Bilkent University

Department of Computer Engineering

Senior Design Project

Analysis Report

VANNY

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1. Introduction

Babies and toddlers are the main focus, care, and concern of all parents. From providing the best food and medical care to paying babysitters to setting up a nanny cam, parents will stop at nothing to make sure their babies and toddlers are healthy and safe. Nanny cams specifically play an increasingly important role in helping parents extend their love and care beyond their immediate physical vicinity, allowing the parents to have a reliable and transparent tool to watch their loved babies and toddlers. The common available nanny cams, however, can be optimised to push this reliability and transparency farther if the newest and most capable technological tools were integrated in said systems. Furthermore, by making these systems more intelligent and able to communicate with the parents the current nanny cam systems can be extended and transformed into an additional caring eye that is always present in the babies and toddlers bedrooms or playrooms.

After conducting a market research we observed that most of the current nanny cam systems don't utilise some very useful Artificial Intelligence and Machine Learning algorithms efficiently. Alfred Home Security Camera, for example, is the most popular similar system on Apple's AppStore with over 40 million users, detects intruders by detecting "any movement", with no other AI or ML capabilities utilised. It can also live stream, see in low-light environments, and act as walkie talkie, among other common features in security cams[1].

Another example "Annie Baby Monitor" acts as a basic nanny cam with motion detection and the ability to play lullabies[2]. Similarly other examples of such systems have motion detection with other AI capabilities like detecting noise and crying and notifying the parent that the toddler is awake[3][4][5]. The most capable similar system is "Mi Home Security Camera". The aforementioned system is a general security camera system. Moreover, it has an angle of 130 degrees, has infrared and night vision scopes, and acts as a two-way voice communication system. In terms of AI capabilities, it has a zoning functionality that makes the system more sensitive to movements in these zones and can detect family members in the camera's range, using Mi Bands or iPhones and turn off when they are in range[6].

Finally, other specialised systems that focus strictly on a specific problem exist. “Angel Eyes”, as an example, watches the baby while sleeping in the crib. The system uses a camera to watch the baby and detects any issues, like objects in the crib, or if the baby is in an unsafe position, and uses sensors to monitor humidity and temperature in the room[7]. Another system detects the hunger of the baby using some cues[8].

A more optimised system will act as a general purpose more capable nanny cam that fits somewhere between “Mi Home Security Camera” and “Angel Eyes”, and more capable than the other aforementioned nanny cams by utilising the capabilities of AI and ML and focus on the toddler in their rooms. Ideally, this system will transform nanny cams by pushing them to the limits of the possible capabilities. This document describes the specifications of a system that optimises and transforms these systems into a virtual babysitter. Note that the age group of children that are the target of the system is 0 to 5-year-old, the document will refer to this age group as toddlers.

2. Current Systems

As mentioned earlier, there are multiple systems with similar features and purposes as Vanny. However, together with Vanny, the shortcomings of the mentioned systems will be compensated and the idea will be further improved and perfectionized with the additional features that will be added to the system.

Current Systems:

- Alfred Home Security Camera
- Annie Baby Monitor
- Mi Home Security Camera
- Angel Eyes

3. Proposed System

3.1 Overview

VANNY (Virtual nANNY) is a Machine Learning, AI, and IoT software used as a virtual babysitter. The system will be a wide-range camera, with night vision, fixed in the corner of the toddler's room, along with a microphone and a speaker, the system will connect to a phone application to communicate with the parents. The system will watch a toddler 24/7 in their rooms in order to assure the parents that their toddler is safe and sound. The camera will monitor the toddlers and their surroundings, detecting any possible danger, including, but not limited to, fire and smoke, sharp objects, foreign moving objects, other toddlers, strangers, and loud noises. Additionally, the system will watch the toddlers themselves in case they fall or cry. Once crying is detected the speakers can be used to play a lullaby that is pre-recorded or fetched from the internet. Finally, the system will analyse the toddlers' daytime movement's patterns, amount, and patterns; the toddlers' sleep's depth, and durations; and the toddlers' crying loudness, duration, and times. Parents will use the mobile application to be notified in case any danger was detected, or if the toddler hurt herself or cries for a certain time or loudly.

