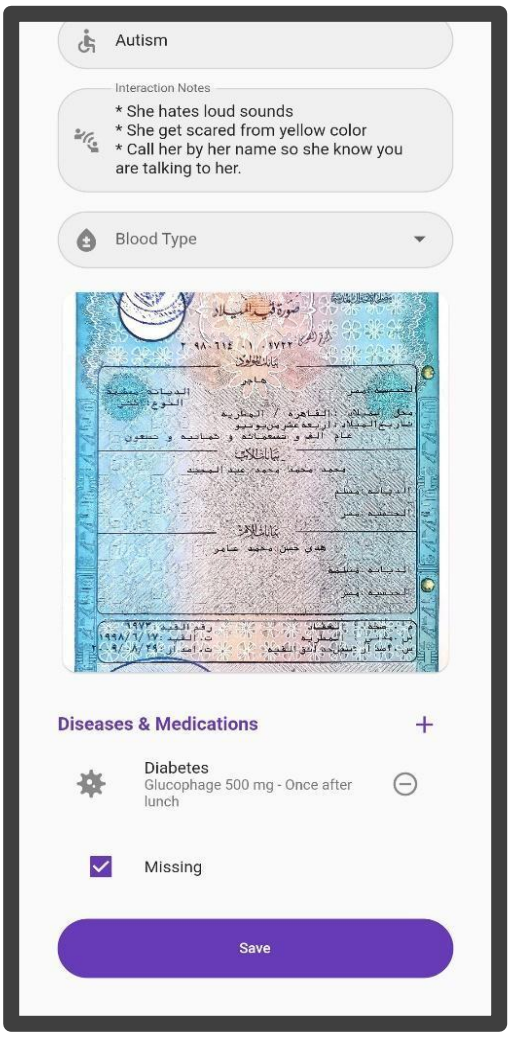


Figure 33 Determine Whether the Dependent is Missing

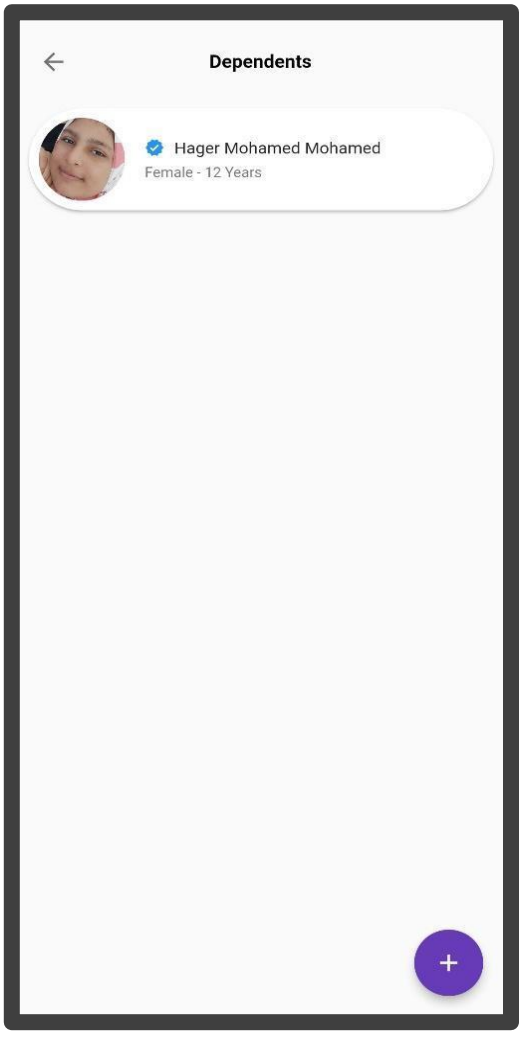


Figure 34 Display Verified Dependents

Thirdly, Search Screen:

On the screen shown in **Figure 35**, the user can search for a missing person or report a missing person with one of the two options as shown.

If the user chooses that he has found someone from **Figure 36**, the application opens the phone camera so that the volunteer takes a picture of the person, so that the image is then processed and compared using the AI-model used.

On the other side of the search screen, it is the user's choice that he has lost someone when the application opens the user's photo gallery to attach a picture of the missing person and some data that speeds up the search process as shown in the figure below.

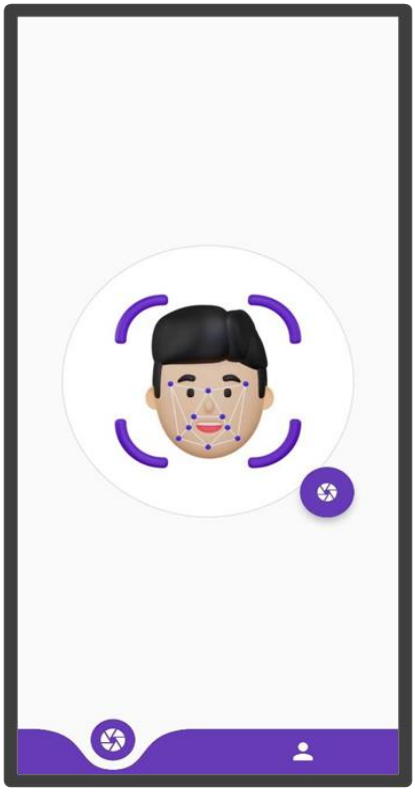


Figure 35 Search for a Missing Dependent Using Camera

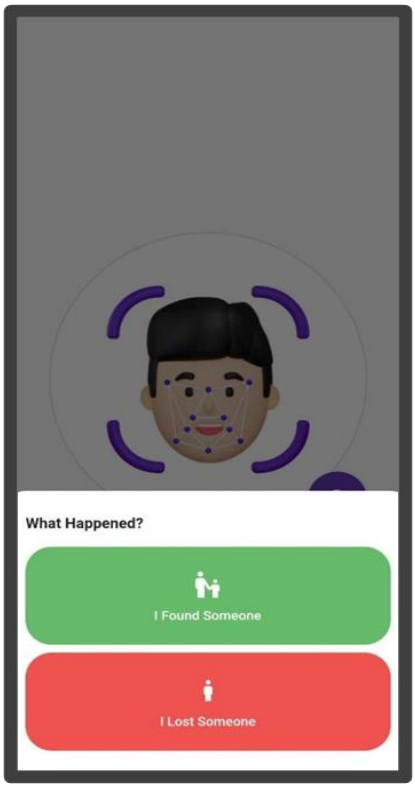


Figure 36 Choose Whether a Volunteer Found Someone or a Principal Has Lost Someone

When a volunteer searches for a dependent he has found, he will enter the category and gender as shown in **Figure 37** to make the searching space smaller, hence faster results.

The screen in **Figure 38** is appeared to the volunteer as the application searches the registered dependents in the database.

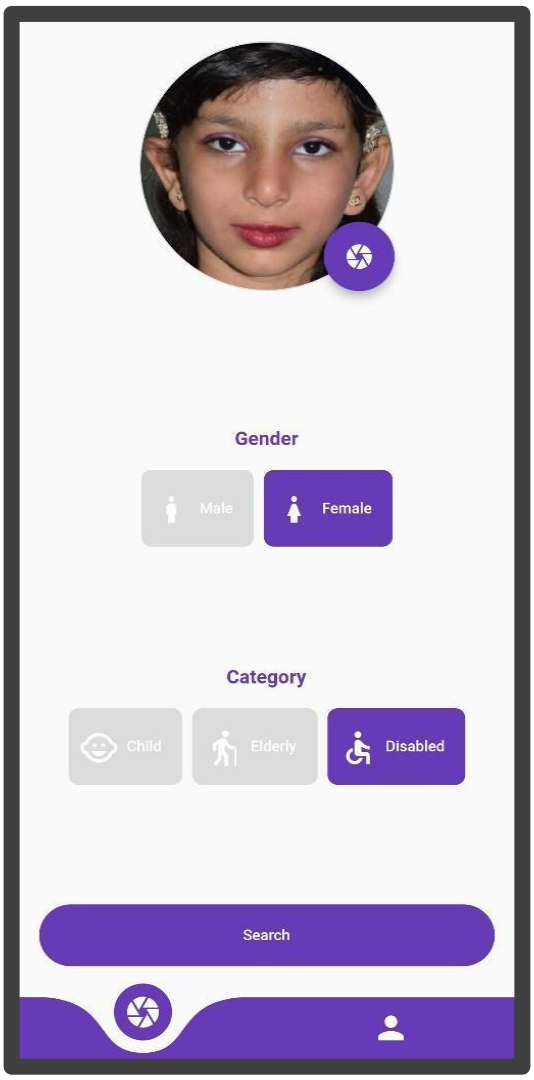


Figure 37 Choose the Category of the Found Dependent

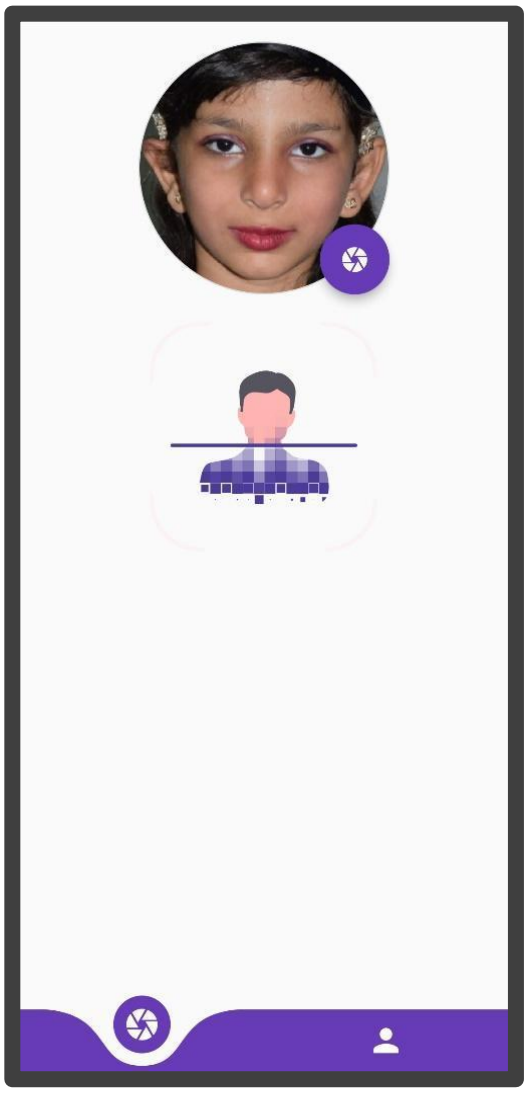


Figure 38 Search Loading Screen

After completing the search and matching the image with the images registered in the database, the search results will appear to the volunteer as shown in the **Figure 39** and **Figure 40** as shown below.

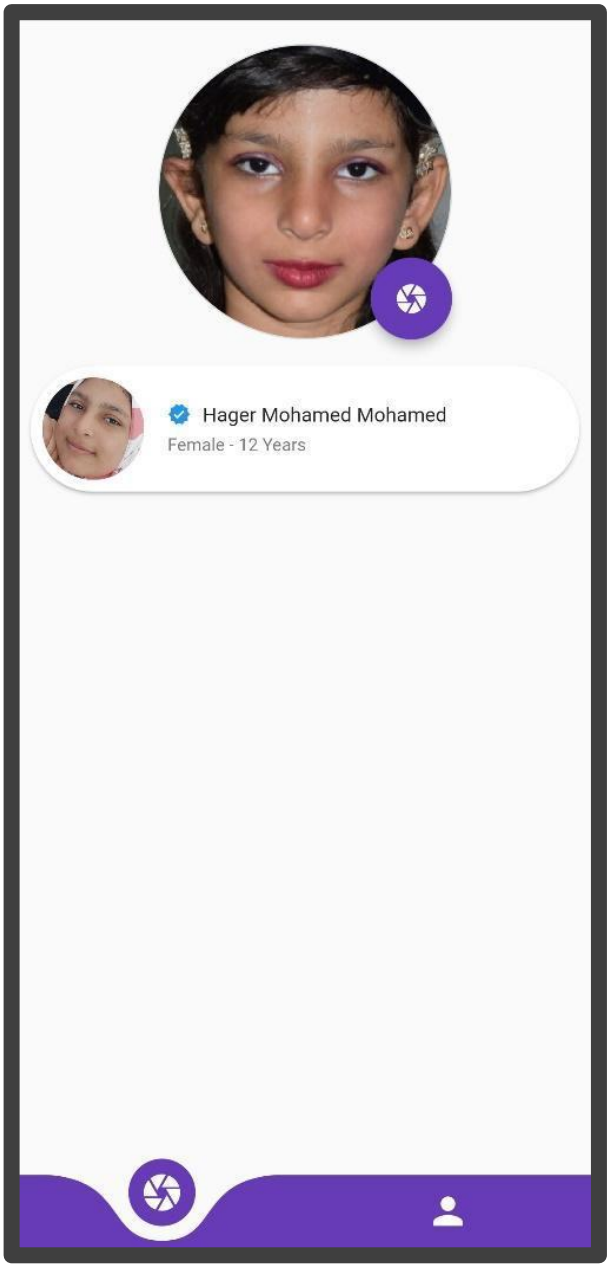


Figure 39 Search Results for the Volunteer

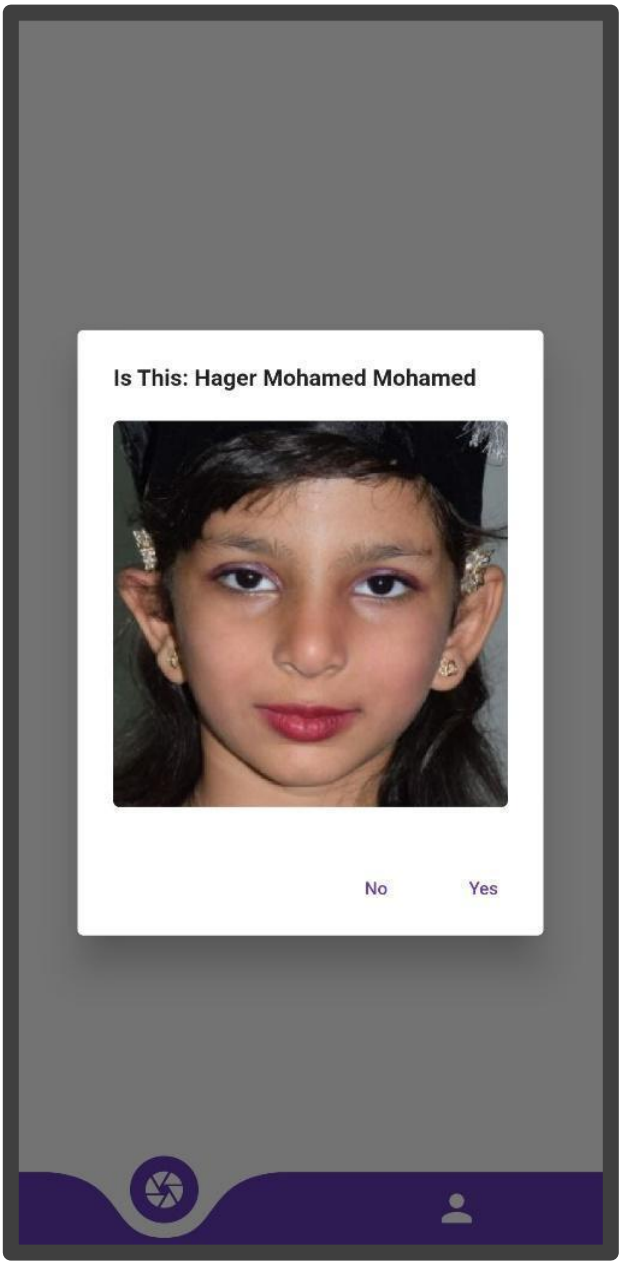


Figure 40 Notify the Principal That Someone Found His Dependent

When the user selects Yes, the application opens the location of the missing person as shown in **Figure 41** and shows his previously registered personal data on the Dependents screen as shown in the **Figure 42**.

