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Project Title

Developing A Nurseries System for Monitoring Child Safety

Team Number: 17

Client: Nurseries

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List of Definitions

- **SMS (Short Message Service):** A text messaging service used for sending short text messages to mobile phones.
- **GPS Module:** A global positioning system module that provides accurate location data.
- **IoT (Internet of Things) Technology:** A network of interconnected devices that can communicate and share data, allowing for remote monitoring and control.
- **Face Net:** A specific deep neural network model used for facial recognition.
- **YOLOv3:** A deep learning model known as "You Only Look Once" is used for object detection and tracking.
- **Mobile App:** Software designed to run on smartphones and tablets, providing a platform for parents and teachers to interact and access information
- **Child-related SDG:** refers to specific Sustainable Development Goals (SDGs) that directly address the well-being, rights, and development of children around the world. The child-related SDGs encompass a range of goals and targets aimed at improving the lives of children and ensuring their healthy growth, protection, and access to education.
- **OpenCV (Open Source Computer Vision Library):** OpenCV is an open-source computer vision and machine learning software library. It provides tools and functions to help developers create applications that can understand and process visual information.
- **AdaBoost (Adaptive Boosting):** AdaBoost is a machine learning algorithm used for binary classification tasks. It combines multiple "weak" classifiers to create a strong classifier. It's particularly effective in improving the accuracy of models.
- **3D Pose:** In computer vision and graphics, 3D pose refers to determining the three-dimensional position and orientation of an object in space. This is often used in applications like object tracking and augmented reality.

- **Support Vector Machine (SVM):** A Support Vector Machine is a supervised machine learning algorithm used for classification and regression tasks. It finds a hyperplane that best separates data points into different classes while maximizing the margin between the classes.
- **Viola-Jones:** Viola-Jones is a face detection framework that combines Haar-like features with AdaBoost to efficiently detect objects, primarily used for face detection but also for other object detection tasks.
- **SMQT (Shape Matching with Quadratic Trees) features:** are a type of feature used in computer vision and image analysis for shape matching and recognition. These features are particularly useful for identifying objects or patterns within images, especially when dealing with complex or irregular shapes.
- **SNOW (Subwindow Non-maximum suppression Over Widths) Classifier:** is a specific algorithm used in object detection and recognition within the field of computer vision. It plays a crucial role in identifying objects or patterns within images by efficiently filtering out non-maximum responses and selecting the most suitable regions of interest.
- **DetEval Software:** DetEval is software used for the evaluation of object detection algorithms. It helps measure the performance of object detection models by providing metrics such as precision and recall.
- **Eigenfaces:** Eigenfaces are a set of eigenvectors used in facial recognition. They are derived from the covariance matrix of facial images and represent the principal components of variation in a set of faces.
- **Artificial Neural Networks (ANN):** Artificial Neural Networks are computational models inspired by the structure and function of the human brain. They consist of interconnected nodes (neurons) organized in layers and are used for various machine learning tasks, including pattern recognition and deep learning.
- **OCD (Obsessive-Compulsive-Disorder):** OCD is a mental health condition characterized by recurring, unwanted, and distressing obsessions (thoughts) and

compulsions (repetitive behaviors) that an individual feels compelled to perform. It can significantly affect a person's daily life.

- **GSM (Global System for Mobile Communications):** GSM is a standard for digital cellular communication used in mobile phones and other devices. It's a widely used technology for mobile communication worldwide.
- **RFID (Radio-Frequency Identification):** RFID is a technology that uses radio waves to identify and track objects, people, or animals. It consists of an RFID tag or chip and an RFID reader, which can read data from the tag without physical contact.
- **Tracked hand Necklace:** is a wearable device designed for children to help parents or guardians keep track of their child's whereabouts. These handy necklaces are equipped with GPS (Global Positioning System) technology, which allows for real-time tracking of the child's location

Abstract

Parents today are actively seeking modern, efficient solutions for nursery registration and payment processes. They desire the convenience of handling these administrative tasks online, simplifying account management. Furthermore, parents are eager to establish better communication channels with teachers and gain more comprehensive insights into their child's daily activities, all accessible through a mobile application. Safety is of paramount concern, prompting the demand for facial recognition technology to enhance security. This technology's ability to recognize children's faces and promptly notify parents about absences or departures brings a new level of assurance. In the context of nursery closures and licensing issues, with over 150 nurseries affected and more than 300,000 children impacted, the need for innovative solutions becomes even more critical. This is particularly significant in addressing the disparities in children's well-being, especially in low-income countries. This research delves into various facial recognition applications, underlining their pivotal role in bolstering security, streamlining tracking processes, and increasing overall efficiency across a range of scenarios and applications. The proposed application represents a step towards resolving these pressing challenges, offering a comprehensive solution that benefits both parents and nurseries, ultimately contributing to the well-being and safety of children.

1 Introductory Material

1.1 Acknowledgment

The team would like to express the sincerest, most humble, and deepest gratitude to our Advisor Dr. Omar Khattab for his constructive contributions and useful supervision and support over the whole project process and helping team members for presenting a complete plan to implement the proposed project and finish it on time to the fullest. The project team would like to thank the Kuwait College of Science and Technology KCST for supporting the student experience in this project and for the efforts to provide an academic environment that helps engineering development.

1.2 Problem Statement

The current manual registration process at nurseries is inconvenient for parents, who would prefer an easier way to register and pay for their children's childcare services. This inconvenience often requires parents to take time off work to visit the nursery in person for payments and registration.

Many nurseries have been closed due to their licensing and lack of awareness of the importance of the child and maintaining his behavior, as well as tracking his movement and continuous communication with the child's parents. The number of nurseries that have been closed may reach more than 150 nurseries, and this will greatly affect the children, whose number is more than 300 thousand children [1].

today, a child born in a low-income country is seven times more likely to live in a country where child-related SDGs require acceleration than a child born in a high-income country. An estimated 150 million children – 6 percent of the child population – live in 11 countries where 50 percent of child-related targets have been met – which is, in fact, the highest level of achievement globally [2].

To address these challenges, there is a need for an electronic payment system that allows parents to pay bills online rather than in cash at the nursery's physical location. Additionally, there is a desire for a comprehensive management system that can efficiently handle employee and child accounts.

In addition to administrative features, the proposed solution aims to improve communication and transparency between parents and teachers. Parents want to be more informed about their children's activities and daily responsibilities, and they prefer to have a direct channel for communication with teachers through a mobile application.

Safety concerns for children have also arisen due to increasing incidents of crimes, accidents, and child abductions. To alleviate these fears, the proposed application includes a feature that utilizes cameras in the nursery to recognize children's faces. If a child is not present or leaves the premises, parents will receive a notification to take immediate action to locate their child.

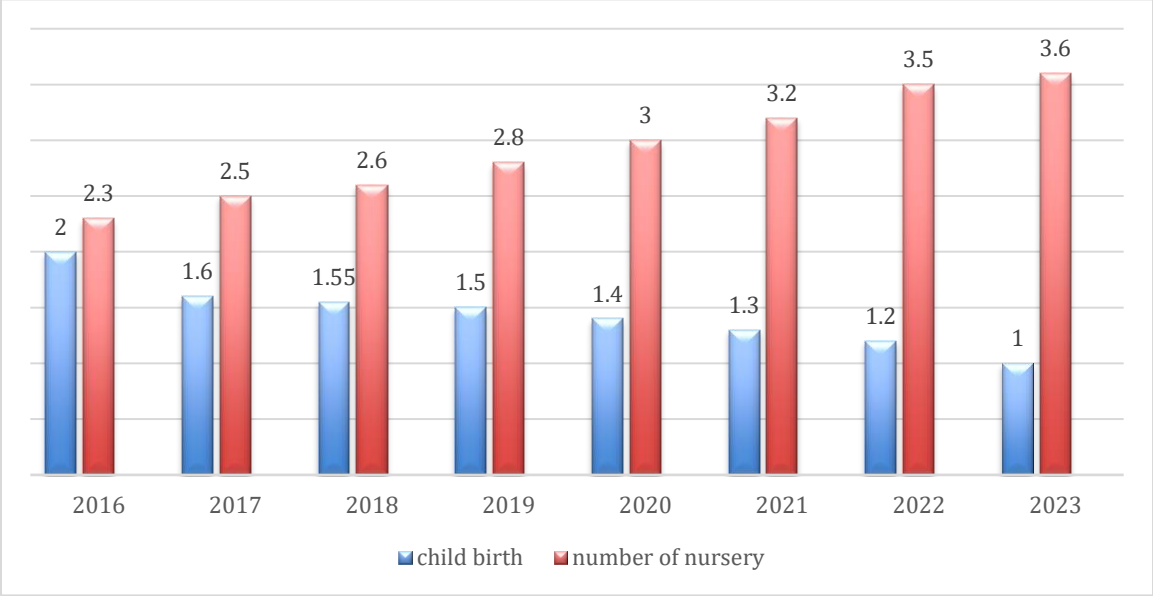


Figure 1: Statistics between the births of children and the number of nurseries in Kuwait over recent years

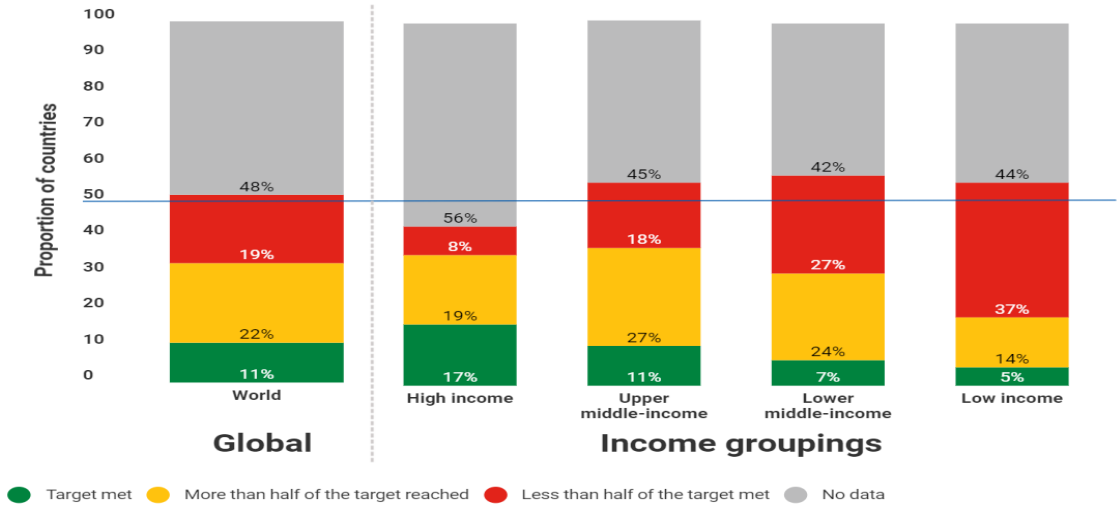


Figure 2: Status of the 48 child-related SDG targets by country income groupings [2]

1.3 Operating Environment

The system aims to know all the information about the child in the nursery and also to register the child in the nursery, especially the child's safety to a great extent through the camera in the nursery, as there are many fears about the child on the part of the parents.

The system hardware will be able to perform all system functions under these conditions:

- The mobile will be used to create the application and connect the camera to the application
- The camera will be in a place suitable for the surrounding conditions in terms of humidity and temperature, as it does not reach 50 degrees Celsius.
- The camera will withstand all shocks, vibrations, and rain during winter and other seasons.