The mobile phone will act as a messenger between the system and the parents. Through it parents can watch their toddlers live, receive notifications and reports after the analysis. The analysis' aim is, solely, to help observe any unusual patterns in the toddlers' movement, sleep or crying, not to provide medical advice. For example an unusually low amount of movement or long crying in the night can provide a hint to the parent's regarding the toddlers' health or uncomforts, i.e growing teeth, bad room temperature, etc.

When all of these components are put together the system will act as a virtual babysitter that helps parents extend their care beyond their physical vicinity, and be at ease when they are not around. Moreover, the system will be completely local, making it more secure and avoiding privacy fears that can turn the system to a source of concern instead of comfort. The innovation type of this system would be "Product Performance" since it focuses on the value, features, and quality of the service, and it attempts to outperform competitors. One important issue regarding this type of innovation is that it is usually easy to copy, and perhaps, be outperformed by other, larger competitors. Additionally, since the needs and features are pre-existing and already realised by the customers but are also adaptive and will continuously improve our innovation is a mix of sustaining and incremental innovation.

3.2 Functional Requirements

3.2.1 Detecting the Environment of the Toddler

- The system is able to monitor the baby or toddler 24/7 and enables the parents of those toddlers to observe if their baby is in confort or not.
- The application is able to detect the baby or toddler as well as any unfamiliar person, namely not his/her parent.
- The system can detect any moving object to present the baby from possible dangers and warn the parents of the baby if there is a need.
- In case of the toddler falling down, the system warns the parents by detecting the baby.
- Any sharp object that might possibly cause a danger for the toddler is detected by the system and the necessary warnings are displayed to the parents.
- The system can detect the open doors and windows to prevent the baby escaping from those and warns the parents of the toddler.
- The system can also detect any fire or smoke that can constitute a danger for the baby together with any source of light that can bother the baby and cause uncomfort for him/her.
- Facial expressions of the baby such as crying can also be detected to make the necessary analyses.

3.2.2 Detecting Noise in the Environment of the Toddler

- The system can detect any loud noises in the environment to ensure the comfort of the toddler and also to see if the toddler is crying and has any uncomfort.

3.2.3 Sending Voice to the Toddler

- In case the parents want to send any voice to the toddler, the system provides two opportunities to the parent.
- First of all the parent can record his/her voice to send to the toddler. It is important for the baby to feel safe since a familiar voice is comforting for the babies that are in discomfort.
- The parents of the baby can also send a lullaby to the baby that can be selected in the application’s lullaby list. It would calm the baby making him/her more comfortable.

3.2.4 Analysing the Observations of the Toddler

- The system is capable of making many observations and detections. There is also the capability that those detections are used to make judgements about the observations.
- The movement duration and frequency of the toddler can be analysed.
- The crying duration, frequency, and loudness of the toddler can be analysed
- The system is capable of analysing the sleep quality of the toddler by making use of the movement of the toddler during the sleep and duration of those movements therefore gathering the depth of the toddler's sleep.

3.2.5 Notifying the Parents Based on the Analysis

- The system is designed so that in case of any situations that can constitute any danger to the toddler. In case any hint is observed and analysed that it can cause an uncomfort for the toddler, the parents are notified and warned accordingly regarding the situation of the toddler.
- To notify the parents, the short captured videos of the situations that should be known by the parents are sent to the parents specifically to prevent them from missing those records.
- The parents are also notified in case of a drastic change in the activity patterns of the toddler or the crying pattern and duration of the toddler.

3.3 Nonfunctional Requirements

3.3.1 Security

- Since the data used in the application contains sensitive information, it needs to be secure in order to prevent any outside access .

3.3.2 Reliability

- The application will be to detect unusual activities without any anomalies.
- The application will perform well-being tests to report any partial failures.

3.3.3 Effectiveness

- The system will detect various types of possible dangers and report them to parents within 5 seconds, protecting the toddler continuously.