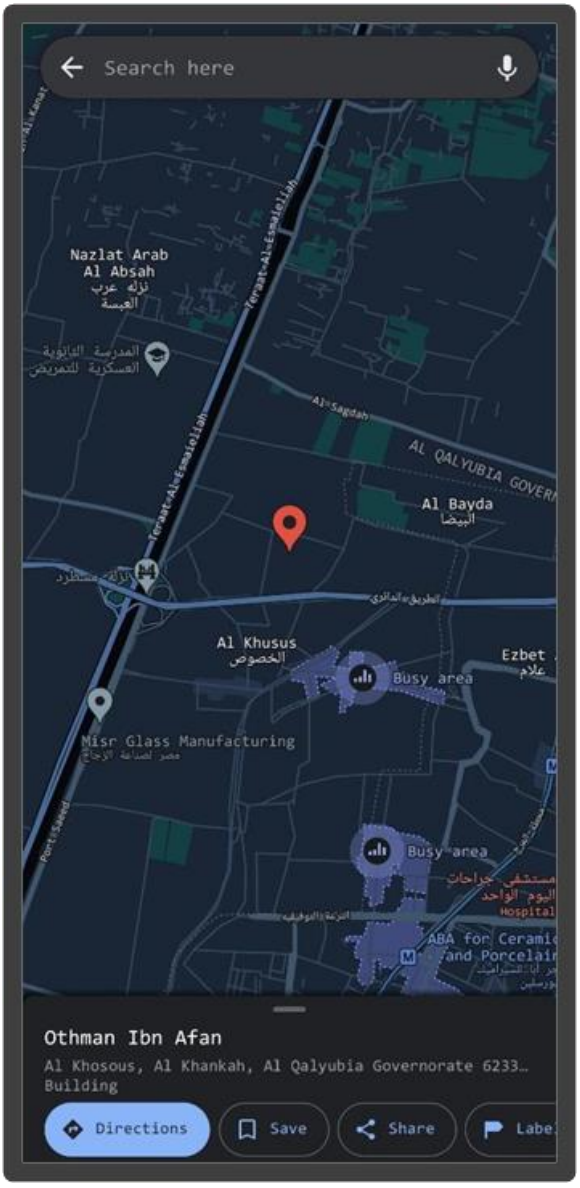


Figure 41 Display the Map Where the Dependent Has Been Found

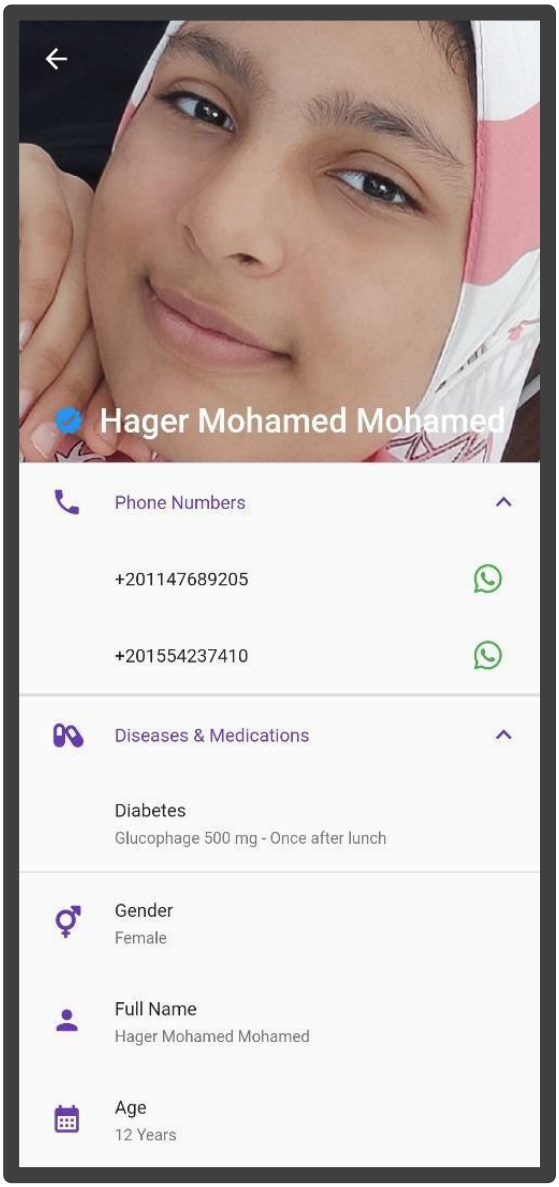


Figure 42 Display Dependent's Data to The Volunteer

To read more data, the user can do so by verifying using the secure code to be allowed more data as shown in **Figure 43**, and then he can communicate with the family of the missing person, and he can also see the address of the missing person in detail, as shown in **Figure 44**.

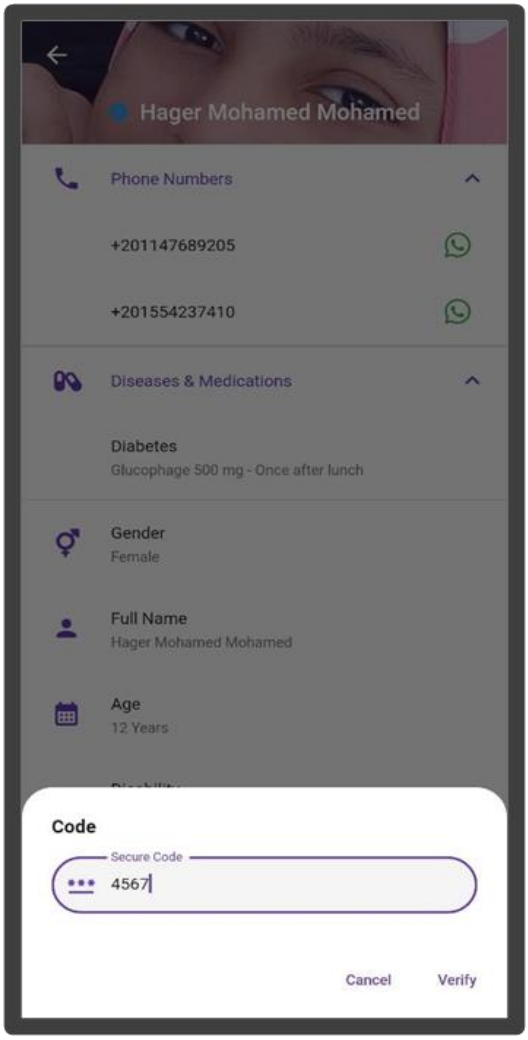


Figure 43 Enter Secure Code to View Further Information

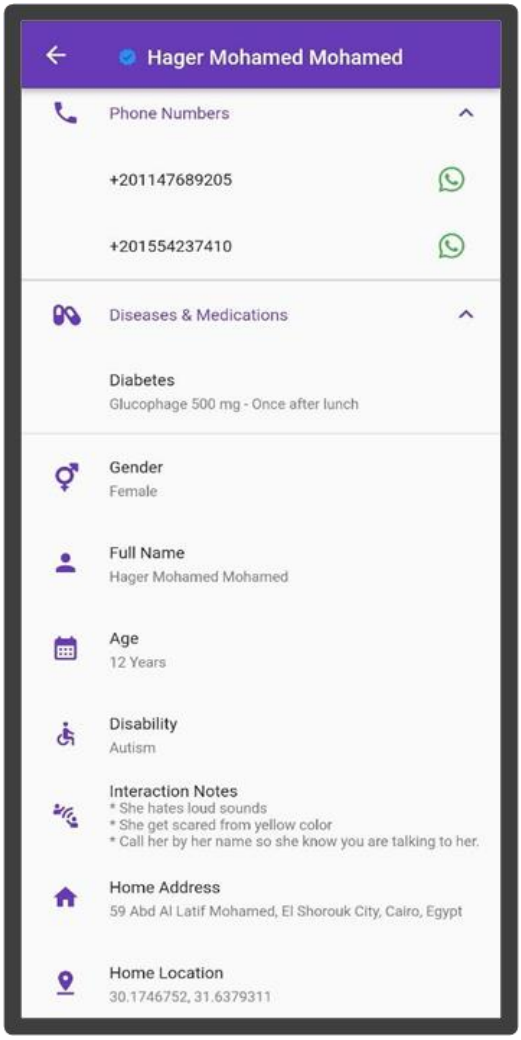


Figure 44 Dependent's Details is Displayed to the Volunteer

Finally, we expanded the idea of this system by connecting surveillance cameras, such as those in streets, malls, metro stations, airports, etc. Where the surveillance camera acts as an entrance to the system, and the missing person

is identified in green on his face, and a notification is sent that there is a missing case in this place. The system will ignore all persons except the missing persons, and in the event that there is a person who is not registered, not missing and verified, or missing and not verified, all of them will be ignored as shown in the **Figure 45** on long distance and **Figure 46** on short distance.

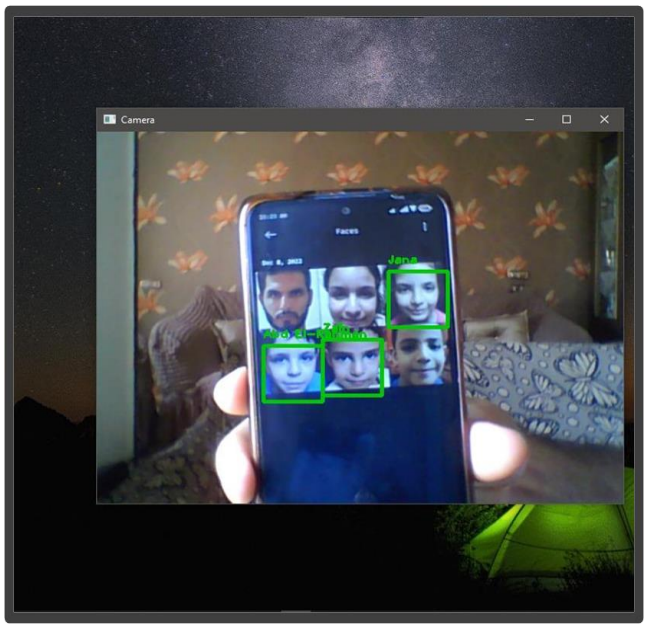


Figure 45 Camera Results on Long Distance

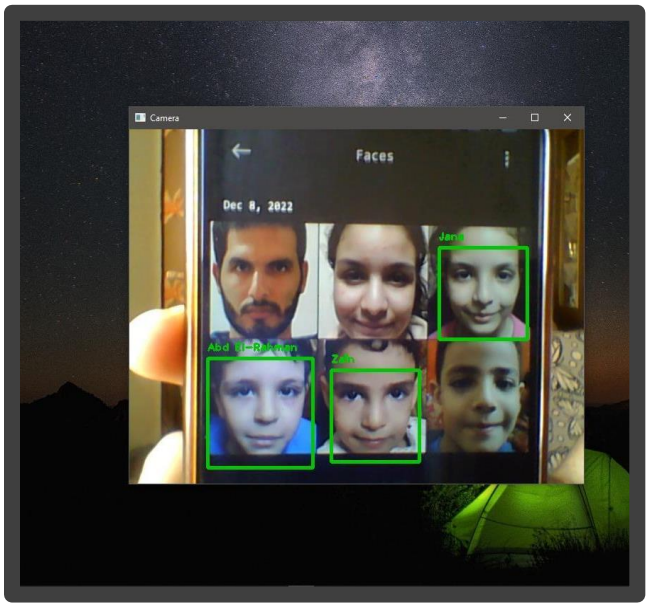


Figure 46 Camera Results on Short Distance

6.2. Web Application

First, employees (such as civil registry officers, school employees or security employees) can login from the screen shown in **Figure 47** with their accounts to get started. It will be shown to every one of them on different web pages depending on what he does.