1.4 Intended Users and Intended Uses

Intended users:

The proposed system helps users save time and provide peace of mind to users' children and users, such as:

- Parents of children in the nursery.
- Teachers and professors in the nursery.

Intended uses:

The proposed system will be used for the following uses:

- Saving time for both children's guardians and teachers working in the nursery in terms of registering a new child, financial transactions, and knowing the child's behavior.
- Monitor the children through the camera and inform the parents as soon as they leave the nursery.

1.5 Assumptions and Limitations

Assumptions:

The proposed system will be implemented with the following assumptions, and the following assumptions must be considered when operating the system:

- Technology and design assumptions:
  - The camera can monitor all the faces of children at the same time without any obstacles.
  - There must be all pictures of children in the system.
- Material assumption for supplies:
  - Implementing the camera and linking it to the application will be a prototype and can be developed.
- Security and privacy assumptions:
  - The camera will be in a safe place so that it will not be stolen.
- General assumptions:
  - The user must register all of the child's data in the system.
  - The nursery must register all teachers and their phone numbers so that parents can be reached with them.
  - Parents must know when their children leave nursery.
  - A promotional offer will be presented to parents when the child leaves the place where the camera is, and how to send a notification to parents that their child has left.

Limitations:

- Technology and design limitations:
  - The proposed system will contain one camera in one place where all children gather to monitor them all.
- Constraints on supplies and materials:
  - The parent will have to add one recent photo of the child upon registration so that the system can easily compare the child's face that it monitors through the camera with this photo.

1.6 Expected End Product and Other Deliverables

The project's expected deliverables will be divided into four main prototypes. The first is project plan documentation including camera project planning that for face recognition, the proposed system approach, as well as previous work and research, and the project timeline. The second prototype of the planned components will be purchased from System and hardware evaluation. The third prototype is the design of the software approach. Finally, the project's final product that connects the hardware to the software is delivered and tested several times for the fourth prototype.

The expected deliverables of the project will be split into four major prototypes as follows:

1. Prototype (1) – from October until December.
   - The project team will prepare the project plan document that will be delivered at the end of the first semester.
2. Prototype (2) – from February until March.
   - The project team will purchase the required components and assemble the hardware components and software models.
3. Prototype (3) – from March until April.
   - The project team will be designing the system software and implementing the hardware.
   - Finishing the final prototype
   - Testing the entire system to ensure that it provides all the planned functional and non-functional requirements.
4. Prototype (4) – from April until May.
   - The final prototype will be delivered as the end product at the end of the second semester. A software manual and hardware manual will be delivered with the final product.

2 Proposed Approach and Statement of Work

2.1 Objective of the Task

The proposed solution seeks to enhance communication and transparency between parents and teachers while providing child monitoring through cameras. Currently, the manual registration process at nurseries inconveniences parents who prefer a more straightforward method for enrolling and paying for childcare services, as it often necessitates in-person visits during work hours.

Parents also desire better awareness of their children's activities and responsibilities and prefer direct communication via a mobile app with teachers. Safety concerns for children have become a significant issue, prompting the proposed application to incorporate facial recognition technology using nursery cameras. Parents receive immediate notifications if a child is absent or leaves the premises, enabling them to take prompt action to ensure their child's safety. Overall, the solution aims to improve the nursery experience for both parents and children by addressing these challenges and safety concerns.

2.2 Functional Requirements

The Nursery System will provide the functional requirements listed below:

- FReq-1: Parents and teachers should be able to create and manage their accounts.
- FReq-2: User roles (Parent, Teacher) must be defined with specific permissions.
- FReq-3: Parents should be able to register their children and maintain their personal files.
- FReq-4: Child information may include name, age, medical details, and allergies.
- FReq-5: Parents should have the option to pay nursery fees electronically.
- FReq-6: Payment records should be kept for tracking purposes.
- FReq-7: Parents and teachers should have a direct channel for communication within the mobile app.
- FReq-8: Messages, advertisements, and notifications should be supported.
- FReq-9: The app should allow parents to view their children's daily activities and responsibilities.
- FReq-10: Teachers can update and record activities and share progress.

FReq-11: Facial recognition technology should recognize children and record their movements.

FReq-12: Parents should receive real-time notifications if their child is absent or leaves the nursery building.

FReq-13: Alerts must include the child's location, time, and relevant details.

FReq-14: Ensure that the application is easy to use and accessible to all users, including people with disabilities.

2.3 Constraints Considerations (non-functional requirements)

The proposed system planned to provide some non-functional requirements as follows:

Availability:

NFReq-1: The system must be available 24/7 to ensure that parents and teachers can access it when needed.

NFReq-2: Downtime for maintenance and upgrades should be minimized.

Reliability:

NFReq-3: The system must operate reliably without frequent malfunctions or disturbances.

NFReq-4: Implement redundancy and failover mechanisms to ensure continuous service.

Accuracy:

NFReq-5: The facial recognition system must provide high accuracy in recognizing children.

NFReq-6: Make sure notifications are accurate and only turn on when necessary.

Maintainability:

NFReq-7: Develop the system with maintainability in mind, allowing updates and bug fixes to be made easily.

NFReq-8: Ensure there is a clear and well-documented database for future maintenance.

Scalability:

NFReq-9: The system should be designed to accommodate the increasing number of users and children.

NFReq-10: Scalability should not affect system performance

Usability:

NFReq-11: Design a user-friendly interface that is easy for parents and teachers to navigate.

NFReq-12: Conduct user testing to collect feedback and make usability improvements.

Capacity:

NFReq-13: Evaluate the system's ability to handle a large number of users, children, and concurrent requests.

NFReq-14: Plan to increase capacity as your user base grows.

Engineering Standard

Table 1: engineering standard table

Element	Engineering Standard	Description
WiFi Module	IEEE 802.11ax	It is the newest and most advanced version of Wi-Fi. Operates on both 2.4 GHz and 5 GHz for better coverage as well as better speed. User will get 10 Gbps of maximum speed around 30-40 % improvement over 802.11ac
Programming Language (Python)	ISO/IEC WD TR24772	Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built-in data structures, combined with dynamic typing and dynamic binding, make it very attractive for rapid application development.
Camera	ISO 12233	a common standard for measuring the resolution and sharpness of digital cameras and using cameras for face detection

2.4 Previous Work and Literature

We discuss in this section, in brief, the previous work and literature survey over 29 papers:

In [3], The proposed school bus system prioritizes student safety through facial recognition and real-time monitoring. It employs a face recognition model and GPS tracking to identify students, count passengers, and track routes, schedules, and locations. Parents receive SMS notifications with detailed information when their child boards or exits the bus. This system ensures parents have real-time updates on their child's whereabouts and promotes adherence to route schedules, enhancing overall student safety during school bus travel.

In [4], This paper presents an innovative IoT-based system focused on child safety and health monitoring. It employs sensor-embedded devices to ensure children's well-being, especially during emergencies. Despite technological advancements, the adoption of such systems remains limited, raising concerns for child safety. The proposed IoT system addresses these concerns by continuously monitoring children's health parameters and tracking their location. It offers a comprehensive solution for smart child tracking and monitoring, aiming to alleviate worries for both schools and parents regarding children's safety in various environments.

In [5], The article focuses on developing a toddler tracking system to improve child safety, addressing challenges parents face due to toddlers' natural curiosity and potential hazards at home. The system utilizes deep neural networks, including FaceNet for face recognition and YOLOv3 for object tracking, in scenarios involving toddlers aged 1.5 to 4 years. It identifies the target toddler's face and tracks their movements, sending warnings if the child approaches dangerous objects. Experimental studies show a significant accuracy improvement from 80.7% to 93.3%, highlighting the potential of deep learning and object tracking in enhancing child safety.

In [6], The rapid growth of image and video data has created a need for automated analysis, particularly in face recognition. This technology converts facial features into a face print stored in a database for identity verification, often using deep learning systems. Facial recognition plays a crucial role in security, surveillance, and applications like online proctoring and airline passenger identification. Image quality is a key concern in existing algorithms, and this study addresses it using OpenCV and Face Recognition libraries in Python. The research presents a method for facial recognition, its implementation, and its various applications.

In [7], This paper introduces a rapid face detection framework with three key contributions. First, it utilizes an efficient image representation called the "Integral

Image" for quick feature computation. Second, it employs a simple and effective classifier using AdaBoost to select crucial visual features. Third, it combines classifiers in a cascade to discard non-relevant regions swiftly. The system achieves face detection performance comparable to previous top systems and operates at 15 frames per second on a standard desktop.

In [8], This paper presents a face detection algorithm designed for color images, addressing challenges like varying lighting and complex backgrounds. It employs a unique lighting compensation method and nonlinear color transformation to detect skin regions throughout the image, forming potential face candidates based on their spatial arrangement. The algorithm then constructs maps for eyes, mouth, and boundaries to verify these candidates. Experimental results showcase the algorithm's success in detecting faces under diverse conditions, including variations in color, position, scale, orientation, 3D pose, and expression, across indoor and outdoor photo collections.

In [9], This paper presents a trainable system for detecting frontal and near-frontal faces in grayscale images using a two-level hierarchy of Support Vector Machine (SVM) classifiers. Component classifiers at the first level independently detect facial components, while a second-level classifier assesses the geometrical configuration of these components against a face model. The system automatically learns components using 3-D head models, eliminating the need for manual interaction. Experimental results demonstrate the system's robustness against depth rotations, outperforming whole-face pattern-trained systems in this regard.

In [10], This paper addresses the challenge of generic and robust human face detection, essential for applications like face, expression, and gesture recognition. The proposed feature-based algorithm emphasizes the importance of leveraging a substantial amount of image evidence while incorporating model knowledge through a probabilistic framework. The algorithm identifies feature points using spatial filters, groups them into potential face candidates based on geometric and gray-level criteria, and employs

a probabilistic framework to assess the likelihood of a candidate being a face. Results demonstrate the algorithm's effectiveness in detecting faces across varying scales, orientations, and viewpoints.

In [11], This paper addresses the growing need for automatic data understanding in the face of massive image and video databases, particularly focusing on the challenging task of face detection. Face detection is crucial for applications like face recognition and analysis. The paper discusses and analyzes various face detection algorithms, including Viola-Jones, SMQT features & SNOW Classifier, Neural Network-Based Face Detection, and Support Vector Machine-Based face detection. Evaluation metrics such as precision and recall are used to compare these methods, with DetEval Software ensuring precise bounding box calculations for accurate results.

In [12], This paper obtains the challenging problem of automatic human face detection, particularly in images with simple backgrounds. The proposed method relies on shape information and is highly efficient for such scenarios. It begins with histogram equalization and multiple-scale filter-based edge detection, followed by edge linking using an energy function. The final step extracts the face contour using direction information from the linked edges. Experimental results validate the method's effectiveness in face detection.

In [13], Abstract-Authentication & Identification has become a major issue in today’s digital world. Face detection plays a significant role in authentication & identification. In this paper, several existing face detection approaches are analyzed and discussed. Each approach is discussed briefly & compared with the other in terms of key evaluation parameters. As face detection is an elementary yet important step towards automatic face recognition, the main goal of this paper is to come up with an approach that is a good candidate for face detection. Keywords: Face Detection, Skin Color Modeling, Haar-like Feature, Principle Component Analysis.

In [14], This paper aims to develop a theoretical model and terminology for understanding how we recognize familiar faces and their relationship with other aspects of face processing. It identifies seven types of information derived from seen faces, including pictorial, structural, semantic, identity-specific, name, expression, and facial speech codes. A functional model is proposed where structural encoding processes generate descriptions for facial speech, expression, and face recognition. Recognizing familiar faces involves matching structural codes with stored ones in face recognition units, followed by accessing identity-specific and name codes. The cognitive system actively assesses the match for true recognition or mere resemblance, influenced by various factors.

In [15], This paper aims to the challenging problem of face recognition in image analysis and computer vision, particularly in the context of security systems. It emphasizes the need for robust systems that can identify or verify individuals from digital images regardless of various factors like lighting, expression, aging, transformations, and pose. The paper discusses common methods for face recognition, including holistic matching, feature extraction, and hybrid approaches. It also highlights real-world applications and provides examples. The final section outlines future research directions in the field of face recognition.

In [16], Face recognition is gaining significant attention in network multimedia information access, benefiting areas like network security, content indexing, video retrieval, and compression. It enhances security by using face recognition for network access control, making it difficult for hackers to steal passwords. Additionally, it improves user-friendliness in human-computer interaction. The technology enables video data indexing and retrieval based on specific individuals, aiding professionals like news reporters, political scientists, and moviegoers. Face recognition also enhances videophone and teleconferencing applications, offering more efficient coding schemes. The paper provides an introductory overview of this information processing

technology, including its generic framework and commonly encountered variants and algorithms like eigenfaces and neural networks.

In [17], This study investigates the impact of movement on face recognition under non-optimal conditions. Participants were tasked with identifying famous and unfamiliar faces presented as either moving or still video clips. The faces were shown in negative, degrading recognition performance while preserving two-dimensional face shapes and features. The results revealed that moving faces were significantly better recognized than still faces, suggesting that movement provides information about the three-dimensional face structure and characteristic gestures. However, when faces were inverted, the movement had no significant effect, indicating challenges in recognizing changing configurations and gestures in upside-down faces.

In [18], This paper presents a novel method for face recognition using sets of images for both training and testing. Recognition decisions are based on comparing image sets, and the approach involves two key components: representing images as points in a linear or affine feature space and characterizing each image set by a convex geometric region (affine or convex hull) formed by its feature points. Set dissimilarity is measured by geometric distances between convex models, with robust methods used to discard outliers. The kernel trick extends the approach to handle complex and nonlinear manifolds of face images. Experiments on public face datasets demonstrate superior performance compared to existing methods.

In [19], The paper introduces a near-real-time face recognition system that tracks a subject's head and identifies them by comparing facial characteristics to known individuals. It treats face recognition as a two-dimensional problem, capitalizing on the upright orientation of faces, which allows representation using a small set of 2-D characteristic views. Face images are projected into a "face space" defined by "eigenfaces," which are eigenvectors of known face images, not specific facial features.

This framework offers unsupervised learning capabilities for recognizing new faces efficiently.

In [20], This paper addresses the challenging problem of face recognition, considering real data, captured images, sensor images, and database images, while dealing with variations in face appearances, illumination effects, and complex backgrounds. The focus is on the use of artificial neural networks (ANN) in image processing and pattern recognition for face recognition. The paper discusses various ANN-based methods and algorithms used in this field, emphasizing their effectiveness compared to other approaches. It provides a comprehensive review of face detection studies and systems based on different ANN approaches, highlighting their strengths, limitations, and performance analyses.

In [21], This survey delves into the realm of face recognition from video sources, driven by its significance in law enforcement and commercial applications. It highlights the unique properties of videos that enable accurate recognition under challenging conditions. The survey categorizes and reviews recent methods designed to tackle the complexities of unconstrained settings, drawing parallels between human and algorithmic face recognition. It also provides insights into popular and challenging face video databases. Ultimately, the survey identifies key research challenges and opportunities that lie ahead in this field.

In [22], This paper presents a groundbreaking long-term object-tracking algorithm tailored for event cameras. It utilizes a discriminative object representation with online learning and excels at detecting and re-tracking objects upon reentry into the camera's field of view. The novel event-based local sliding window technique is a standout feature, offering robust performance even in cluttered backgrounds. Bayesian bootstrapping enhances real-time processing and improves the object representation's discrimination capabilities. Extensive experiments on a public event camera dataset showcase the algorithm's effectiveness in tracking and detecting various object shapes

and sizes, outperforming previous methods, particularly in challenging background scenarios and object reentry situations.

In [23], This paper addresses the challenge of early diagnosis and monitoring of mental illnesses like autism and OCD in young children by automating behavioral monitoring. The proposed system leverages computer vision and non-invasive sensors, including cameras and depth sensors, to track and analyze children's activities in their natural environment. The system offers robust tracking algorithms to monitor children's behavior continuously. Experiments conducted in a laboratory school validate the effectiveness of this approach, showcasing its potential for assisting clinicians in early diagnosis and monitoring of behavioral abnormalities in at-risk children.

In [24], This research addresses the safety concern of students traveling to and from school by proposing a system that combines RFID technology with GSM for tracking and monitoring children on school buses. Passive RFID tracking is chosen for its tracking capabilities and cost-effectiveness. However, this system may suffer from negligence. To enhance safety, the proposed system integrates face recognition technology with GSM, providing an efficient means of identifying children, ensuring their safety during the journey, and simplifying system maintenance.

In [25], An application for tracking and detecting faces in videos and cameras can be used for multipurpose activities. The intention of the paper is a deep study of face detection using an open CV. A tabular comparison is performed to understand the algorithms more easily. It talks about various algorithms like Adaboost, and Haar cascades. This paper aims to help in understanding the best prerequisites for face detection.

In [26], This paper provides a comprehensive review of face detection methods and algorithms, with a focus on Haar cascade, Adaboost, and template matching. It discusses their application in the field of face detection. The methodology for real-time

face detection using Haar-like classifiers and Adaboost on the OpenCV platform is presented, emphasizing its robustness and efficiency in a real-world environment. This work contributes to advancing face detection technology and its practical applications.

In [27], The paper introduces a smart baby monitoring system based on IoT and machine learning to address the challenges faced by working parents in monitoring their infants. The system monitors room temperature, humidity, cry detection, and facial emotions through various sensors and transfers data to a server. Parents can access real-time data and control the baby's cradle remotely via a mobile app. The system sends notifications to parents if any abnormal actions are detected, providing efficient baby monitoring and peace of mind for working parents.

In [28], The project addresses the safety concerns related to the transportation of school children by developing a bus safety system. This system utilizes RFID and GSM technologies to efficiently control the entry and exit of students from school buses. It ensures that all students are tracked during boarding and disembarking without requiring any additional actions from students or drivers. The system also sends SMS notifications to the management to inform them about the bus's departure and arrival, enhancing the safety and monitoring of school bus journeys. The implementation and testing of the system, which combines RFID, GPS, GSM, and microcontroller technologies, are presented in the paper.

In [29], The proposed advanced national tracking system is inspired by the Indian Government's National Tracking System, aiming to generalize its capabilities for the public. It employs a robust face recognition algorithm, the Eigen face algorithm, for enhanced accuracy. Users can simply upload a photo of a missing person to the server, which then utilizes face recognition algorithms to find potential matches. The system streamlines the process of assisting in locating missing individuals and can be a valuable tool for law enforcement for further verification. Its primary objective is to

provide a user-friendly way for the public to contribute to finding missing people efficiently.

In [30], The paper discusses the importance of automated learning analytics in education and its potential in monitoring the learning process and providing feedback to teachers. It highlights the use of visual sensors and computer vision for monitoring student behavior and affective states, such as interest and attention, based on facial expressions and visual cues. The proposed methodology leverages webcams to collect behavioral data from students attending traditional or virtual lectures. It aims to build machine learning models for predicting individual student attention states by analyzing observable behaviors. This automated feedback system benefits both teachers and students by improving teaching methods, curriculum design, and individual engagement levels.

2.5 Proposed Design and Solution Approach

The proposed application aims to enhance the nursery management experience for parents and staff by providing a range of convenient features. Users can easily create profiles for parents and staff members, streamlining administrative tasks. Parents benefit from a seamless online payment system, simplifying financial transactions. Each parent's profile is associated with their children, allowing for efficient management of family accounts. Notifications play a pivotal role, as the app facilitates communication by sending updates and alerts to both parents and staff, ensuring everyone stays informed about important functions and activities. The app also offers the convenience of online child registration. To bolster child safety, a camera within the school employs facial recognition technology to monitor the children. In the event a child leaves the designated area, automatic notifications are sent to their parents, enabling prompt action to locate the child and ensure their safety. This comprehensive solution aims to address the needs and concerns of parents and nursery staff while promoting a secure and efficient nursery management process.

We listed our findings in the following Table 2: Proposed system in comparison of the previous work, in terms of the used technologies compared to our proposed system.

Table 2: Proposed system in comparison of the previous work

Surveyed Projects	Year	PCB board	ANN	OpenCV	GSM	RFID	Raspberry PI	Coding	Camera	GPS	IOT	Database	Xml files	SCM	Mobile App
[3]	2017									■					■
[4]	2021	■								■	■				
[5]	2021								■	■	■	■			
[6]	2021			■					■						■
[7]	2004								■			■			
[8]	2002								■			■			
[9]	2001								■			■			
[10]	1996							■	■						
[11]	2017								■				■		
[12]	2000								■			■			
[13]	2014								■			■		■	
[14]	1986							■							
[15]	2013								■			■			
[16]	2000								■						
[17]	1997							■	■						
[18]	2011								■			■			
[19]	1991							■	■			■			
[20]	2016		■					■				■			
[21]	2012							■	■			■			
[22]	2018							■	■						
[23]	2012								■			■			
[24]	2016				■	■			■						
[25]	2017			■				■	■			■			
[26]	2014			■					■						
[27]	2023						■		■		■	■			■
[28]	2019				■	■			■	■	■				■
[29]	2014											■			■
[30]	2021		■	■				■	■						
Nursery System	2023/ 2024							■	■			■			■

We conclude from the previous table that the number of surveyed research and the year of publishing the research corresponding to the year each one was published in as shown in Figure 3 as a statistical representation.