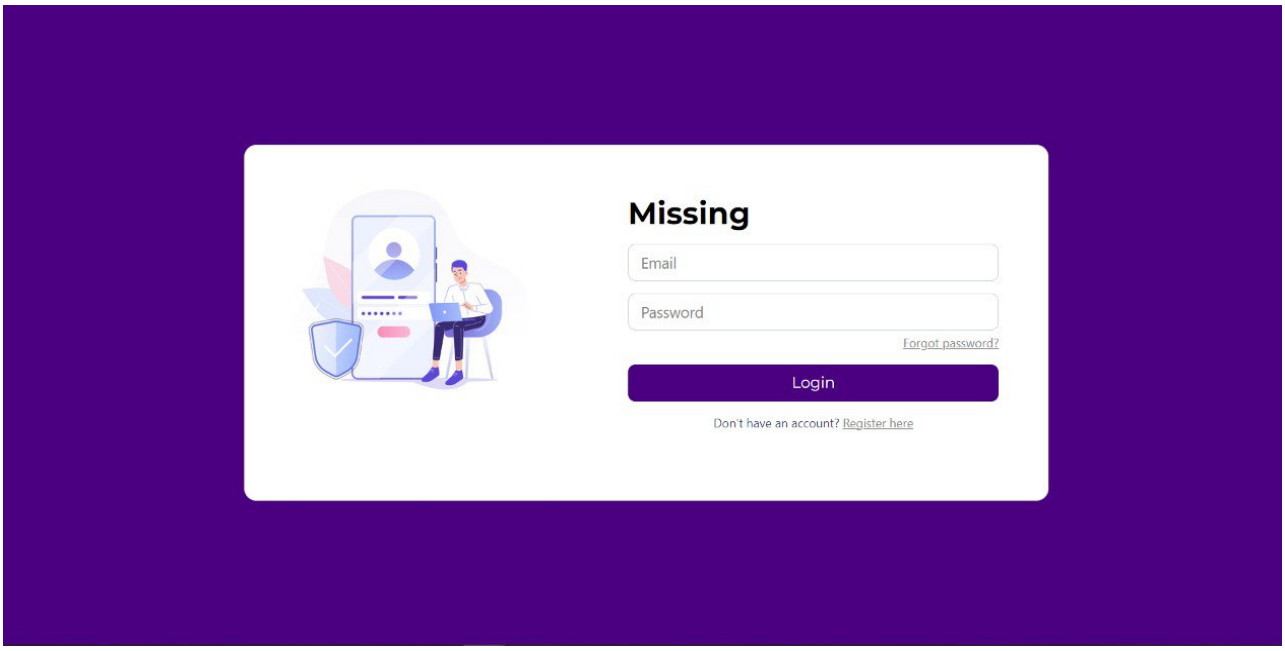


Figure 47 Web Application Employees Login Page

If an employee doesn't have an account, he will be moved to a registration page which is shown in **Figure 48** where he can register and have an account by entering some information like his name, email, password and definitely his position at work. Email has to end with **missing.org.eg** to make it unique for us.

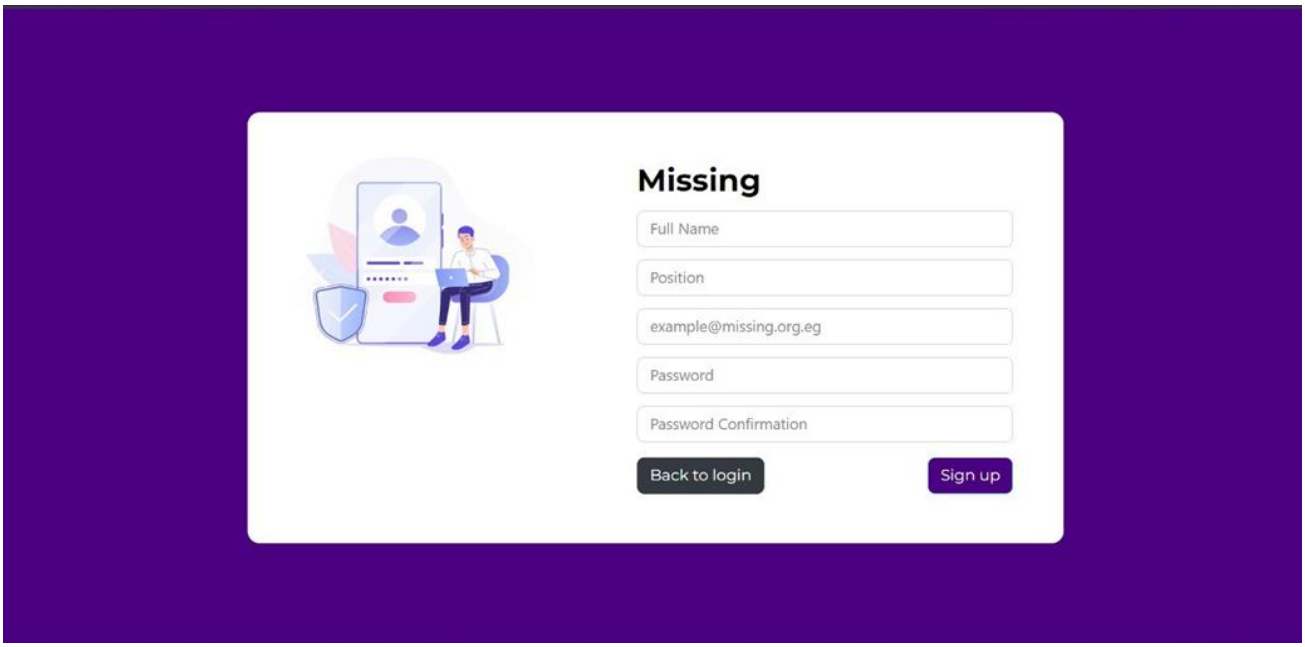


Figure 48 Web Application Employees Registration Page

The view in **Figure 49** will appear when a civil registry officer login with his account. First one if there is no data or dependents need to be verified or there is no data at all. Second one in **Figure 50** which table contains data of dependents and they are not verified yet. And here is the first one.

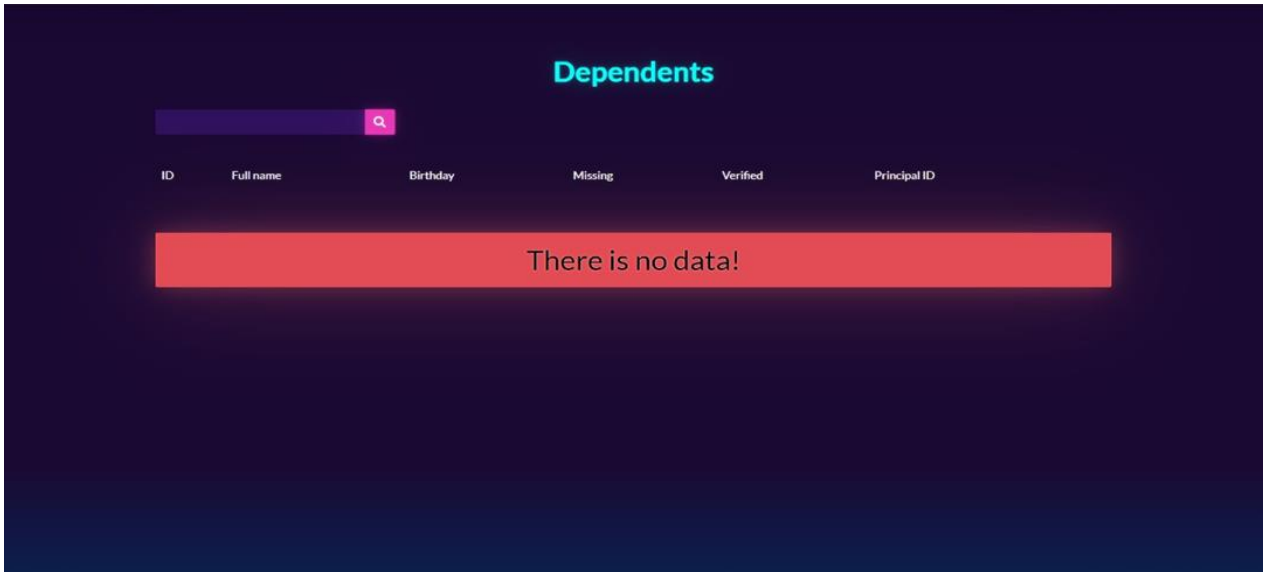


Figure 49 Empty Dependents Index View

This page has multiple features like search sorting data ascendingly depending on age and depending whether the dependent is missing or not.

Figure 50 Dependents Index View

The last column of the Index view shown above is an icon referring to details of dependents. If an employee clicks on it, it will show a page which has the dependent's details which is shown in **Figure 51** and his principal's details too. Civil registry employees will either verify or reject this registration.

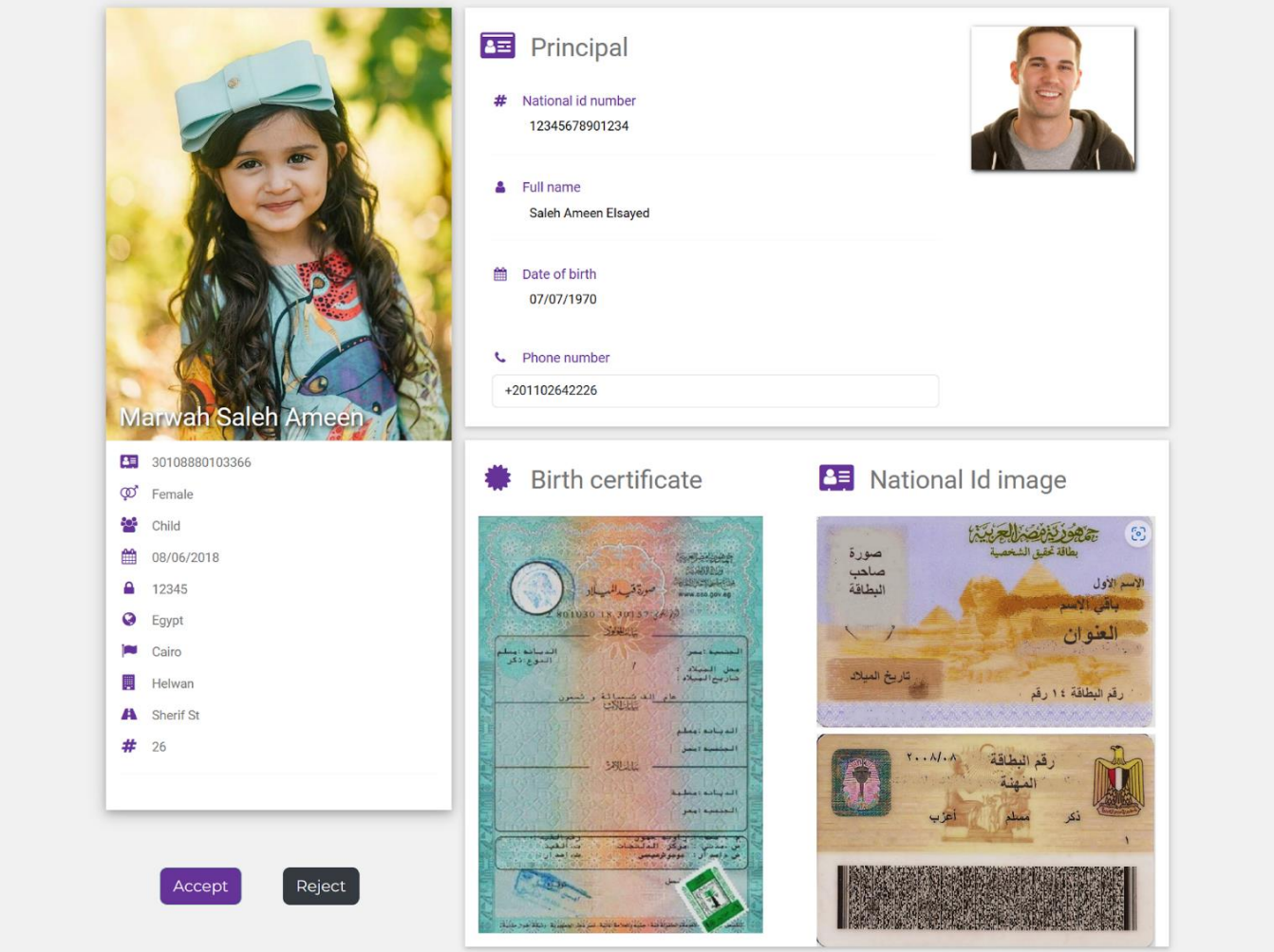


Figure 51 Dependents Details View

Second scenario is if the employee is a school employee who is in charge of students' registration, then the web pages for school employees will be displayed as shown in **Figure 52**. First one ordinary home page contains several buttons, one for adding students as dependents for their parents (principal).

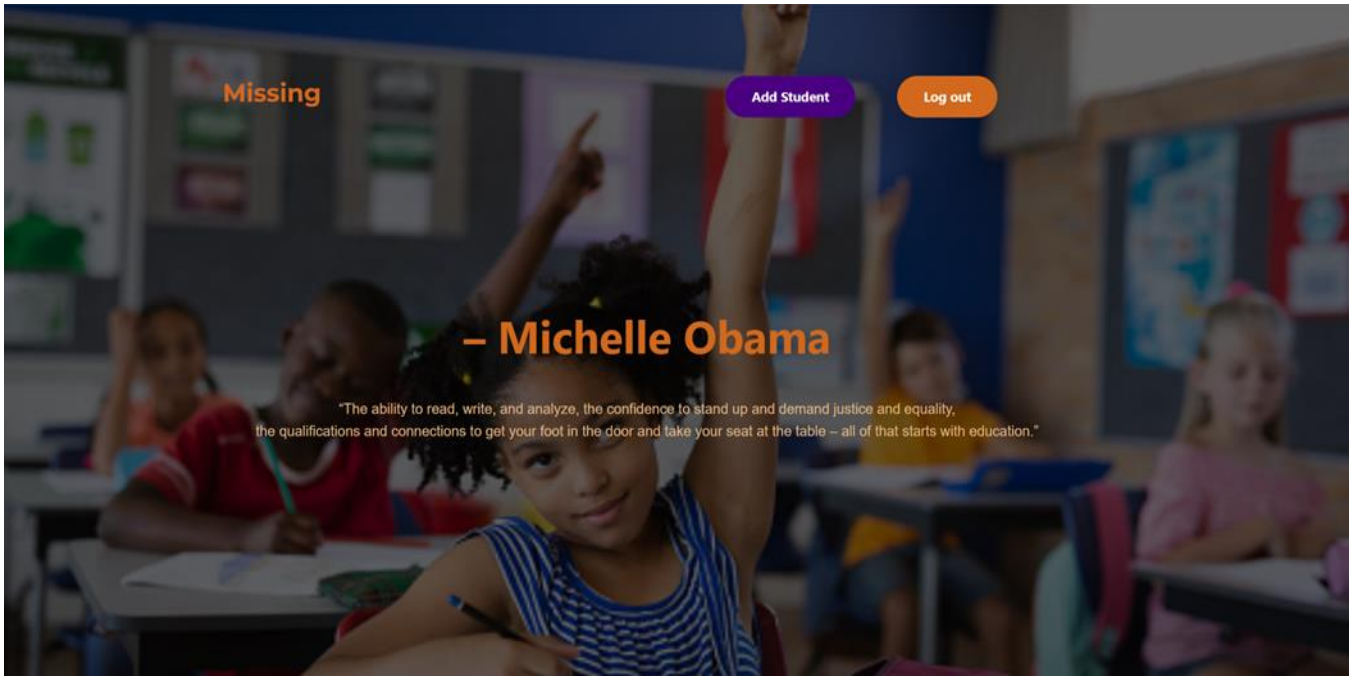


Figure 52 School Index View

To add students as dependents, the principal needs to have an account on a mobile application so we are checking first if the parent has an account or not by his phone number as shown in **Figure 53**.