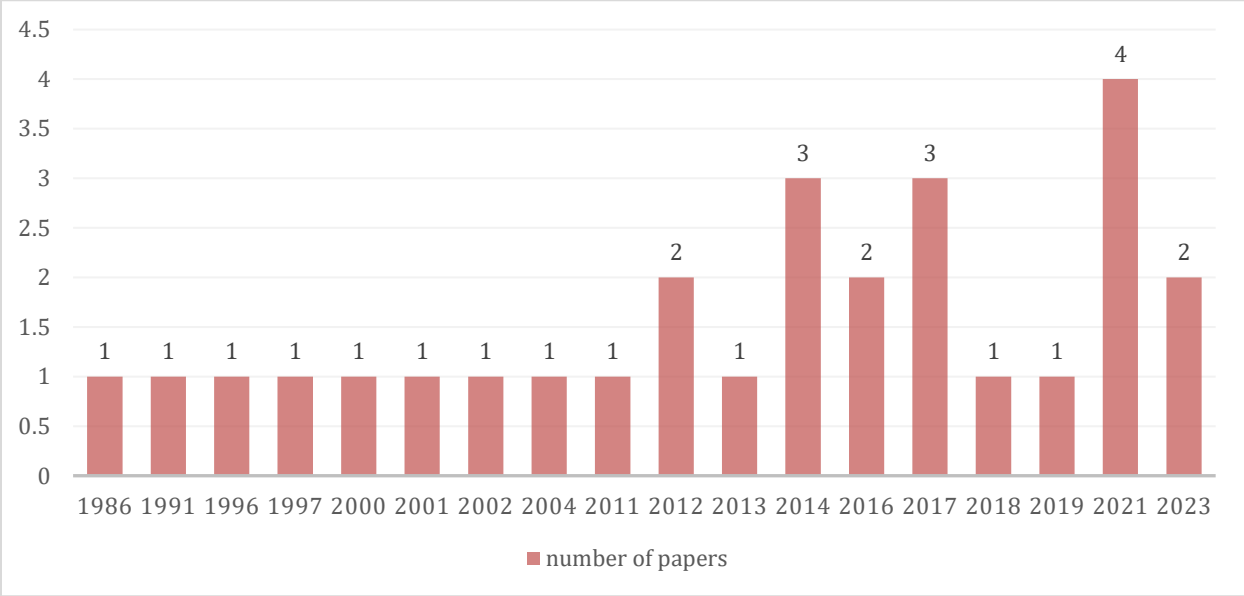


Figure 3: Number of papers published in each year

Based on the equipment used in nursery system surveyed research papers we classify the surveyed papers using each technology as shown the following chart, Figure 4

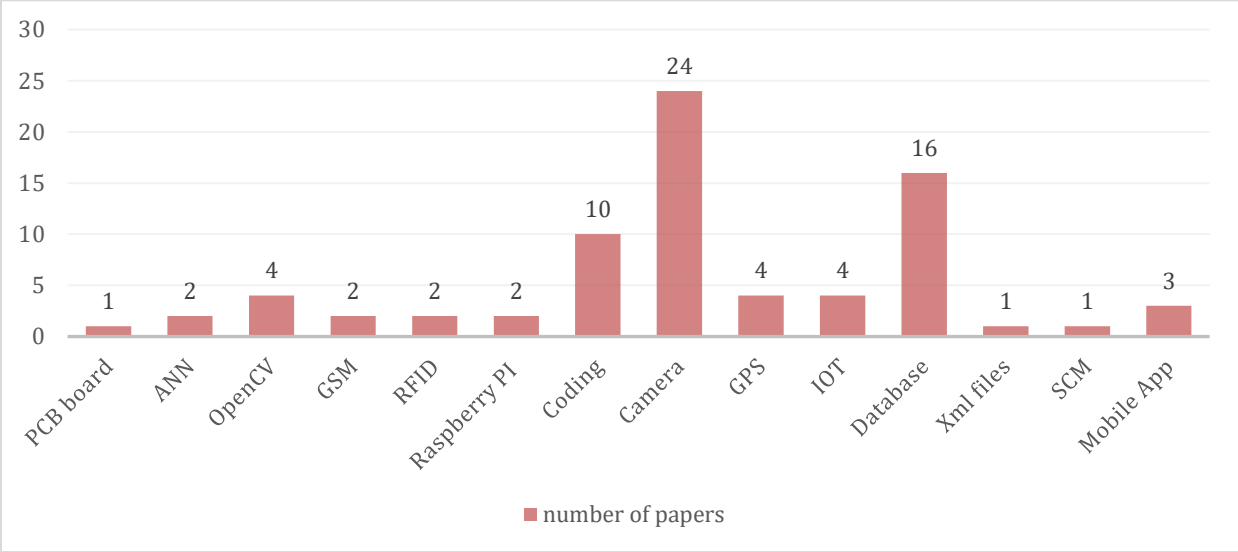


Figure 4:Used technologies in each surveyed paper

We will discuss two phases for the solution approach. The first stage is called the solution and includes the main solutions. Each one describes in detail how each scenario achieves the desired purposes of the proposed system. The solution uses the mobile phone to enter the children and their photos through the parents, and then the father can pay all the nursery expenses and can chat with the teachers. On the other hand, we use the camera to take all the pictures of the children in the nursery, and if one of them leaves, you can send a notification to the father through the computer device linked to the camera, as it is linked to the private data boxes. By system. The second stage is called system design and mobile application interface for our proposed system.

Phase one: Solution

a. Main Solution

The parent can register in app with fill all data or login if have account and then show all its features as shown in figure 5

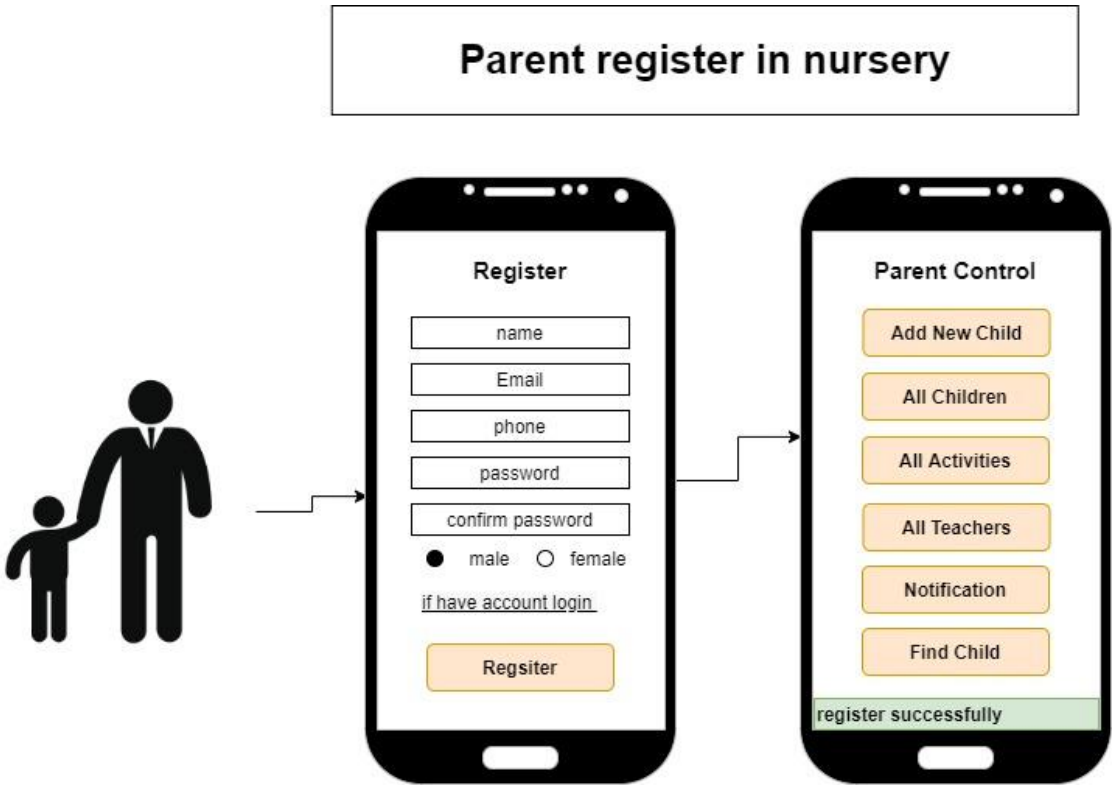


Figure 5: Parent Register in app

The parent can add new kids in app with add all details such as name, age and must upload photos and after add kids, we show all added child in app as shown in figure 6

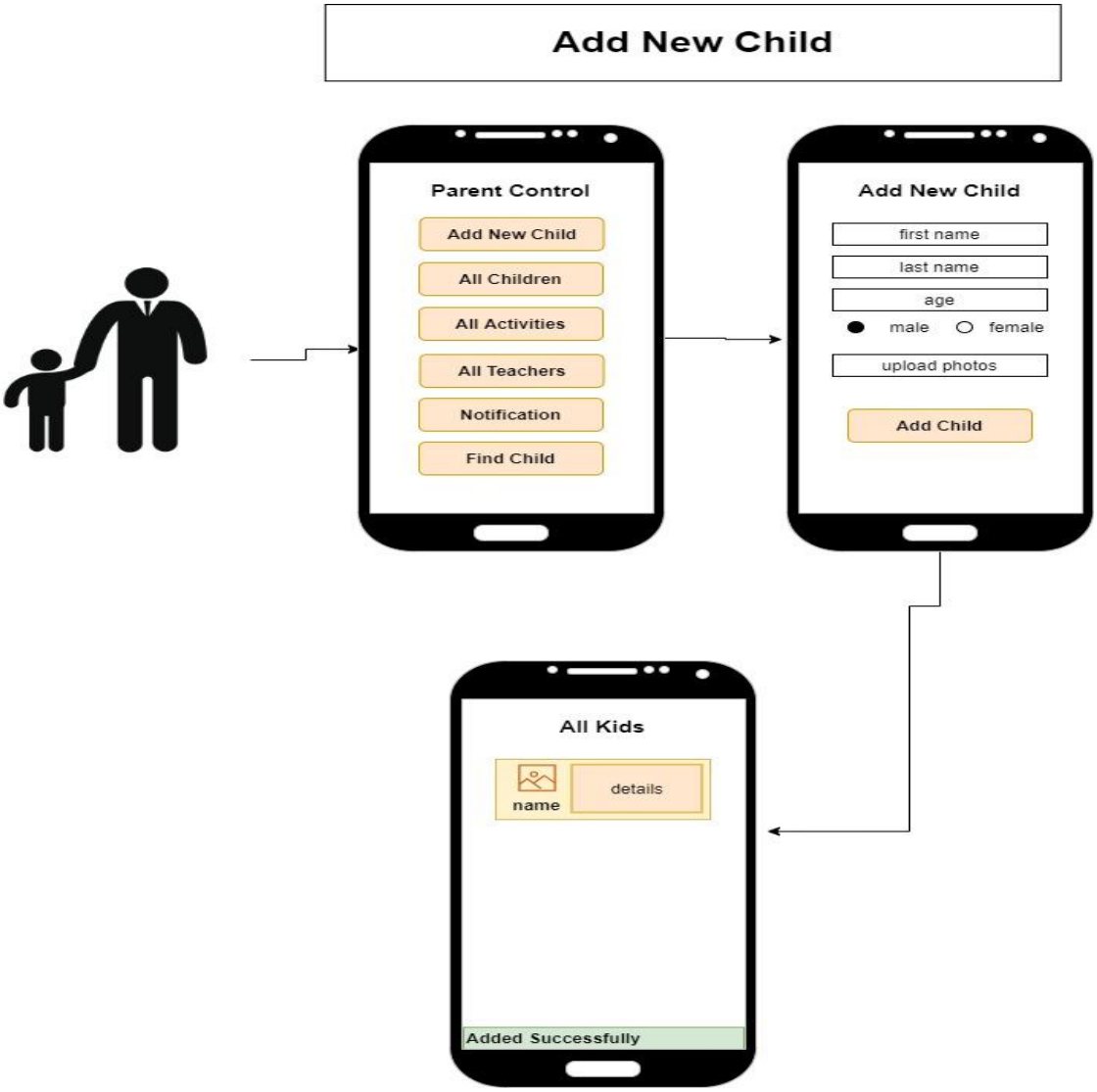


Figure 6: Add New Child

The teacher can add tracked hand necklace with fill all data such as serial number for necklace and details and then choose child by search about child and final can show all kids and can find them in app as shown in figure 7

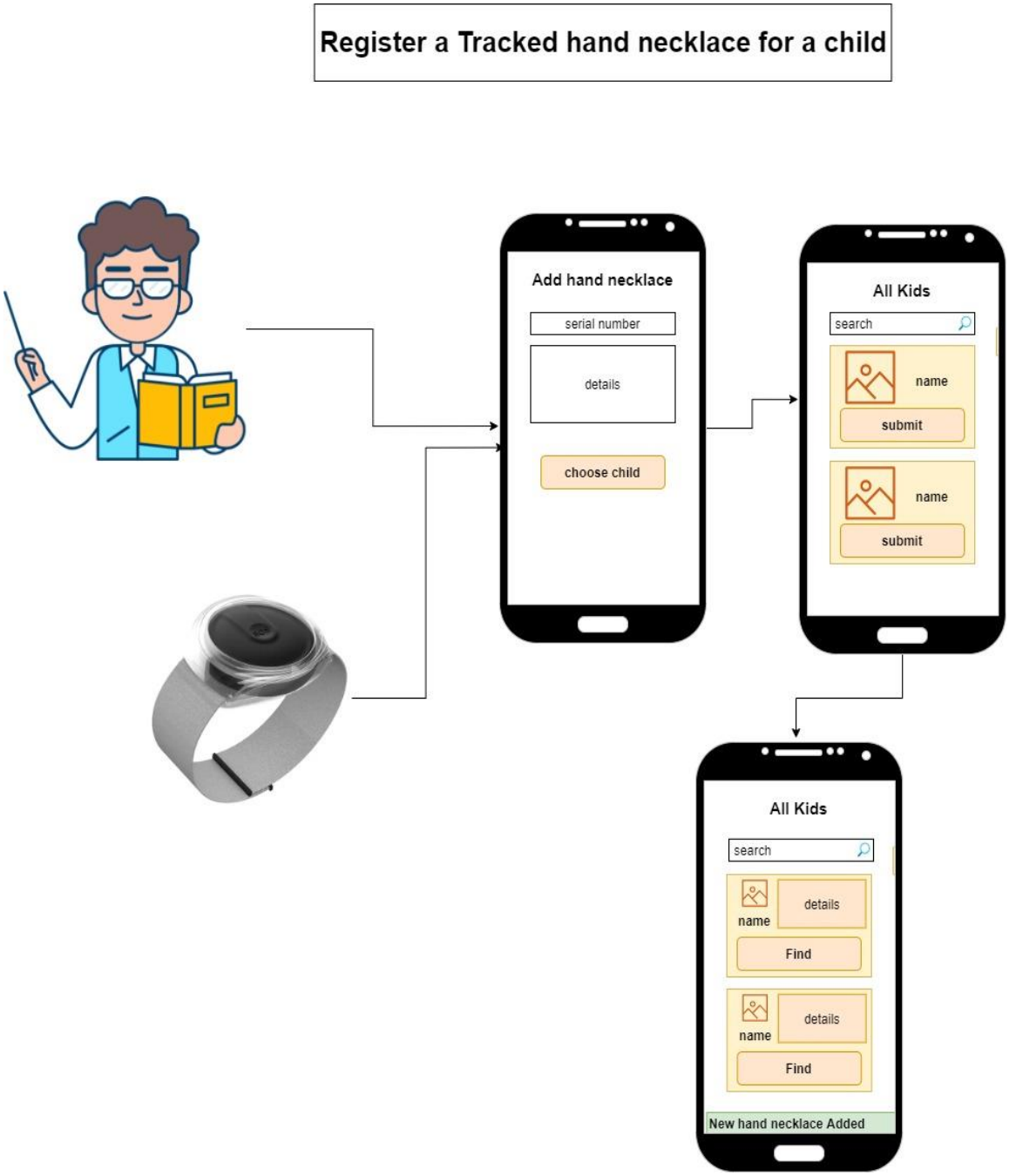


Figure 7: Register a Tracked hand necklace for child

The parent after login or registering show all the features and then can click on the find kids feature to find the child and choose any child that need to find and then system can retrieve the serial number for the child's necklace from the database and then get its location by GPS and finally send location to the app and show in screen for parent as shown in figure 8

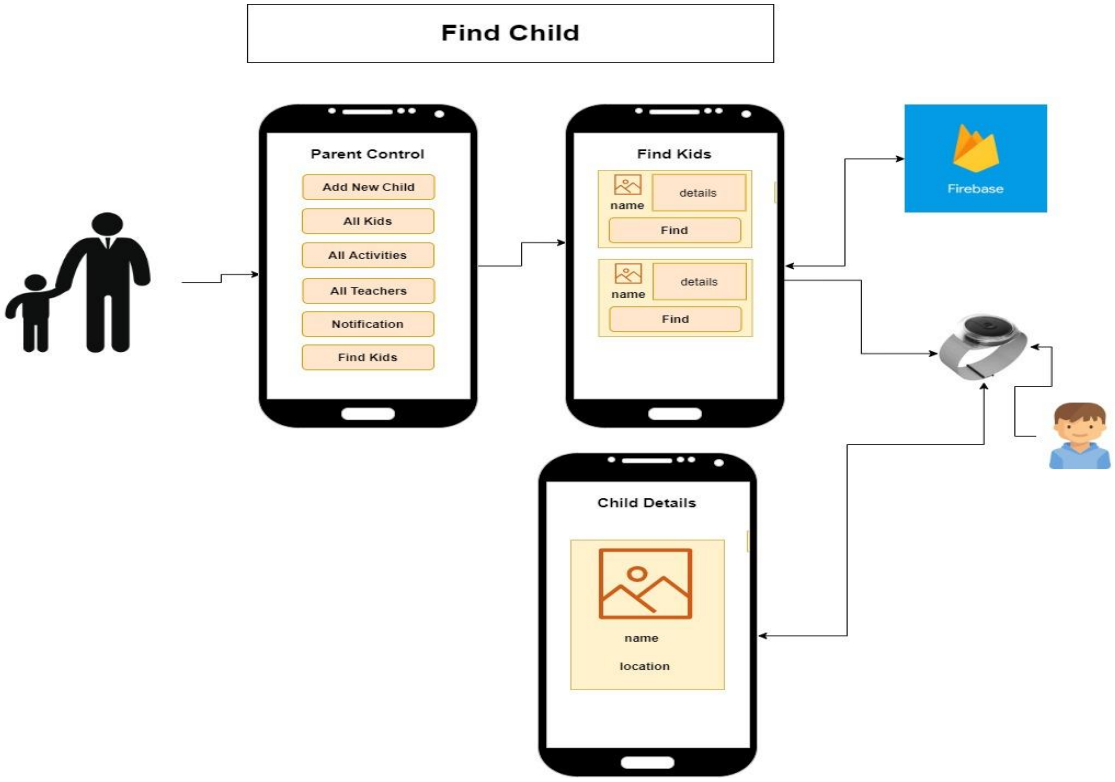


Figure 8: Find Child

Components of the solution:

The hardware components of the proposed system will be implemented in a prototype for experimental purposes and test analysis. Our project will use the following components:

- Tracked Hand Necklace for child
- Wi-Fi module
- Mobile Phone
- Firebase Database

b. Alternative Solution

The parent can add new kids in app with add all details such as name, age and must upload photos for using later in detect child face and after add kids, we show congratulation message for added child in app as shown in figure 9.

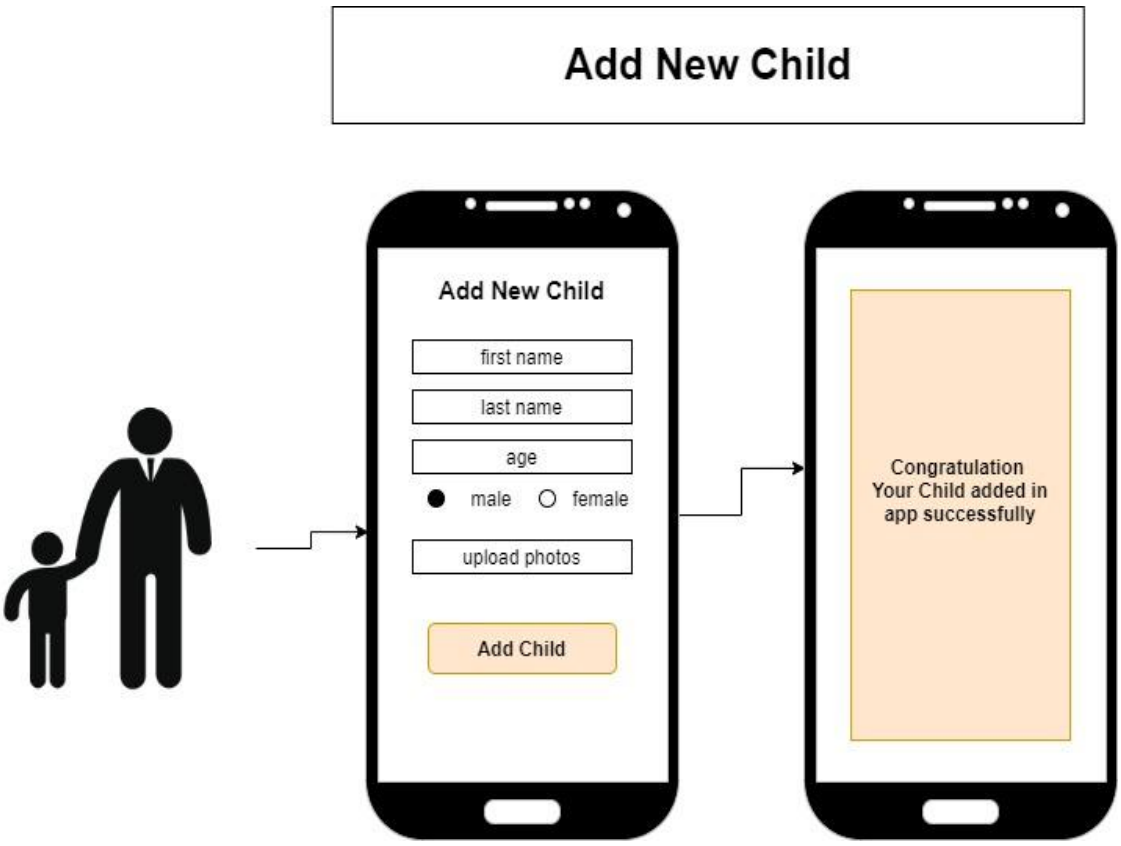


Figure 9: Add new Kid in app

The parent can chat with teachers for asking about his child and all details about child behavior and homework as shown in figure 10