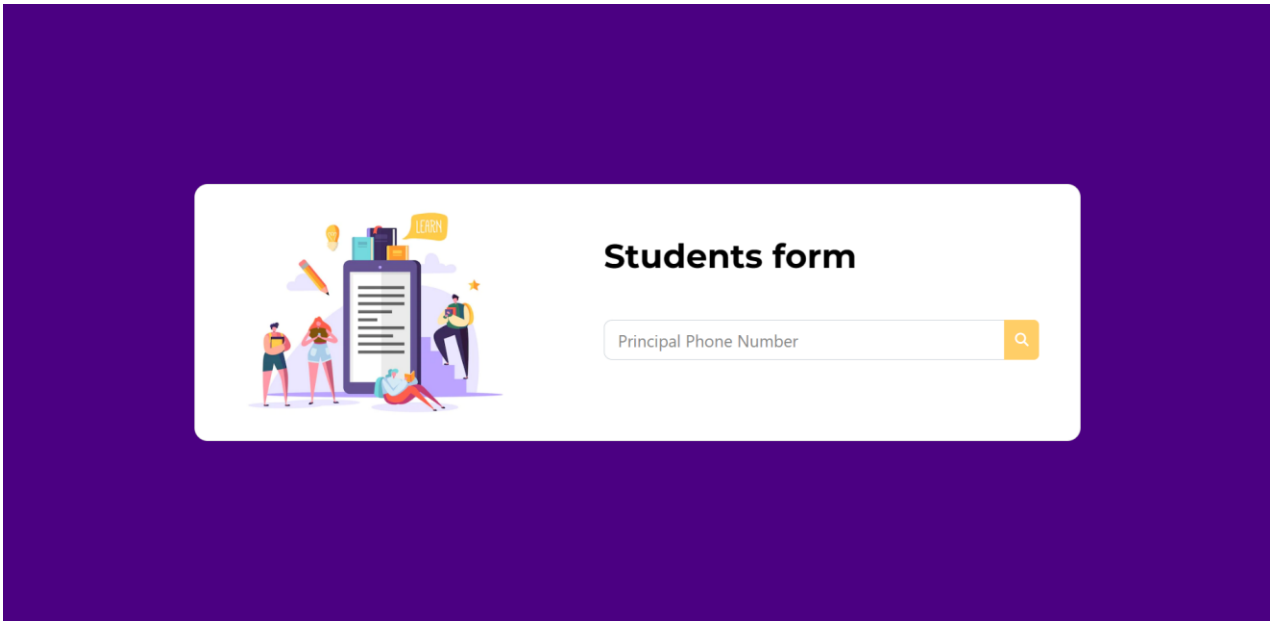


Figure 53Search for a Parent to Register His Children

If the parent doesn’t have an account, he will be moved to another page to create an account as shown in **Figure 54** just like mobile application procedure.

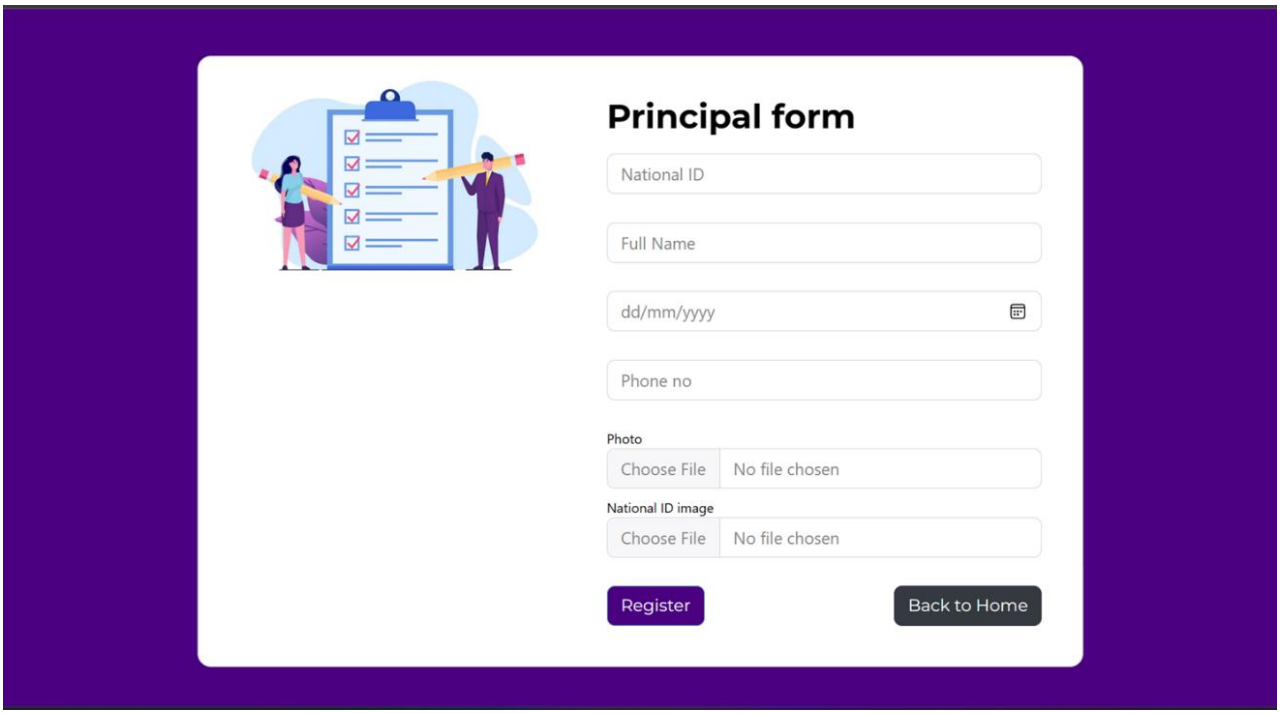


Figure 54 Register a Principal (Parent)

Otherwise, the parent details will be displayed on the screen shown in as **Figure 55** to the student registration employee at school to be checked and confirmed as follows.

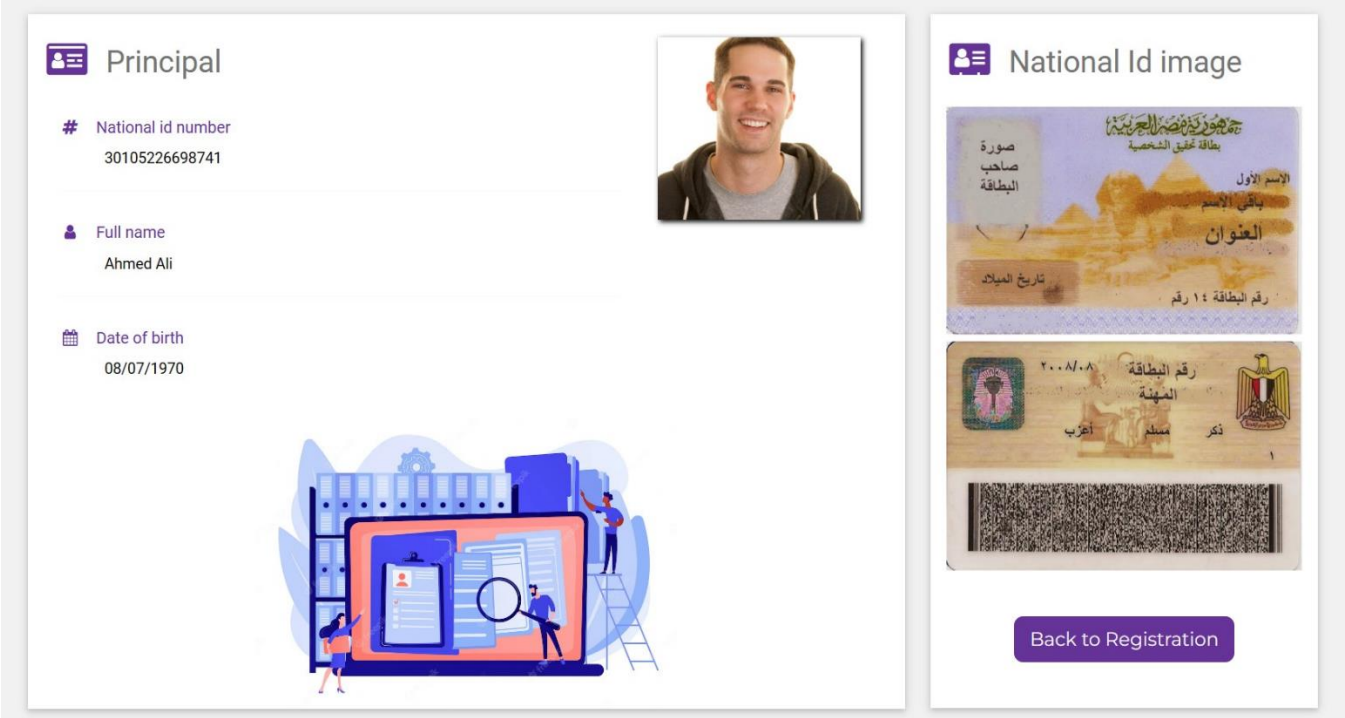


Figure 55 Principal Details View

If a parent has an account directly will be moved to the student registration page in **Figure 56** to add students as a dependent to their principal such as mobile application. Now we can get a large number of users and dependents on application.

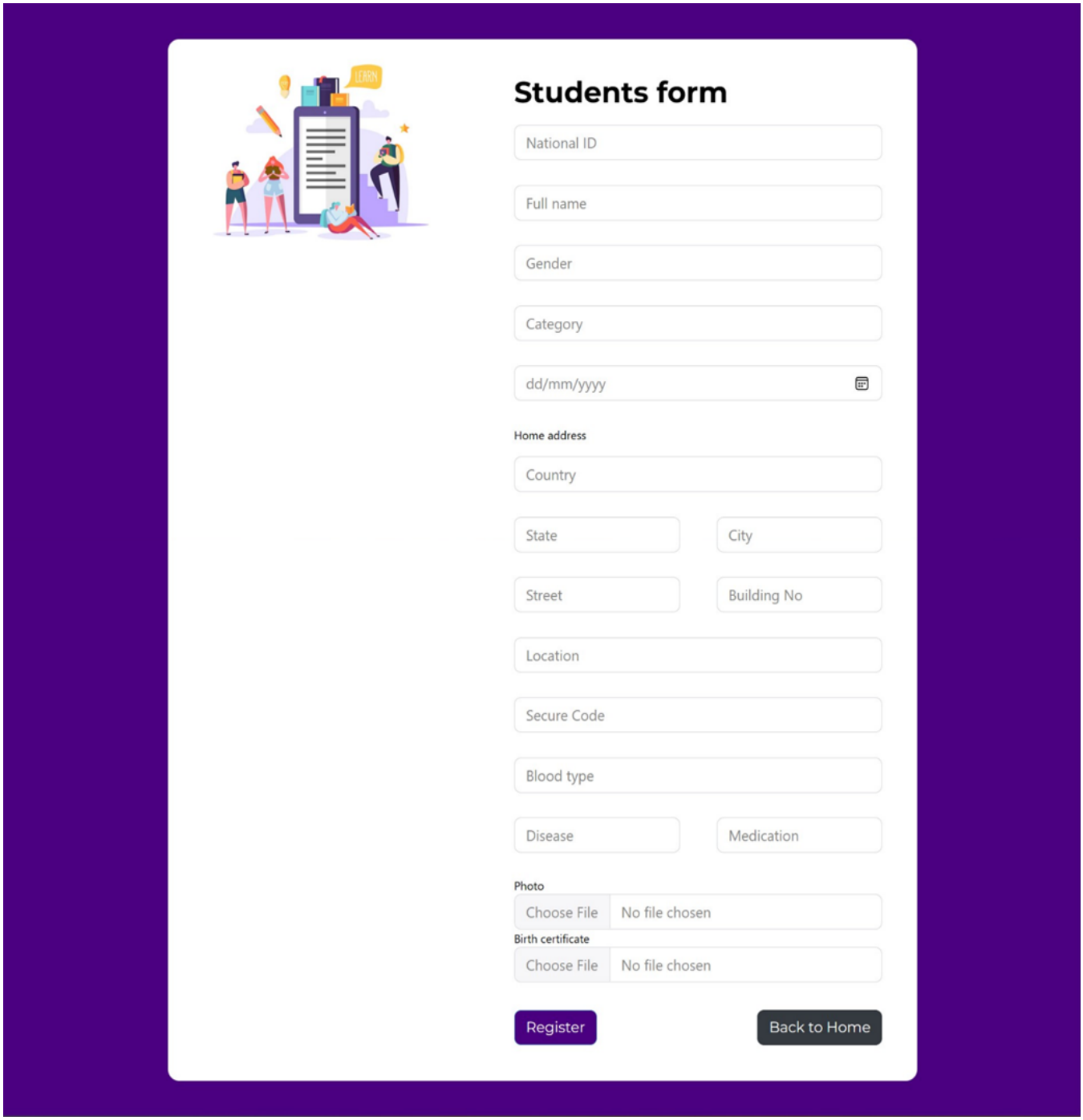


Figure 56 Student Registration View

The third scenario and the last one if a security guard logged in. There are two options, the first one to have no data or there are not any lost ones, then the screen in **Figure 57** will be shown to him.

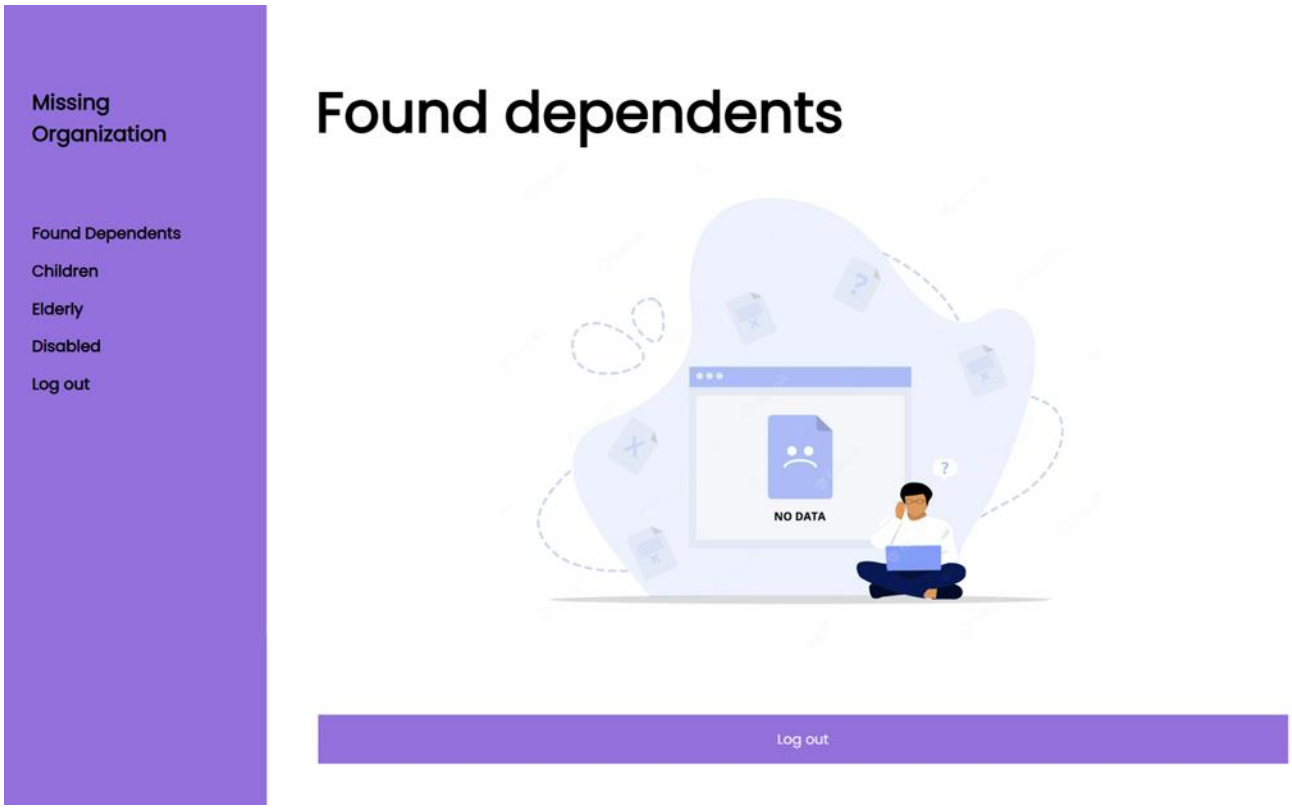


Figure 57 Empty Found Dependents View

The second one is if there are lost people in a close area (in the region of about 110 km radius far from the security center) so it will be shown on the certain page as shown in **Figure 58** classified as their gender and category (children, elderly, disabled). When a picture is clicked, more information about each dependent will be displayed to the security guard. So, when a principal looks for his dependent in security centers, he can find it if someone else found it even if he is not registering his son at the system's database.

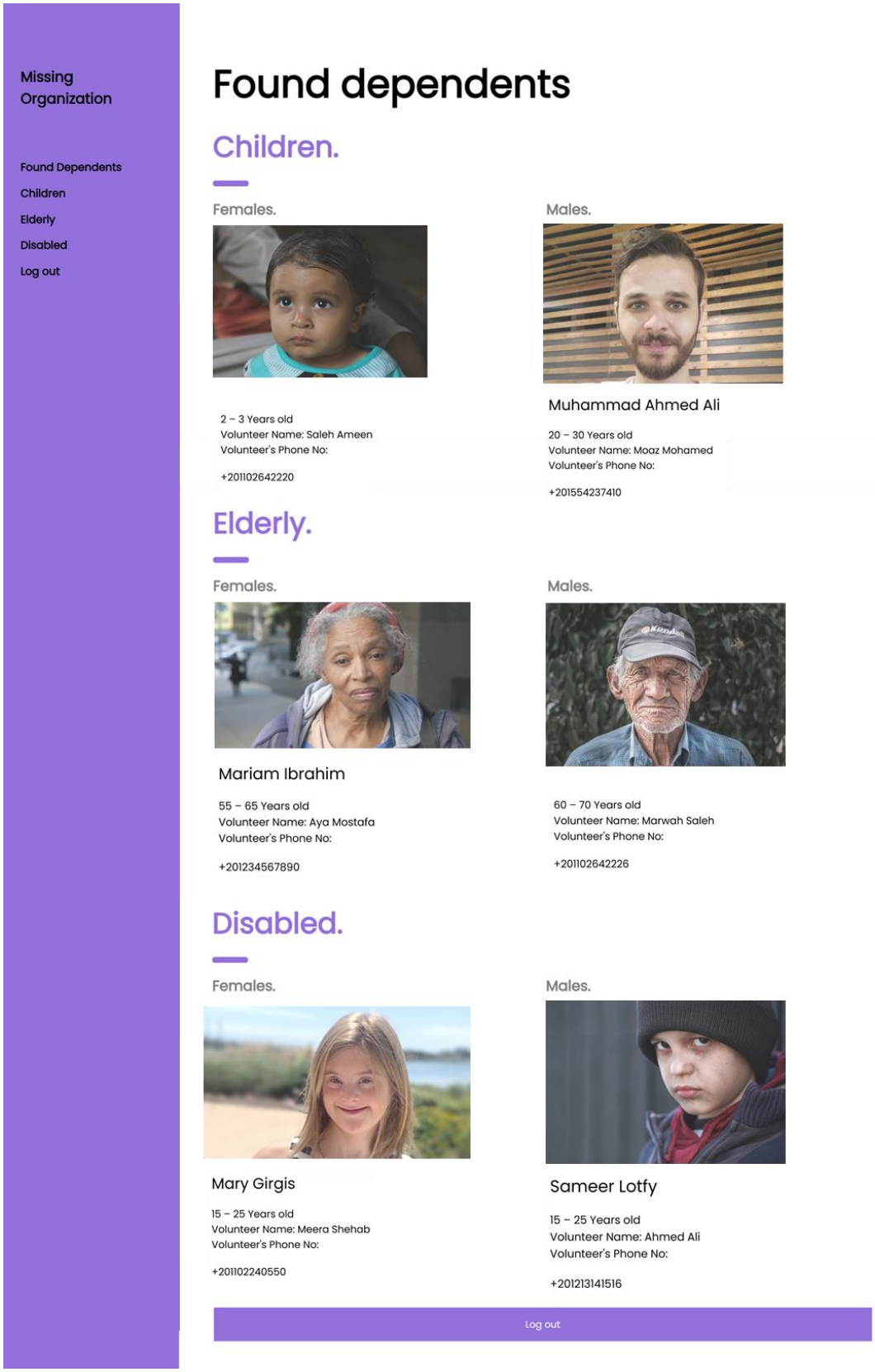


Figure 58 Found Dependents View

When a picture is clicked it expands to display further information about the dependent as shown in **Figure 59**.

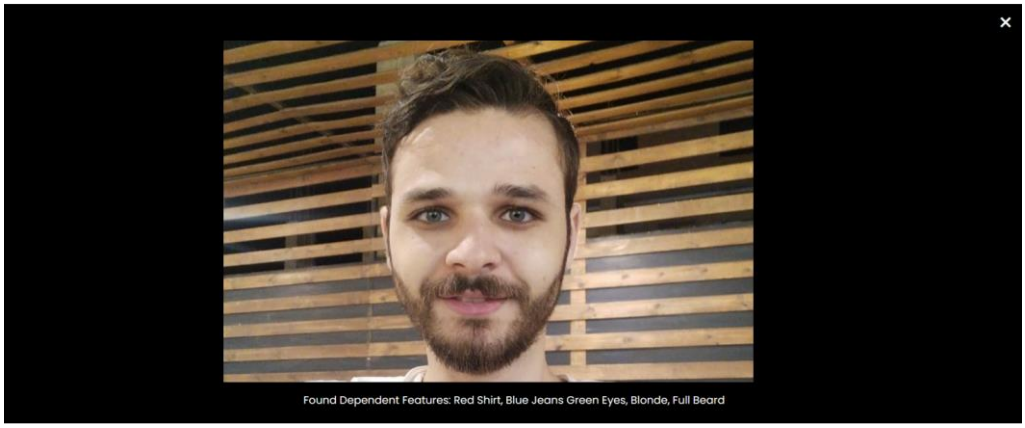


Figure 59 Further Details of Found Dependents

Chapter 7: Diagrams

7.1. Use Case Diagram

In UML, use-case diagrams model the behavior of a system and help to capture the requirements of the system. Use-case diagrams describe the high-level functions and scope of a system. These diagrams also identify the interactions between the system and its actors (users, volunteer, and employee).

The use cases and actors in use-case diagrams describe what the system does and how the actors use it, but not how the system operates internally as shown in **Figure 60**.

Use-case diagrams illustrate and define the context and requirements of either an entire system or the important parts of the system. You can model a complex system with a single use-case diagram or create many use-case diagrams to model the components of the system.

The following topics describe model elements in use-case diagrams:

Use cases: A use case describes a function that a system performs to achieve the user's goal. A use case must yield an observable result that is of value to the user of the system.

Actors: An actor represents the role of a user that interacts with the system that you are modeling. The user can be a human user, an organization, a machine, or another external system.

Subsystems: In UML models, subsystems are a type of stereotyped component that represent independent, behavioral units in a system. Subsystems are used

in class, component, and use-case diagrams to represent large-scale components in the system that you are modeling.

Relationships in use-case diagrams: In UML, a relationship is a connection between model elements. A UML relationship is a type of model element that adds semantics to a model by defining the structure and behavior between the model elements.

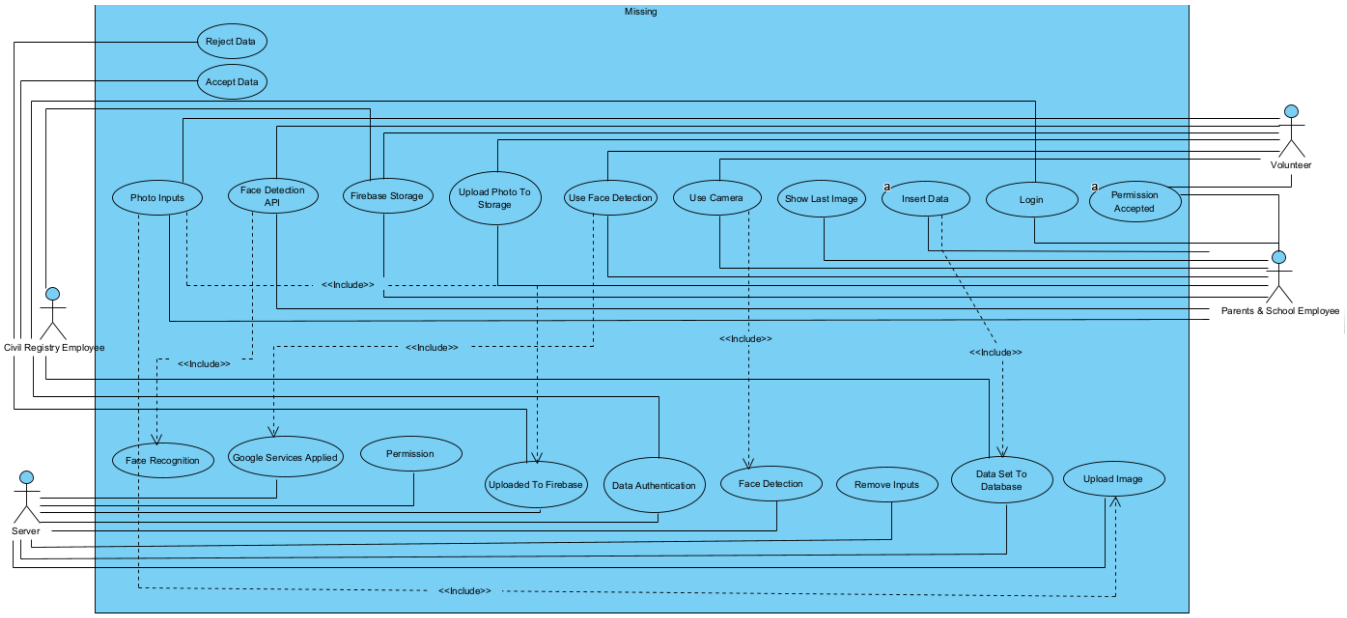


Figure 60 Use Case Diagram

7.2. Entity Relationship Diagram

An entity relationship diagram (ERD), also known as an entity relationship model, is a graphical representation that depicts relationships among people,

objects, places, concepts or events within an information technology (IT) system.

As shown in **Figure 60** entity relationship diagrams provide a visual starting point for database design that can also be used to help determine information system requirements throughout an organization. After a relational database is rolled out, an ERD can still serve as a reference point, should any debugging or business process re-engineering be needed later.

However, while an ERD can be useful for organizing data that can be represented by a relational structure, it can't sufficiently represent semi-structured or unstructured data. It's also unlikely to be helpful on its own in integrating data into a pre-existing information system.