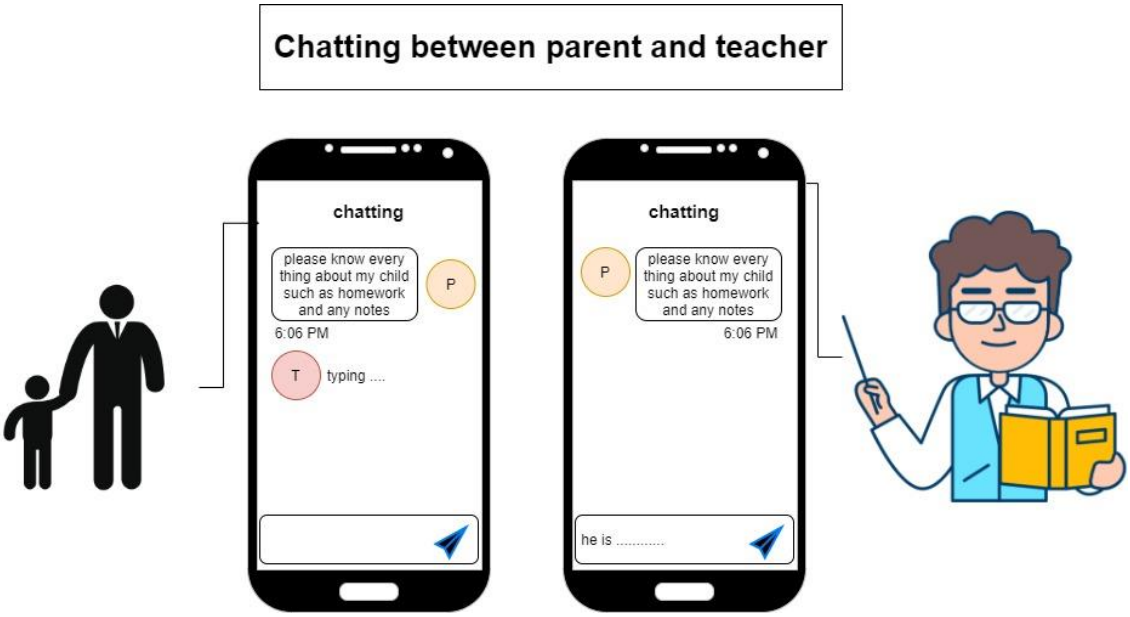


Figure 10: chatting between parent and teacher

The teacher can add all activities and then show all activities with show message for adding activity successfully as shown in figure 11

Figure 11: teacher add activity

The camera detects that the child has left, then the child is identified through the computer and a notification is sent to the child's father on the mobile phone as shown in figure 12

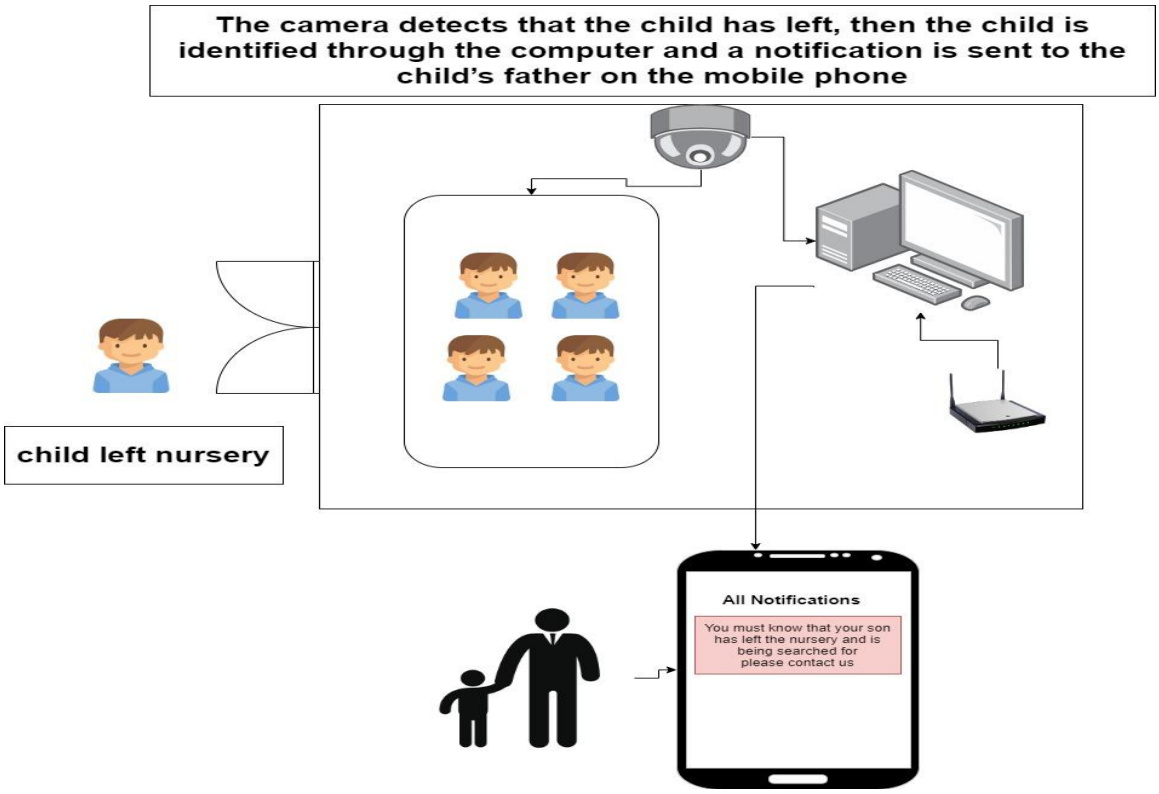


Figure 12: Camera Detect left Child

Components of the solution:

The hardware components of the proposed system will be implemented in a prototype for experimental purposes and test analysis. These components will include communication modules responsible for communication between the camera, computer, cloud server as well as the mobile application. Our project will use the following components:

- Camera
- Wi-Fi module
- Mobile Phone
- Computer
- Database

Components description

The following list describes the required components to implement the proposed project design:

1. Mobile Phone is shown in figure 13 that used for adding all details about parent and children and chatting between parent and teachers and etc.

Figure 13: Mobile phone

2. Camera is shown in figure 14 that used for detect face of child.

Figure 14: Camera

3. Computer is shown in figure 15 that used for send notification to app if camera detect child left nursery.

Figure 15: Computer

4. Wifi-module is shown in figure 16 that connected with computer for connecting to internet and access on database and allow computer send notification to parent mobile.

Figure 16: Wifi-module

Phase two: System design

A. Mobile Application

Users can navigate to the mobile application of our proposed system

1. Parent can login in app or register if not have account as shown in figure 17

Figure 17: Login screen

2. Parent can register in app with fill all data or login if have account as shown in figure 18.

Figure 18: Register Screen

3. Parent can manage profile in app with change personal data or upload new image as shown in figure 19.

Figure 19: Manage profile screen

4. Parent can change password as shown in figure 20.

Figure 20: Change password screen

5. Teacher can show all kids as shown in figure 21.

Figure 21: show all kid's screen

Use case diagram for our proposed system:

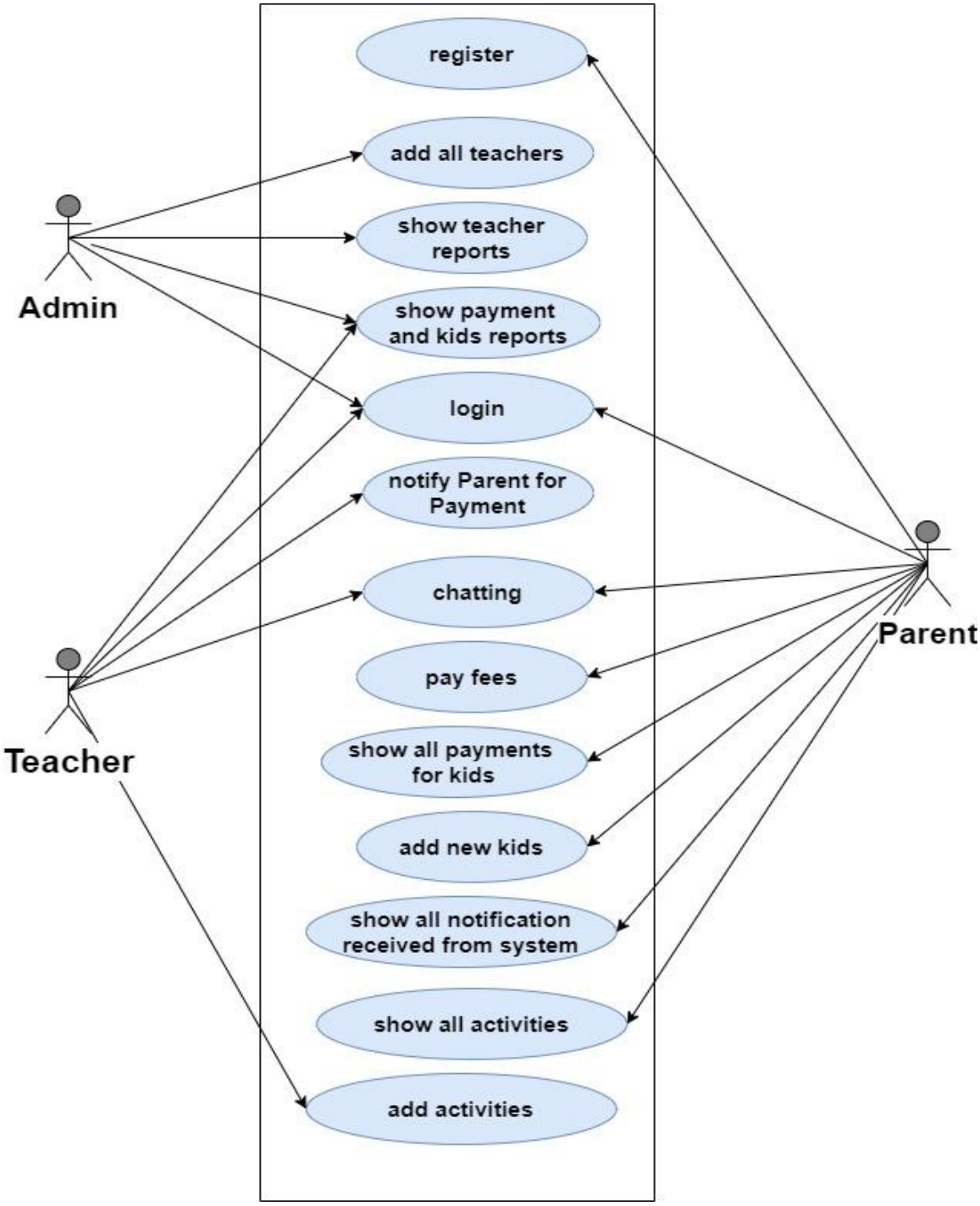


Figure 22: Use case for system

Flow chart diagram for our proposed system:

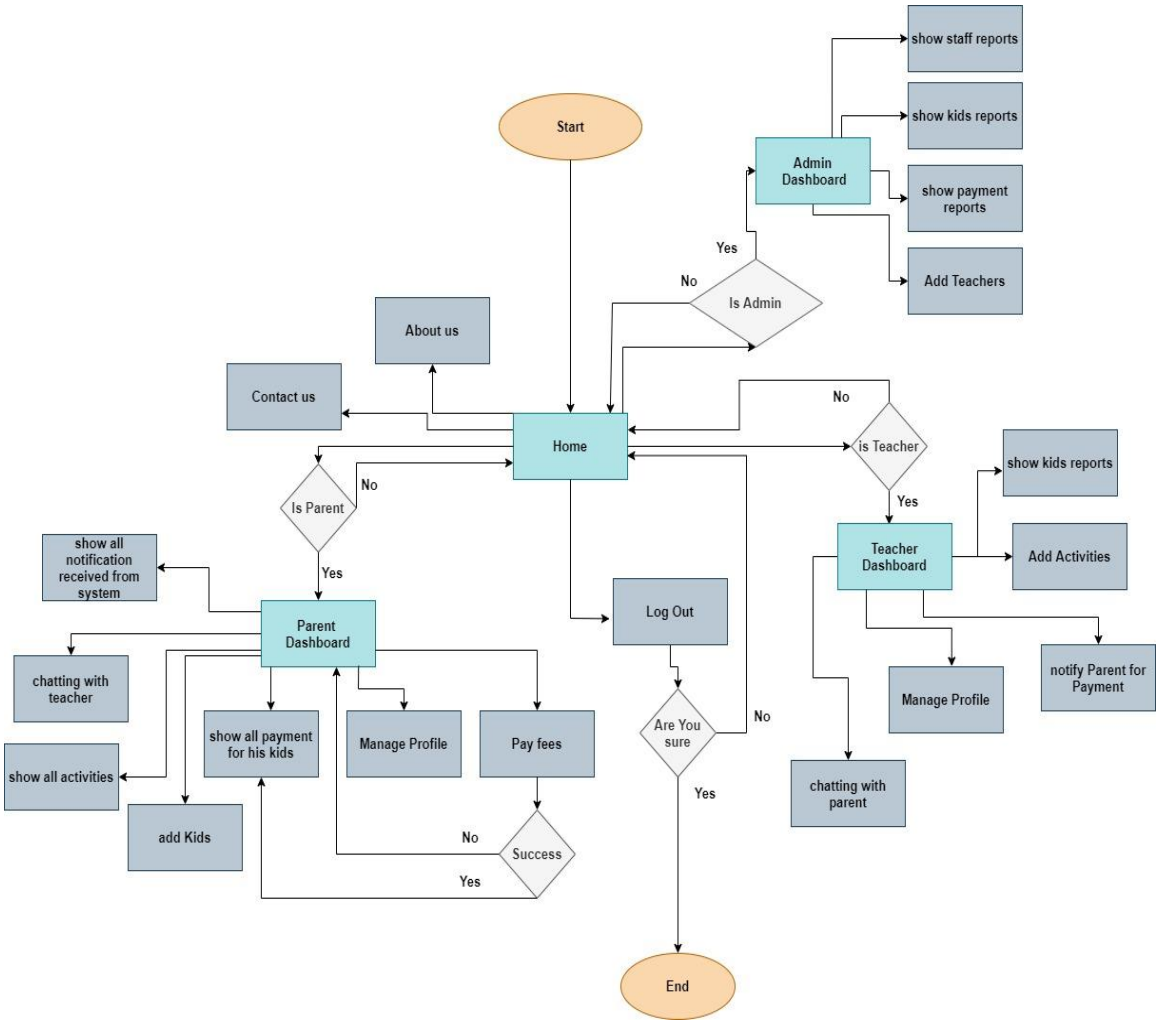


Figure 23 : Flow chart Diagram for system

2.6 Technology Considerations

The proposed nursery management application offers several **Strengths**:
including convenient online payments, efficient account management, improved communication, child activity insights, and enhanced safety through facial recognition. **Weaks**: data security, device dependency, privacy concerns, and maintenance.

Possible Solutions: implementing robust security measures, offering web-based accessibility, providing privacy controls, optimizing battery usage, and prioritizing feature development. Additionally, design alternatives such as federated learning for data processing, responsive web applications, alternative child monitoring methods, and automated deployment tools can be explored. Balancing user experience, data security, accessibility, privacy, real-time updates, and development costs will be crucial in designing an effective and comprehensive nursery management application that caters to the needs of both parents and nursery staff.

2.7 Safety Considerations

The proposed system is very safe for use in public places, as information is not connected to the internet. The proposed approach cannot be hacked, thus preserving their privacy. The proposed system contains no hazardous components and should be used with caution. The proposed system is safe for payment and does not expose the customer's bank data to theft.

2.8 Possible Risks and Risk Management

The proposed Nursery System could face some expected risks that hinder the implementation during the second semester, so the group shall consider some procedures to avoid any problems during the implementation phase; these procedures include:

1. The project team will purchase spare hardware components used in the implementation process to avoid any delay during the implementation if any part fails.
2. The implementation process will be under the supervision of an expert technician to avoid any fatal mistakes.
3. The project group will learn all the technical knowledge of the hardware and software requirements, like Raspberry programming. That will be used to implement the proposed design to avoid knowledge obstacles.
4. Risk of losing components or soft copies of the written documentation of the project design algorithm as well as the final report document. A solution is proposed to have the most recent copy of any related documents on the personal computers uploaded to any cloud storage platform.

2.9 Project Proposed Milestones and Evaluation Criteria

To meet the intended standards, the project will go through four stages. The final product will be established using four significant prototypes. The project plan document report, which will be distributed after the first semester, will serve as the prototype. Beginning in the second semester, work will be done on the prototype's assembly, testing, and installation as well as the design and implementation of the system software. Four milestones of our project are stated as follows:

Prototype (1):

- The documentation phase of the project is the initial stage. The initiative underlying the proposed idea of the project is defined by a specific problem statement. Along with a review of relevant studies, a valid comparison of the results of earlier studies with those of our own planned project, and an estimation of resources. Weekly

updates and changes with our advisers help us portray our project in a better condition and provide a good overview of the project's requirements overall, all with a view to the feedback we will probably receive from the supervisor.

Prototype (2):

- The selection, accessibility, and implementation of the hardware components are the topics of this stage. An essential step in creating a successful project is choosing the best components. At this step, it is also necessary to test components such as a Raspberry Pi, camera, and WIFI module.

Prototype (3):

- The project software must be designed at this time and interfaced with the hardware.
- The third phase of the project will also see the design and implementation of the mobile application's user interface. The database and software must therefore be tested to suit all the project's various attributes and scenarios.

Prototype (4):

- The project's final stage involves integrating all of its earlier phases into the finished prototype model. Integration of the product database, hardware, and software for the completion of the project. The end product will also come with a project documentation and instruction manual.

2.10 Project Tracking Procedures

The project team is expected to complete the project within two semesters, the first of which is the planning stage and the second is the implementation stage.

First Semester

The first milestone deliverables, Prototype (1), as described in Section 2.9, focus primarily on research, concept development, and analysis of previous work and related research articles. The project strategy, recommended assumptions and constraints, as well as project

report documentation, must be completed by the end of the first three months. After receiving weekly input from the project consultant, who has evaluated progress each week and documented each step, the report should be concluded in specific terms.

Second Semester

During the second semester, outputs (2), (3), and (4) will be achieved. Assemble and test hardware parts for the project prototype, such as Raspberry Pi, camera and WIFI modules. Then came the implementation of programming and hardware for the entire department, with the design of the program responsible for registering the child in the nursery and making all the designs for the chat, payment system and notifications within the application. At the end of the second semester, we will prepare complete documentation for implementation procedures and test results.

2.11 Expected Results and Validation

The final product of the proposed system will be a camera for taking pictures of children, connected to a Raspberry Pi, and there will also be a mobile phone to enter all the data and deal with the application. The proposed system provides the ability for parents to register their children through the application, provide electronic payment instead of cash, and also communicate with teachers in the nursery. They will receive notifications to track their children if they move from the place, as the camera will recognize the child if he is not in the place or moves from it, and he will be verified. Through the data base and through the code programmed on the Raspberry Pi, a notification will be sent to the mobile phone of the child's guardian for the speed of movement. We will verify the validity of the proposed project by testing it with more than one child under different conditions to ensure that the proposed system will meet all the functional and non-functional requirements that It was planned.

2.12 Test Plan

The project team will test the final product to ensure that all planned functional and non-functional requirements are met. Table 3 shows the test plan for the functional requirements of the Nursery system to be performed by the project team.

Table 3: Functional requirement test plan

Test Case	Input	Expected output
Add new Child	Parent add new child in app	Child added successfully in database.
Online Payment	Parent attempts to make an online payment and select payment method for complete payment operation	Payment gateway options are displayed and Payment is processed, and a receipt is generated.
Login's Parent	Parent logs into the application.	Parent dashboard with child and show all teachers in app.
Chatting	Parent sends a message to the child's teacher.	Teacher receives the message and can respond.
Track the child	Child exits nursery premises.	Camera recognizes the child's face and sends a notification to the parent.

The following Table 4 show the test cases for the non-functional requirements that the project team will perform

Table 4:Non-functional requirements test plan

Test Case	Input	Expected output
Availability	App will be available for teacher and parents.	The application should be accessible in online store
Reliability	Parent will add new child with personal information	The teachers will check information and call parents if missed any information such as photo
	Teacher can manage any activities for child in app	Adding or removing activities for children in database
	System will send notification if child is left nursery location	Notification added in database and parents show notification
Accuracy	Updating any information for children or record new payment	Data entered into the system, including child records and payments, should be accurate and error-free.
Maintainability	Project team will specify all the required components for the proposed system and will work of documenting all the required information and task approach in the project report.	The application should be easy to maintain and update with minimal disruption to users and system component must be available on store
Scalability	All child, teachers, notification and others used in system will be stored	The application should handle an increasing number of users and data without significant performance degradation.
Usability	Parent and teachers will interact with app easily and often	Users should find the application's interface intuitive and user-friendly. Navigation and task completion should be straightforward.
Capacity	We will add 10 children in app for testing app and check if occurred any errors or	The application should efficiently handle a large volume of data, including

	slowdowns with app or database	child records and financial transactions, without slowdowns or errors.

3 Project Timeline, Estimated Resources, and Challenges

3.1 Project Timeline

The planned schedule and the Gantt chart of the first semester for the project planning process is shown in Figure 24, where the expected timetable for the project planning started on 13 September 2023 and is likely to finish due 14 December 2023.

ID	Task Name	Start	Finish	Duration
1	Prototype 1	9/13/2023	12/14/2023	93d
2	Advisor meeting	9/13/2023	9/13/2023	1d
3	Researching	9/14/2023	9/14/2023	1d
4	Problem definition	9/16/2023	9/16/2023	1d
5	Documentation	9/18/2023	9/18/2023	1d
6	Advisor meeting	9/20/2023	9/20/2023	1d
7	Researching	9/21/2023	9/21/2023	1d
8	Time schedule	9/23/2023	9/23/2023	1d
9	Proposed design	9/23/2023	9/23/2023	1d
10	Task approach	9/24/2023	9/25/2023	2d
11	Advisor meeting	9/27/2023	9/27/2023	1d
12	Proposed approach	9/28/2023	10/2/2023	5d
13	Advisor meeting	10/4/2023	10/4/2023	1d
14	Project estimated resources and challenges	10/5/2023	10/9/2023	5d
15	Advisor meeting	10/11/2023	10/11/2023	1d
16	Final documentation	10/12/2023	10/16/2023	5d
17	Advisor meeting	10/18/2023	10/18/2023	1d
18	Presentation preparing	10/19/2023	10/23/2023	5d
19	Advisor meeting	10/25/2023	10/25/2023	1d
20	Final presentation	10/26/2023	12/14/2023	50d