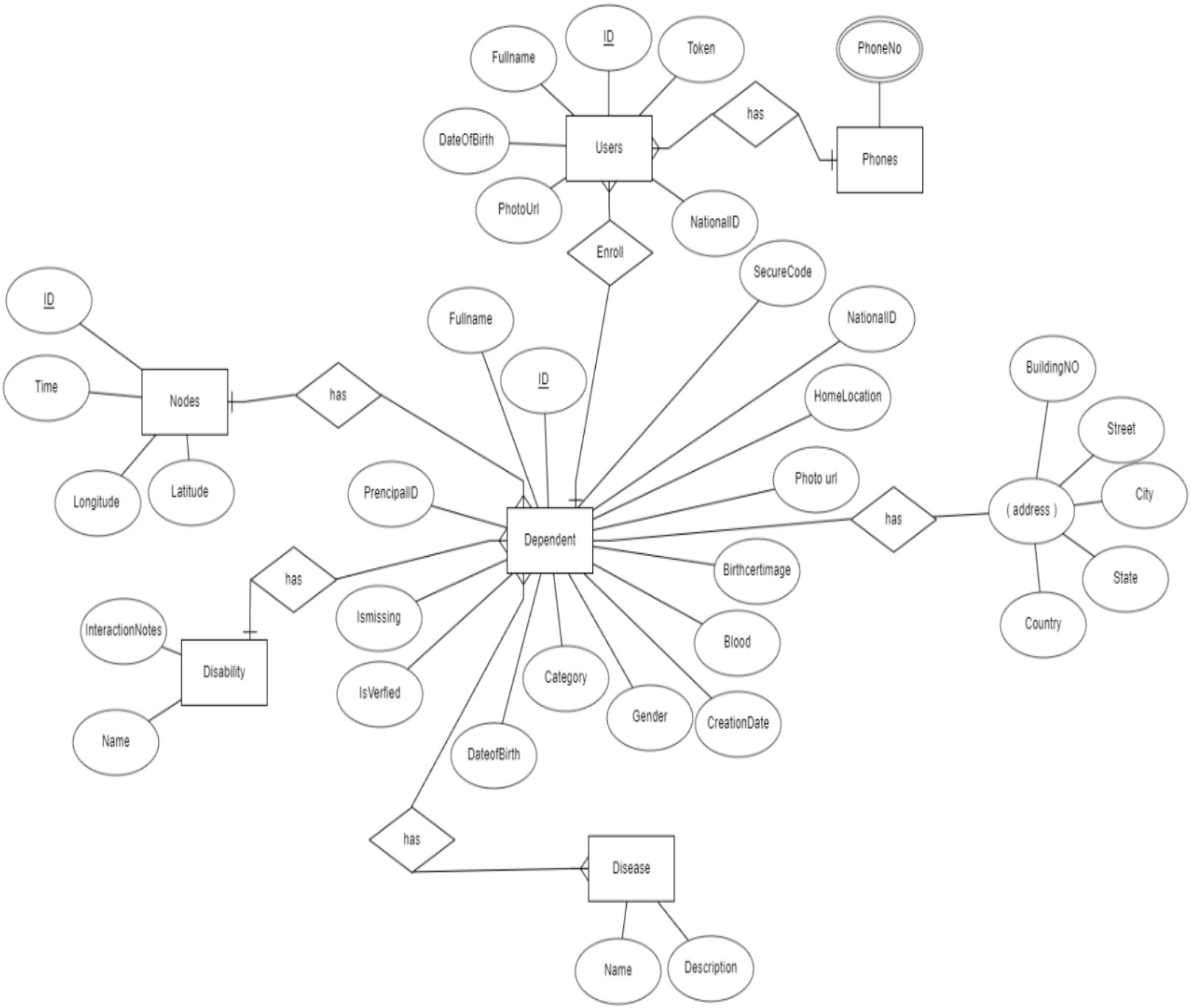


Figure 61 Entity Relationship Diagram

7.3. Relational Model

The following is the relational model of our system, it shows the data and the relationship between them in the database.

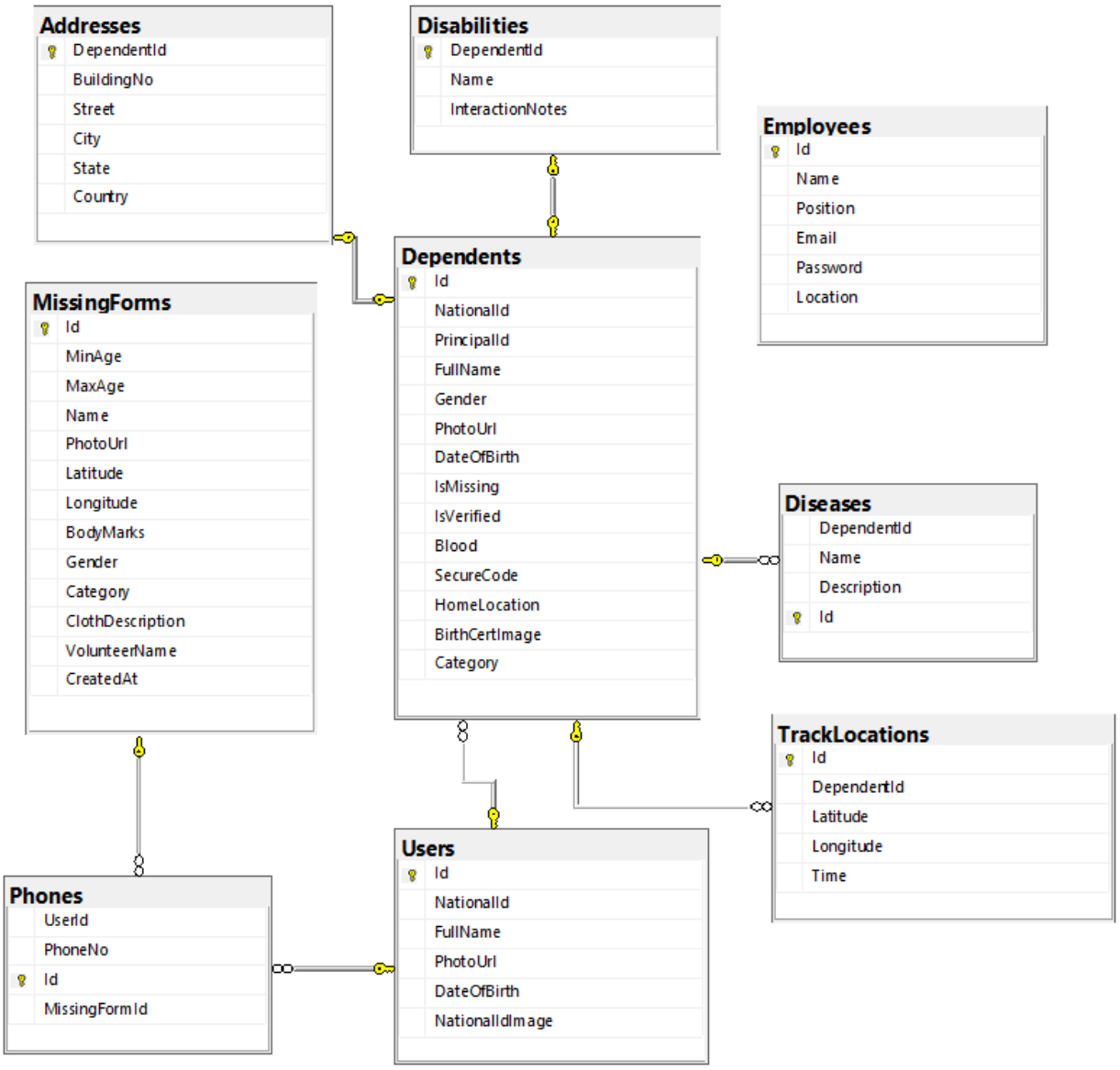


Figure 62 Relational Model

7.4. Sequence Diagram

This sequence diagram for the user of a mobile application when he opens it and gets a picture for the one who is lost to help him be found. Firstly, he opens the camera and captures the photo then the photo is added to the database and gets detected at face detection model. On another hand there are other users whose relatives are lost, so they open the application, insert the data of the lost relative and upload his photo. The sequence diagram in **Figure 63** shows the process.

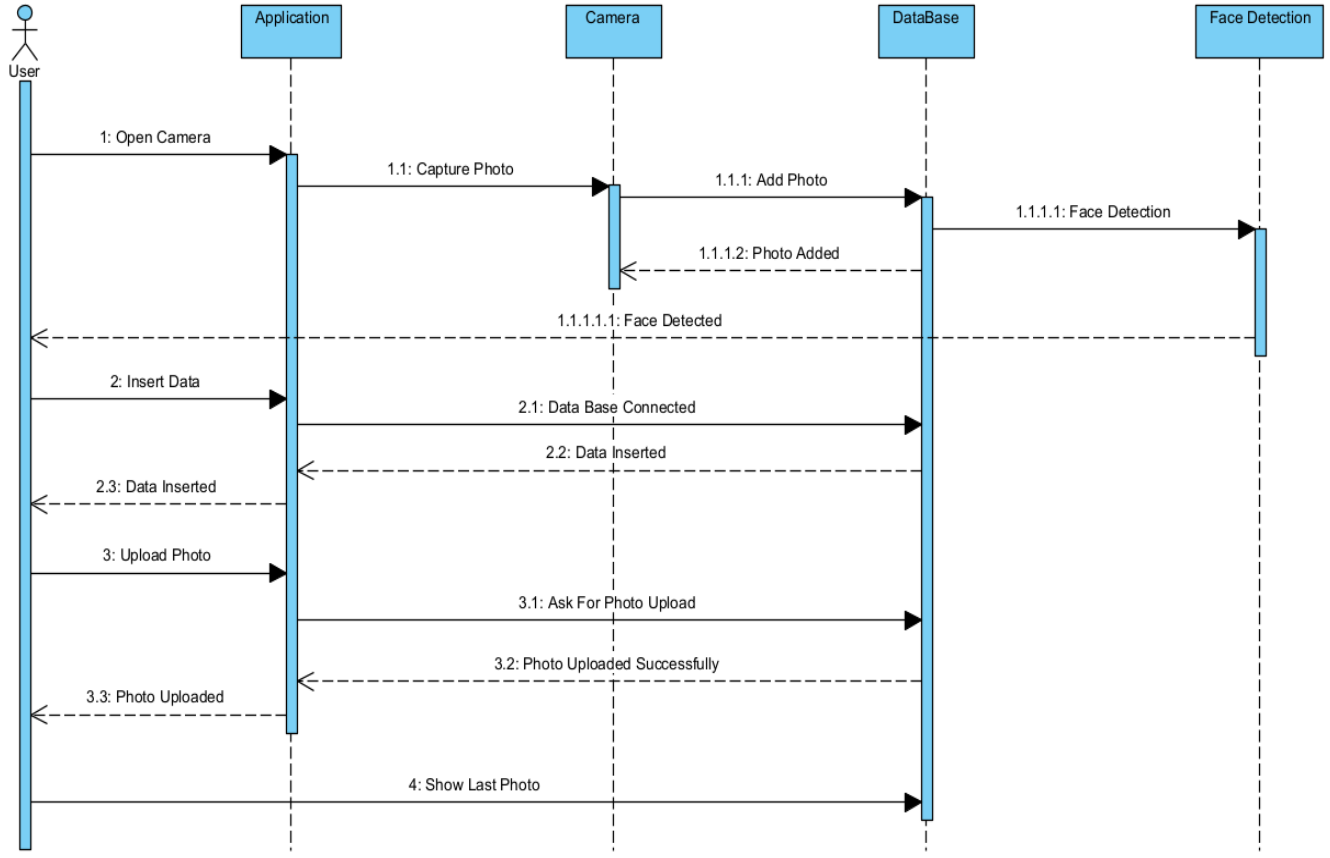


Figure 63 Sequence Diagram of Mobile Application

School employees, civil registry employees or security guards have accounts on the web application so they can do their jobs and the sequence diagram in **Figure 64** shows the process of registration and login for them. First, the employee enters registration information, then information is verified and saved in the database now the account is registered. Now they can login easily by entering login information then verifying the account by database when the account is valid, the logging in succeeded.

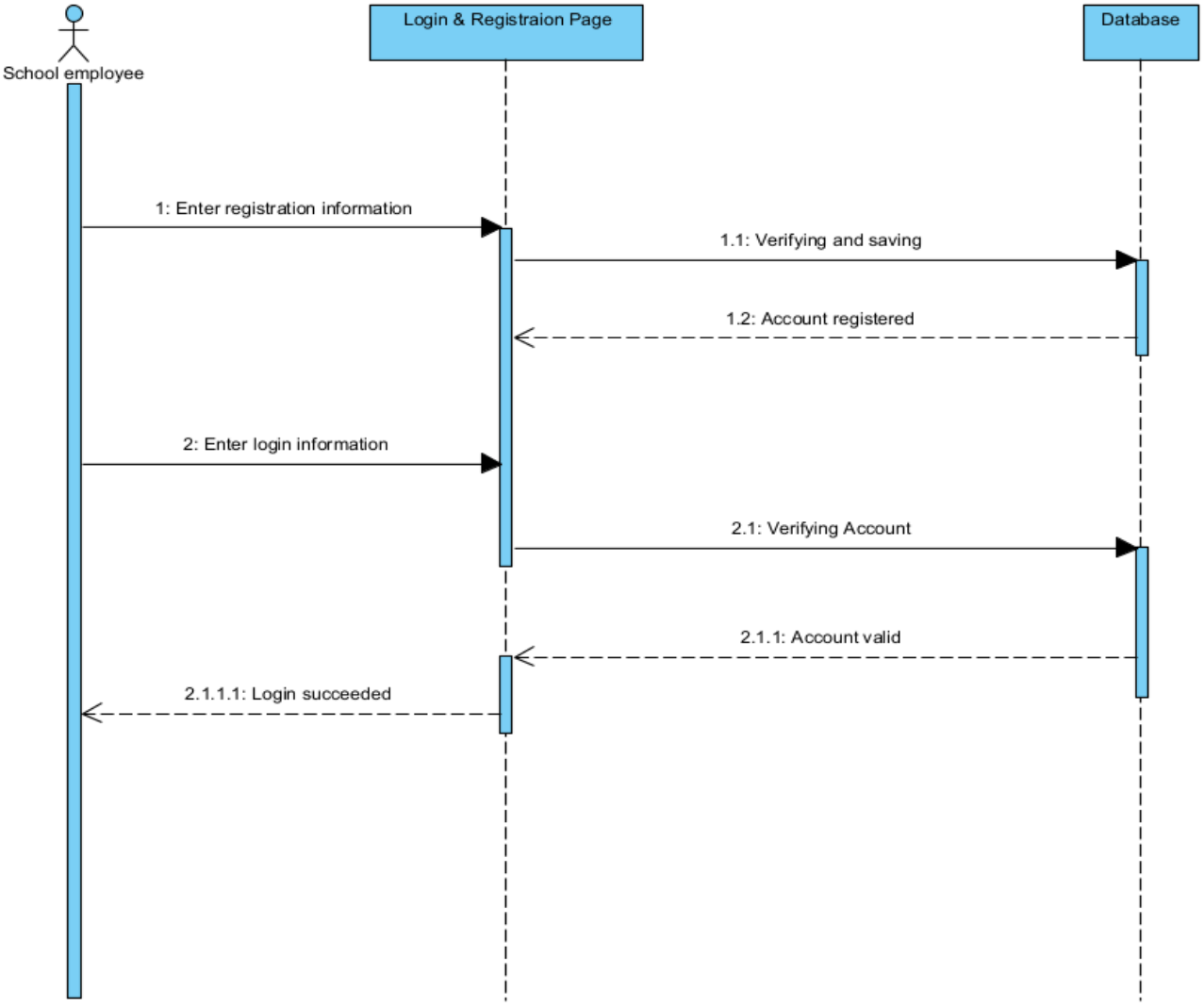


Figure 64 Sequence Diagram of Registration and Login

The sequence diagram in **Figure 65** shows how dependents get accepted by civil registry employees who use the web application to do this job. User enters registration information for dependent then saving data in the database and sending it to the civil registry employee for checking. After checking, the employee accepts or rejects the dependent. If data is accepted registration succeeded and if not, registration failed, hence updating data in the database.

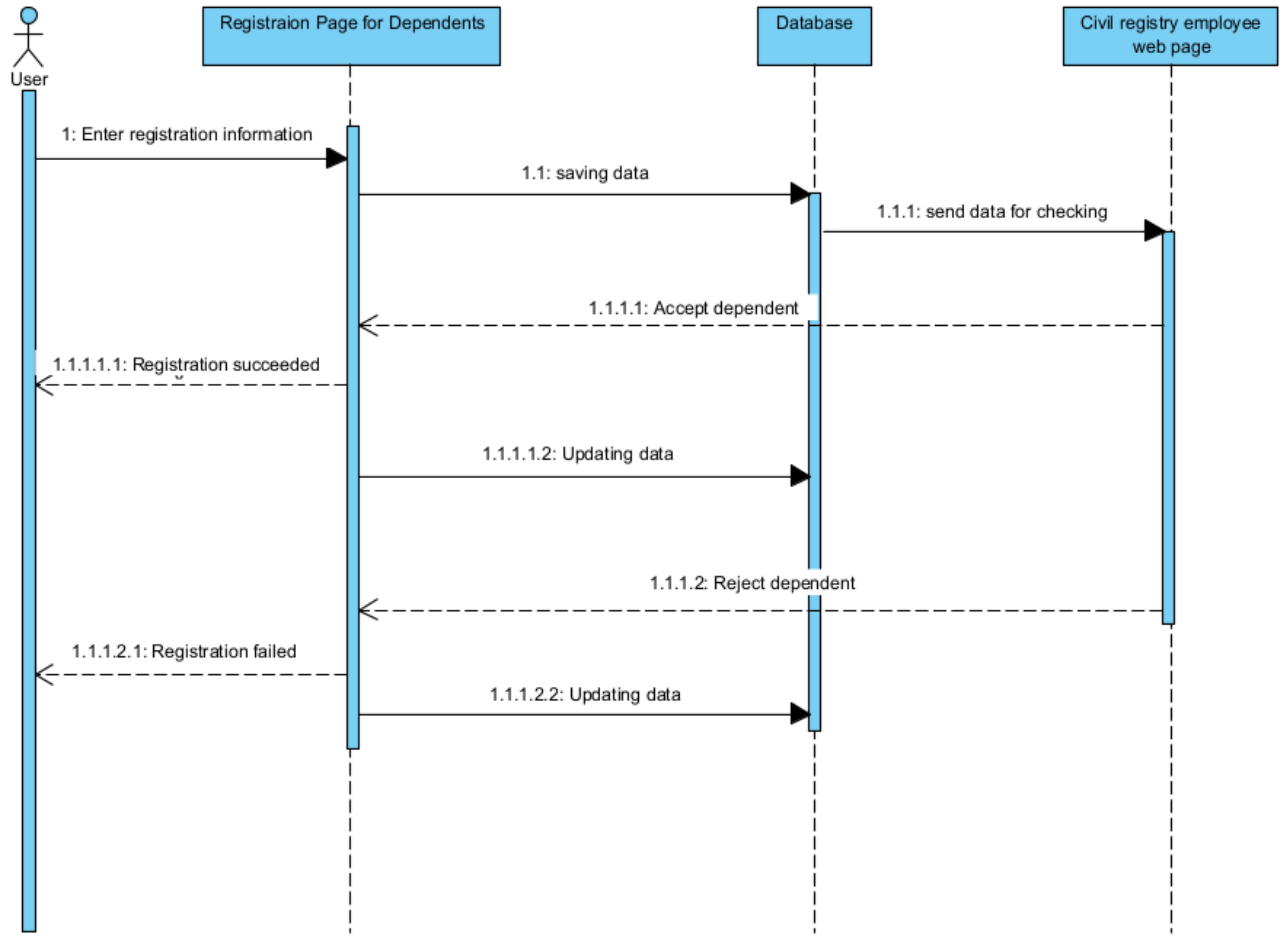


Figure 65 Sequence Diagram of Registration and Login

The sequence diagram in **Figure 66** shows how school employee adds users (principal) and students (dependents) to the application. First, the employee adds principal information then verifying and saving data in the database and now the account is registered. Second, the employee adds dependent information then verifying, saving data in the database and sending it to the civil registry employee to check it. After checking, if data is accepted registration succeeded and if not, registration failed, so updating data in the database.

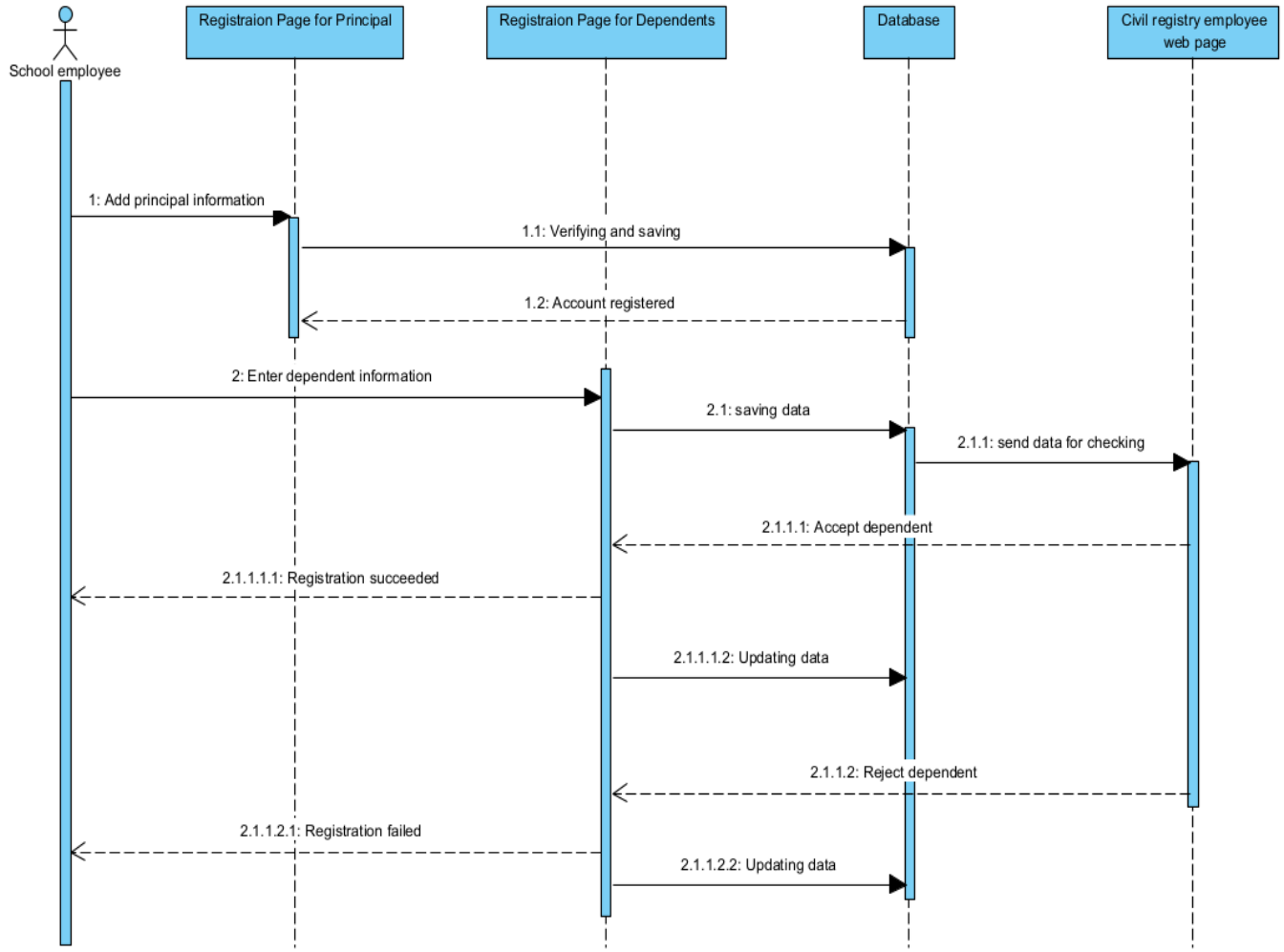


Figure 66 Sequence Diagram of Registration and Login

Chapter 8: Software Testing

8. Software Testing

Software testing can be stated as the process of verifying and validating whether a software or application is bug-free, meets the technical requirements as guided by its design and development, and meets the user requirements effectively and efficiently by handling all the exceptional and boundary cases. The process of software testing aims not only at finding faults in the existing software but also at finding measures to improve the software in terms of efficiency, accuracy, and usability. It mainly aims at measuring the specification, functionality, and performance of a software program or application.

Software testing can be divided into two steps:

Verification: it refers to the set of tasks that ensure that the software correctly implements a specific function.

Validation: it refers to a different set of tasks that ensure that the software that has been built is traceable to customer requirements.

Different types of Software Testing Techniques:

Software testing techniques can be majorly classified into two categories:

Black Box Testing: The technique of testing in which the tester doesn't have access to the source code of the software and is conducted at the software interface without any concern with the internal logical structure of the software is known as black-box testing.

White-Box Testing: The technique of testing in which the tester is aware of the internal workings of the product, has access to its source code, and is conducted by making sure that all internal operations are performed according to the specifications is known as white box testing.

8.1. Mobile Testing

Black Box Test for Mobile Application

Principal Screens

In this table, we will discuss how the user's phone number can be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the phone number, which must not exceed or fall below the permissible value.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	Test how a new user can be added to the application.	-Open the app. -Enter the valid phone number. -Click Save Verification Code	Phone Number= “01119891581”	Registration Success	Pass
TC-02	Invalid Message Appears for Phone Number	-Open the app. -Enter the invalid phone number. -Click Save Verification Code	Phone Number= “0111989158”	Registration Success	Fail

Table 1 Principal Testing

Verification Screen

In this table, we will discuss how the verification code data be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the verification code sent in phone number, which must not exceed or fall below the permissible value.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	Verify the user's phone number	-User receives a message -Enter verification code -Click Verify	Code= ”112233”	Must be verified	Pass
TC-02	Verify the user's phone number	-User receives a message -Enter verification code -Click Verify	Code= ”1122”	Must be verified	Fail
TC-03	Verify the user's phone number	-User receives a message -Enter verification code -Click Verify	Code= ”None”	Message appears saying “Verification code is required”	Fail

Table 2 Verification Testing

Profile User Test.

In the profile user table, we will discuss how the user's data be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the full name, data of birth National ID and user image, which must not exceed or fall below the permissible value and must not be empty.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	Insert Image Full Name Data of Birth National ID Birth Certificate Image	-Enter all required data as shown in each field -Enter Save button	Insert Image ="" Full Name = "Muhammad Ahmed Ali" Data of Birth= "15/9/1996" National ID = "11223344556677" Birth Certificate Image = ""	Added a new user	Pass
TC-02	Insert user image	-Enter all required data as shown in each field (Insert image) -Enter Save button	Insert Image = " None"	Message appears saying "image is required"	Fail

TC-03	Insert user image	-Enter all required data as shown in each field (Insert image) -Enter Save button	Insert Image = ””	User Image has been registered	Pass
TC-04	User full name	-Enter all required data as shown in each field (full name) -Enter Save button	Full Name = “Muhammad”	Message appears saying “full name is not correct”	Fail
TC-05	Dependent full name	-Enter all required data as shown in each field (Full name) -Enter Save button	Full Name = “Muhammad Ahmed Ali”	Full Name has been registered	Pass
TC-06	Birth Date	-Enter all required data as shown in each field (Select your birth date) -Enter Save button	Birth Date = “15/9/”	Message appears saying “birth date is not correct”	Fail
TC-07	Birth Date for dependent	-Enter all required data as shown in each field (Select your birth date) -Enter Save button	Birth Date = “8/6/2020”	Birth Date has been registered	Pass

TC-08	National ID for verification	-Enter all required data as shown in each field (Enter the national ID) -Enter Save button	National ID = “11223344”	Message appears saying “National ID is not correct”	Fail
TC-09	National ID for verification	-Enter all required data as shown in each field (Enter the national ID) -Enter Save button	National ID = “11223344001122”	National ID has been registered	Pass

Table 3 Profile User Testing

Add Dependents Test

In the add dependent table, we will discuss how the dependent’s data be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the full name, data of birth National ID, home location, home address, category and dependent image, which must not exceed or fall below the permissible value and must not be empty.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	-Insert Image -Full Name -Data of Birth -National ID -Home Location -Home Address -Secure Code -Category of dependent -Birth Certificate Image	-Enter all required data as shown in each field -Enter Save button	Insert Image =”” Full Name = “Muhammad Ahmed Ali” Data of Birth= “15/9/1996” National ID = “11223344556677” Home Location = “i.e.51.52376,-0.15849” Home Address = “14 ElAhlam street – Farag Yousef Dar ElSalam - Cairo” Secure Code = “112233” Category = “child” Birth Certificate Image = “”	Added a new Dependent	Pass
TC-02	Insert dependent image	-Enter all required data as shown in each field (Insert image) -Enter Save button	Insert Image = ” None”	Message appears saying “image is required”	Fail

TC-03	Insert dependent image	-Enter all required data as shown in each field (Insert image) -Enter Save button	Insert Image = ” ”	Image has been registered	Pass
TC-04	Dependent full name	-Enter all required data as shown in each field (full name) -Enter Save button	Full Name = “Lina”	Message appears saying “this field is required”	Fail
TC-05	Dependent full name	-Enter all required data as shown in each field (full name) -Enter Save button	Full Name = “Lina Mahmoud Ali”	Full Name has been registered	Pass
TC-06	Birth Date for dependent	-Enter all required data as shown in each field (Select your birth date) -Enter Save button	Birth Date = “8/6/”	Message appears saying “this field is required”	Fail
TC-07	Birth Date for dependent	-Enter all required data as shown in each field (Select your birth date)	Birth Date = “8/6/2020”	Birth Date has been registered	Pass