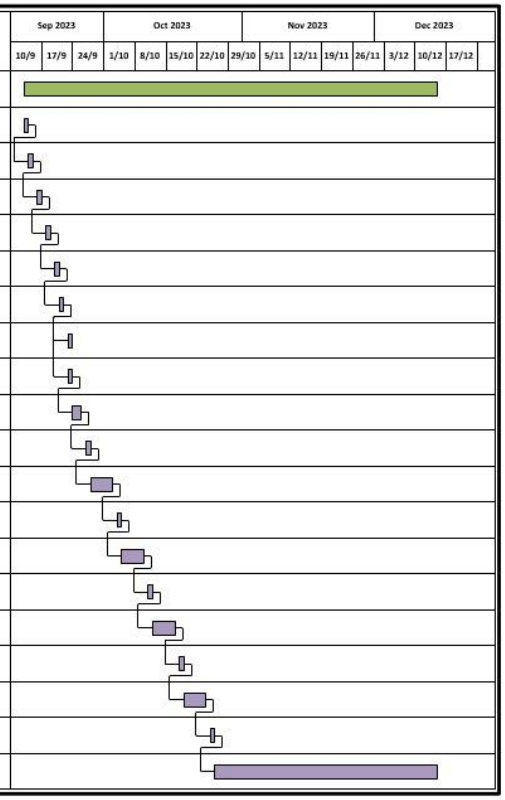
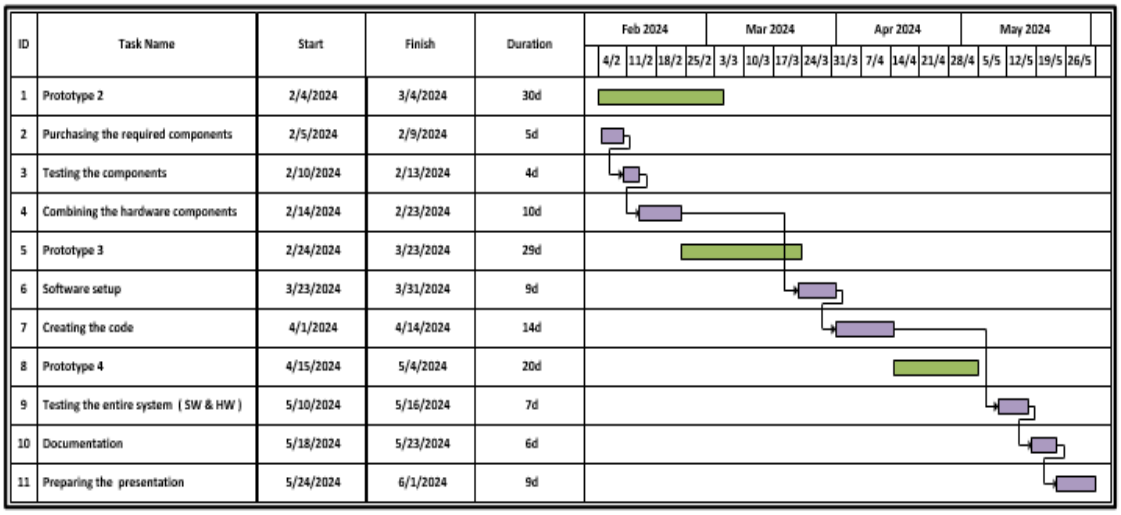


Figure 24: Gantt chart and timeline of the first semester

The schedule of the implementation process of the proposed project will be during the next semester, and it is expected to start on February 4, 2024, and finish on June 1, 2024, as shown in the Gantt chart in Figure 25. The implementation process will begin in mid-February. In the first semester, the team members will purchase the necessary electronic components and then assemble the circuits according to the proposed design.

The proposed system will be tested to ensure that it meets all functional and non-functional requirements, and then these results will be recorded in the final report with implementation procedures.



ID	Task Name	Start	Finish	Duration
1	Prototype 2	2/4/2024	3/4/2024	30d
2	Purchasing the required components	2/5/2024	2/9/2024	5d
3	Testing the components	2/10/2024	2/13/2024	4d
4	Combining the hardware components	2/14/2024	2/23/2024	10d
5	Prototype 3	2/24/2024	3/23/2024	29d
6	Software setup	3/23/2024	3/31/2024	9d
7	Creating the code	4/1/2024	4/14/2024	14d
8	Prototype 4	4/15/2024	5/4/2024	20d
9	Testing the entire system (SW & HW)	5/10/2024	5/16/2024	7d
10	Documentation	5/18/2024	5/23/2024	6d
11	Preparing the presentation	5/24/2024	6/1/2024	9d

Figure 25: Gantt chart and the timeline of the second semester

3.2 Feasibility Assessment

Operational feasibility:

The proposed electronic solution simplifies the registration, payment and communications process, enhancing operational efficiency. Facial recognition technology improves children's safety and parents' peace of mind. Staff training may be needed to adapt to the new system. Ensuring parents can trust the security and privacy of facial recognition data is crucial.

Economic Feasibility:

The initial investment in software and hardware development (cameras) and staff training should be justified by the long-term benefits of increased efficiency, reduced manual labor, and improved parent satisfaction. The cost savings from reduced paperwork and streamlined processes should outweigh the initial outlay. The app can be monetized through subscription models or transaction fees for payment processing, which may generate revenue for the nursery.

Technical feasibility:

Evaluate the availability of appropriate cameras, mobile devices and secure server infrastructure. Ensuring compatibility with different operating systems and devices is vital for a user-friendly experience.

There is a need for compatibility with existing guard management systems and seamless integration with payment gateways and facial recognition technology. Strong security measures must be implemented to protect sensitive data, especially facial recognition data, from breaches and unauthorized access.

Schedule Feasibility:

A realistic timeline for software development, testing and implementation phases will be created. The development schedule will be coordinated with the purchase of devices so that no risks arise later. There will be time to conduct extensive testing, bug fixes, and iterate based on user feedback before the official launch. Of course, we will take into account that there is a project manager to divide all possible tasks in order for the application to be fully implemented.

3.3 Personnel Effort Requirements

The main activities that must be completed mentioned in Table 5 which required to complete the project. The required time to achieve every task is estimated according to the group members point of view

Table 5:Personnel effort requirements

Main task	Description	Estimated hours
Meetings with supervisor	Weekly meeting with the team supervisor to discuss project writing and define all requirements.	25 hours
Planning	The project team will build a plan for the proposed design implementation and testing.	70 Hours
Online research	Research the project objectives and highlight the essential points.	30 hours
Mission statement	List of traits for the project generally and its purpose.	20 hours
Group members meeting	Project team members will meet together to determine and discuss the project tasks and innovative ideas.	25 hours
Purchasing required components	Team members will need to collect the hardware components at least to construct 1 sample of the system.	15 hours
Implementation	Hardware and software implementation	70 hours
Programming	Team members will need to program the code	65 hours
Testing	Testing the end-product to ensure that it accurately provides all the functions.	5 hours
Documentation	Prepare the documents of all the implementation procedures and the test results.	40 hours

3.4 Other Resource Requirements

Implementation of the proposed project requires other means to complete the proposed system, such as the following:

- A camera to capture and identify children's faces.
- You must prepare a computer to program it on our system and connect it to the camera.

3.5 Financial Requirements

The estimated cost of the required components according to the main scenario the proposed project is listed in Table 6.

Table 6: Cost of the required components

Component	Quantity	Cost / unit [KWD]	Cost [KWD]
Raspberry Pi 3 Model B	1	15	15
Camera TP-link	1	12.200	12.200
WIFI module	1	5	5
Mobile Redmi A2	1	21.900	21.900
Hosting	1	0.56/ month	0.56
Server	1	0.56/ month	0.56
Total			55.22 KWD

4 Closure Materials

4.1 Conclusion

The proposed nursery management application is designed to be a comprehensive and user-friendly tool for parents and staff. It streamlines administrative tasks by allowing easy profile creation for all users. Parents benefit from the convenience of online payments and efficient management of their family accounts. The app's robust notification system ensures effective communication between parents and staff, keeping everyone informed about important events and activities. Moreover, the application prioritizes child safety by employing facial recognition technology to monitor children, sending automatic notifications to parents if a child leaves the designated area. This holistic approach to nursery management enhances the overall experience for parents and staff, providing convenience, efficiency, and most importantly, child safety.

Next semester, the project team will manage the implementation of the hardware components after choosing the best ones. It is also necessary at this stage to test the hardware components and ensure their availability on the market for the overall project's reliability and maintainability. Moreover, the project team will design the software code, which must be designed and interfaced with the hardware.

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4.3 Appendices

Android studio

What is android Studio?

Android Studio is the official integrated development environment (IDE) for Android application development. It is based on the IntelliJ IDEA, a Java integrated development environment for software, and incorporates its code editing and developer tools.

On top of IntelliJ's powerful code editor and developer tools, Android Studio offers even more features that enhance your productivity when building Android apps, such as:

A flexible Gradle-based build system

A fast and feature-rich emulator

A unified environment where you can develop for all Android devices.

Apply Changes to push code and resource changes to your running app without restarting your app.

Code templates and GitHub integration to help you build common app features and import sample code.

Extensive testing tools and frameworks

Lint tools to catch performance, usability, version compatibility, and other problems.

C++ and NDK support

Built-in support for Google Cloud Platform, making it easy to integrate Google Cloud Messaging and App Engine

Project structure

Each project in Android Studio contains one or more modules with source code files and resource files. Types of modules include:

Android app modules

Library modules

Google App Engine modules

By default, Android Studio displays your project files in the Android project view. This view is organized by modules to provide quick access to your project's key source files.

All the build files are visible at the top level under Gradle Scripts and each app module contains the following folders:

manifests: Contains the AndroidManifest.xml file.

java: Contains the Java source code files, including JUnit test code.

res: Contains all non-code resources, such as XML layouts, UI strings, and bitmap images.

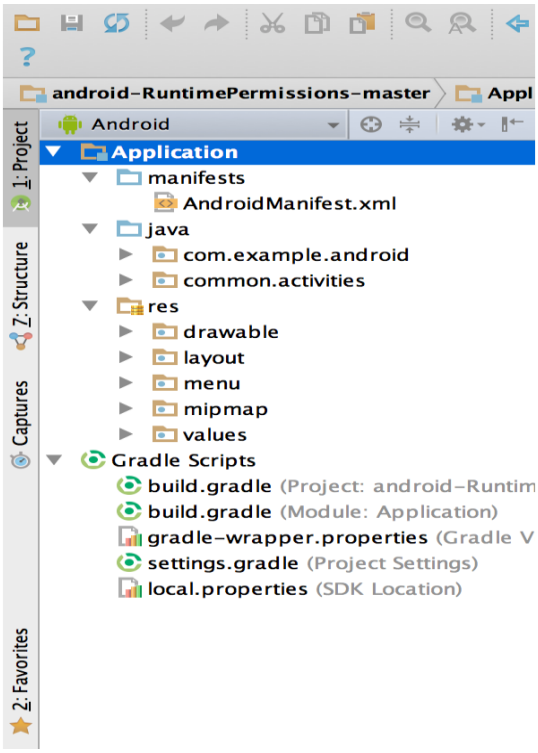

Figure 26: Android studio screen

Firebase Database

A brief post about what Firebase is all about, and it's new NoSQL Database-Cloud Fire store. With a variety of server-side technologies that are on the market today, developers have a tough job of deciding what kind of backend is most suitable for their app.

In this post, we will explore one of these choices that goes by the name of Firebase, and all the tools and services that it provides.

Firebase is a mobile and web app development platform that provides developers with a plethora of tools and services to help them develop high-quality apps, grow their user base, and earn more profit.

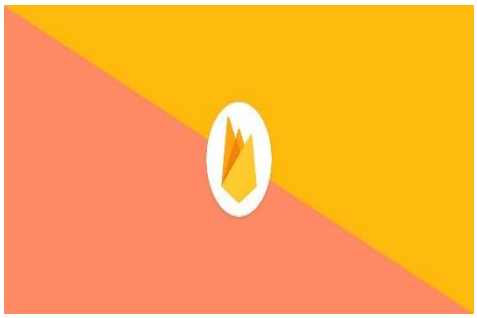

Figure 27:Firebase database