		-Enter Save button			
TC-08	National ID for verification	-Enter all required data as shown in each field (Enter the national ID) -Enter Save button	National ID = “11223344”	Message appears saying “this field is required”	Fail
TC-09	National ID for verification	-Enter all required data as shown in each field (Enter the national ID) -Enter Save button	National ID = “11223344001122”	National ID has been registered	Pass
TC-10	Home Location	-Enter all required data as shown in each field (Home Location) -Enter Save button	Home Location = “None”	Message appears saying “this field is required”	Fail
TC-11	Home Location	-Enter all required data as shown in each field (Home Location) -Enter Save button	Home Location = “i.e.51.52376,-0.15849”	Home Location has been registered	Pass

TC-12	Home Address	-Enter all required data as shown in each field (Home Address) -Enter Save button	Home Address = “None”	Message appears saying “this field is required”	Fail
TC-13	Home Address	-Enter all required data as shown in each field (Home Address) -Enter Save button	Home Address = “14 ElAhlam street”	Message appears saying “this field is required”	Fail
TC-14	Home Address	-Enter all required data as shown in each field (Home Address) -Enter Save button	Home Address = “14 ElAhlam street Farag Yousef Dar ElSalam”	Message appears saying “this field is required”	Fail
TC-15	Home Address	-Enter all required data	Home Address = “14 ElAhlam street	The Home Address	Pass

		as shown in each field (Home Address) -Enter Save button	Farag Yousef Dar ElSalam-Cairo”	has been registered	
TC-16	Secure Code	-Enter all required data as shown in each field (Secure Code) -Enter Save button	Secure Code = “None”	Message appears saying “this field is required”	Fail
TC-17	Secure Code	-Enter all required data as shown in each field (Secure Code) -Enter Save	Secure Code = “1122”	Message appears saying “this field is required”	Fail
TC-18	Secure Code	-Enter all required data as shown in each field (Secure Code) -Enter Save button	Secure Code = “112233”	Secure Code has been registered	Pass
TC-19	Category of dependent	-Enter all required data as shown in each field (Category) -Enter Save button	Category = “None”	Message appears saying “this field is required”	Fail

TC-20	Category of dependent	-Enter all required data as shown in each field (Category) -Enter Save button	Category = “Child”	Category has been registered	Pass
TC-21	Insert dependent image	-Enter all required data as shown in each field (Insert image) -Enter Save button	Insert Image = ” None”	Message appears saying “image is required”	Fail
TC-22	Insert dependent image	-Enter all required data as shown in each field (Insert image) -Enter Save button	Insert Image = ””	Dependent Image has been registered	Pass

Table 4 Add Dependent Testing

8.2. Web Testing

Black Box Test for Web Application

Registration for employee

In the registration of employee table, we will discuss how the employee’s data be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the full name, position, password and confirm password, which must not exceed or fall below the permissible value and must not be empty.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	test registration for employees (School employee - civil registry employee - security guard)	-Enter all required data -Enter register button	Full Name = "Maya Khaled Hammad" Position = " school employee" Email = "MayaMo@missing.org.eg" Password = "M125987" Password confirmation = "M125987"	Registration succeeded	Pass
TC-02	test registration for employees	-Enter all required data -Enter register button	Full Name = "Maya Khaled Hammad" Position = " school employee" Email = "MayaMo@gmail.com" Password = "M125987" Password confirmation = "M125987"	Registration succeeded	Fail

TC-03	test registration for employees	-Enter all required data -Enter register button	Full Name = “Maya Khaled Hammad” Position = “ school employee” Email = “MayaMo@missing.org.eg” Password = “M125987” Password confirmation = “M5987”	Registration succeeded	Fail
TC-04	test registration for employees	-Enter all required data -Enter register button	Full Name = “Maya Khaled Hammad” Position = “ school employee” Email = “MayaMo@missing.org.eg” Password = “ ” Password confirmation = “ ”	Registration succeeded	Fail
TC-05	test registration for employees	-Enter all required data -Enter register button	Full Name = “Maya Khaled Hammad” Position = “school employee” Email = “ ” Password = “M125987” Password confirmation = “M125987”	Registration succeeded	Fail

TC-06	test registration for employees	-Enter all required data -Enter register button	Full Name = “Maya Khaled Hammad” Position = “ ” Email = “MayaMo@missing.org.eg ” Password = “M125987” Password confirmation = “M125987”	Registration succeeded	Fail
TC-07	test registration for employees	-Enter all required data -Enter register button	Full Name = “ ” Position = “civil registry employee” Email = “MayaMo@missing.org.eg” Password = “M125987” Password confirmation = “M125987”	Registration succeeded	Fail
TC-08	test registration for employees	-Enter all required data -Enter register button	Full Name = “Maya Khaled Hammad” Position = “ security employee” Location = “data” Email = “MayaMo@missing.org.eg” Password = “M125987” Password confirmation = “M125987”	Registration succeeded	Pass

TC-09	test registration for employees	-Enter all required data -Enter register button	Full Name = “Maya Khaled Hammad” Position = “ security employee” Location = “ ” Email = “MayaMo@missing.org.eg” Password = “M125987” Password confirmation = “M125987”	Registration succeeded	Fail

Table 5 Registration for Employee Testing

Login for employee

In the login for employee table, we will discuss how the employee’s data be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the email and password, which must not exceed or fall below the permissible value and must not be empty.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	test login for employees (school employee - civil registry employee - security guard)	-Enter all required data -Enter login button	Email = “MayaMo@missing.org.eg” Password = “M125987”	Login succeeded	Pass

TC-02	test login for employees	-Enter all required data -Enter login button	Email = "MayaMo@missing.org.eg" Password = " "	Login succeeded	Fail
TC-03	test login for employees	-Enter all required data -Enter login button	Email = " " Password = "M125987"	Login succeeded	Fail
TC-04	test login for employees	-Enter all required data -Enter login button	Email = " " Password = " "	Login succeeded	Fail
TC-05	test login for employees	-Enter all required data -Enter login button	Email = "MayaMo@missing.org.eg " Password = "M5987"	Login succeeded	Fail
TC-06	test login for employees	-Enter all required data -Enter login button	Email = "MayaMo@gmail.com " Password = "M125987"	Login succeeded	Fail

Table 6 Login for Employee Testing

Test for user account

In the user account table, we will discuss how the user's phone number be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the phone number, which must not exceed or fall below the permissible value and must not be empty.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	check if user has account or not by his number	-insert user's phone -click on search icon	Phone number = "+201559876355" (exist)	Get details of account	Pass
TC-02	check if user has account or not by his number	-insert user's phone -click on search icon	Phone number = "+201449876398" (not exist)	Get details of account	Fail
TC-03	check if user has account or not by his number	-insert user's phone -click on search icon	Phone number = " "	Get details of account	Fail
TC-04	check if user has account or not by his number	-insert user's phone -click on search icon	Phone number = "+2014498768"	Get details of account	Fail

Table 7 User Account Testing

Add principal

In the add principal table, we will discuss how the principal's data be tested, which is as follows. Testing each case, the steps followed in the testing process, how to test the data, and finally the result of the testing process.

This test includes the full name, data of birth National ID, and National ID image, which must not exceed or fall below the permissible value and must not be empty.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = "60003691527895" Full Name = "Amr Khaled Hammad" Birthday = "5/6/1999" Phone number = "+201623598722" Photo = " photo.png" National Id image = "photo1.png"	Registration succeeded	Pass
TC-02	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = " " Full Name = "Amr Khaled Hammad" Birthday = "5/6/1999" Phone number = "+201623598722" Photo = " photo.png" National Id image = "photo1.png"	Registration succeeded	Fail

TC-03	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “6000527895” Full Name = “Amr Khaled Hammad” Birthday = “5/6/1999” Phone number = ”+201623598722” Photo = “ photo.png” National Id image = “photo1.png”	Registration succeeded	Fail
TC-04	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “ ” Birthday = “5/6/1999” Phone number = ”+201623598722” Photo = “ photo.png” National Id image = “photo1.png”	Registration succeeded	Fail
TC-05	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “600031527895” Full Name = “Amr Khaled Hammad” Birthday = “5/6/1999” Phone number = ”+2016298722” Photo = “ photo.png” National Id image = “photo1.png”	Registration succeeded	Fail

TC-06	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Amr Khaled Hammad” Birthday = “ ” Phone number = ”+201623598722” Photo = “ photo.png” National Id image = “photo1.png”	Registration succeeded	Fail
TC-07	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Amr Khaled Hammad” Birthday = “5/6/1999” Phone number = ” ” Photo = “ photo.png” National Id image = “photo1.png”	Registration succeeded	Fail
TC-08	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Amr Khaled Hammad” Birthday = “5/6/1999” Phone number = ”+20162359” Photo = “ photo.png” National Id image = “photo1.png”	Registration succeeded	Fail

TC-09	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Amr Khaled Hammad” Birthday = “5/6/1999” Phone number = ”+201623598722” Photo = “ ” National Id image = “photo1.png”	Registration succeeded	Fail
TC-10	test for adding principal as users to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Amr Khaled Hammad” Birthday = “5/6/1999” Phone number = ”+201623598722” Photo = “ photo.png” National Id image = “ ”	Registration succeeded	Fail

Table 8 Add Principal Testing

Add student as dependents

The same as add dependent.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Pass

TC-02	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “” Blood type = “” Disease = “diabetes” Medication = “glucophage ” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Pass

TC-03	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “” Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail
TC-04	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “6000527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5”	Registration succeeded	Fail

			}” Location = “data” Secure code = “” Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”		
TC-05	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “ ” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “” Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail

TC-06	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “ ” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “” Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail

TC-07	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “ ” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “” Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail
TC-08	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “ ” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “”	Registration succeeded	Fail

			Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”		
TC-09	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “ ” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “” Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail

TC-10	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “ ” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “” Blood type = “” Disease = “” Medication = “” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail
TC-11	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “ ” Street = “Rady” Building no = “5” }” Location = “data”	Registration succeeded	Fail

			Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”		
TC-12	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “ ” Building no = “5” }” Location = “data” Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail

TC-13	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “ ” }” Location = “data” Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail
TC-14	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }”	Registration succeeded	Fail

			Location = “ ” Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”		
TC-15	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “ ” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail

TC-16	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “1122” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Fail
TC-17	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }”	Registration succeeded	Fail

			Location = “data” Secure code = “112233” Blood type = “ ” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”		
TC-18	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ ” Birth certification = “photo1.png”	Registration succeeded	Fail

TC-19	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “ ”	Registration succeeded	Fail
TC-20	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Malika Zayn Mohamed” Gender = “female” Category = “child” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }”	Registration succeeded	Pass

			Location = “data” Secure code = “112233” Blood type = “A-” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”		
TC-21	test for adding student as dependent to mobile application	-Enter all required data -Enter register button	National ID = “60003691527895” Full Name = “Zayn Malik Mohamed” Gender = “male” Category = “disable” Birthday = “15/5/2015” Home address = “{ Country = “Egypt” State = “Cairo” City = “Zayton” Street = “Rady” Building no = “5” }” Location = “data” Secure code = “112233” Blood type = “A+” Disease = “ ” Medication = “ ” Photo = “ photo.png” Birth certification = “photo1.png”	Registration succeeded	Pass

Table 9 Add Student Testing

8.3. AI Model Testing

Black Box Test for AI part

In this pat we will discus how can test and verify that the face recognition system correctly identifies a known face stored in the database, check the system's response to an unknown face, validate the system's robustness against variations in lighting conditions, angles, validate the system's robustness against variations in facial expressions, verify the system's performance in recognizing faces of diverse age groups, verify the system's performance in recognizing faces of different genders.
This test must not exceed or fall below the permissible value and must not be empty.

Test Case ID (TC-ID)	Test Case Description	Test Steps	Test Data	Expected Result	Actual Result
TC-01	Verify that the face recognition system correctly identifies a known face stored in the database.	- Provide a known face image as input to the face recognition system. -Verify that the system correctly recognizes the face and returns a positive match.	image of known person	recognized	recognized
TC-02	Check the system's response to an unknown face.	- Provide an unknown face image as input to the face recognition system.	image of unknown person	not recognized	not recognized

TC-03	Validate the system's robustness against variations in lighting conditions, angles.	-Provide different images of the same person with variations in lighting conditions, angles. -Verify that the face recognition system consistently identifies the person across different variations.	images of the same known person with variations in lighting conditions, angles.	all images recognized	recognized
TC-04	Validate the system's robustness against variations in facial expressions	-Provide different images of the same person with variations in facial expressions.	images of the same known person with variations in facial expressions.	all images recognized	recognized
TC-05	Verify the system's performance in recognizing faces of diverse age groups	- Provide face images of the same individual in different ages	image of the same person in different ages	recognized	Recognized

TC-06	Verify the system's performance in recognizing faces of different genders	- Provide face images of known people with different genders -Verify that the system correctly recognizes the face and returns a positive match.	known face images of different genders	recognized	recognized
TC-07	Verify the system's ability to handle facial hair such as a beard or mustache	- Provide face images of the same individual with different types of facial hair, such as a beard or mustache -Verify that the face recognition system can accurately recognize and match faces despite variations in facial hair .	image of the same known person with different types of facial hair, such as a beard or mustache and without facial hair.	recognized	recognized

Table 10 AI-Part Testing

Chapter 9: Conclusion and Future Work

9.1. Conclusions

Our project is mainly used to help return any lost dependent to their families. It is a complete system consisting of a mobile application made for principals to register their dependents and report whenever they are lost and volunteers who are going to help finding the lost ones and report found dependents to security centers. In addition, it consists of a web application made for governmental institutions employees which are: civil registry employee who is in charge of confirming the incoming registration data of and dependent and its principle in our system, school employee who is going to register each student in the system to make sure that all children in the country are registered in the system in a centralized database, and a security guard who is going to collect the reports of found dependents – in the nearby region – which are not registered in the system or not recognized by the AI model and return them back to their families.

If a dependent has been reported as missing and has been captured by surveillance cameras, the principal of this dependent will be notified that his dependent has appeared in a specific location and the captured image and the location will be sent to the principal.

All employees will be registered to our specific domain which is missing.org.eg to confirm the identities of the registered employees and restrict them to be of the system's organization.

9.2. Future Work

In future, when this project is deployed and approved by the government, we will automate the process of civil registry employee by automatically authorizing registered principals and dependents as we will get the permission to connect our database by the civil registry database to approve the confidential documents such as birth certificate and national id.

We will create an avatar to the dependent that is being reported as missing to create a predicted image to him such as his cloths that he was wearing the day he has been missing on, his height, and other specific features like glasses and accessories that will help people and volunteers to recognize him and make it easy for cameras to search for him using these features not only his face.

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