3.3.4 Memory Optimization

- Recording of the last 3 days will be saved locally in case the parents need them.
- Recordings that are older than 3 days will not be saved except when unusual activity or issues are detected. The recorded moments will be stored for only 7 days to increase the storage efficiency.

3.3.5 Privacy

- User data will be protected by encryption between the server and the client in the system.
- Recordings will be private with access from any third-party or individuals.
- Users can disable the recording whenever desired.
- Users can delete any form of data saved.

3.3.6 Reporting

- Any suspicious activity will be reported to the user immediately and saved for 7 days.
- Analysis of activity, sleep, and crying will be reported regularly to the parents.

3.3.7 Extensibility

- For the application to be extensible, its implementation will be modular and systematic. Thus, the application will be compatible with updates and features to be added or removed.

3.3.8 Robustness

- If a failure of the application occurs, the application will be able to restart automatically and continue from where it failed without losing information.
- The system will perform well-being tests and confirm that all components work and try to resolve any connectivity issues.

3.3.9 Usability

- The system will require a one-time setup afterwards users can use the system without directly interacting with the server side.
- The UI of the phone application will be designed so it is used by any user regardless of their tech knowledge.

3.3.10 Efficiency

- The system will be able to watch a frame-per-second rate of at least 10.
- The system detects any issues and reports in real-time therefore the notifications sent to the user should arrive within 5 seconds.
- The system will delete full day recordings in 3 days and highlights in 7 days, enabling efficient memory management.

3.3.11 Ethicality

- Parents will be made aware of what the system records and for how long.
- No third-party activity of any kind will have access to the data stored.
- Reports generated will only be shared with parents.
- Encryption and predefined password will be implemented to prevent any undesired access and undermining toddlers' safety or privacy.

3.4 Pseudo Requirements

- The accuracy of the trained models is an important factor of the application. Therefore the accuracy of the trained models needs to be considered carefully.
- The application will be a mobile application and therefore the client side of the application needs to be carefully implemented to be in the minimum storage requirements for the users.
- If there will be any need to use a third-party API or a library then the licence agreements of those third-parties will be considered and applied if necessary.
- The system should enable the user to securely pair his/her mobile device with the system.
- The user should have access to manage all kinds of his/her recorded data.
- The user should be able to enable or disable the camera anytime he/she wants.

3.5 System Models

3.5.1 Scenarios

3.5.1.1 Scenario 1

Use Case Name	Watch a Live Stream of Toddler
Participating Actors	Parent
Flow of Events	1. The parent visits the streaming screen 2. The parent monitors the toddler 3. The parent exits the streaming screen
Entry Condition(s)	- The parent successfully paired his/her mobile device with the system - The parent chooses the Watch Stream option
Exit Condition(s)	- The parent exits the Watch Stream screen
Quality Requirements	- Live stream of the toddler should be available for watching 24/7

3.5.1.2 Scenario 2

Use Case Name	Setting the Safety Mode
Participating Actors	Parent
Flow of Events	1. The parent visits the settings menu 2. The parent chooses between safety modes 3. The analysis of the events are adjusted according to the changed settings 4. The parent exits the settings menu
Entry Condition(s)	- The parent chooses the Settings option
Exit Condition(s)	- The parent exits the Settings options
Quality Requirements	None

3.5.1.3 Scenario 3

Use Case Name	Playing Lullabies
Participating Actors	Parent
Flow of Events	1. The parent visits the Send Lullaby screen 2. The parent decides to record his/her voice to send as the lullaby to the toddler 3. The parent sends the audio 4. Speaker hardware plays the lullaby to the toddler 5. The parent exits the Send Lullaby screen
Alternative Flow of Events	1. The parent visits the Send Lullaby screen 2. The parent decides to choose the lullaby from the internet 3. The parent is directed to the choose screed sends the audio 4. The parent chooses the lullaby 5. The parent sends the audio 6. Speaker hardware plays the lullaby to the toddler 7. The parent exits the Send Lullaby screen
Entry Condition(s)	- The parent needs an internet connection - The parent chooses the send lullaby option
Exit Condition(s)	- The parent successfully sends the audio
Quality Requirements	None

3.5.1.4 Scenario 4

Use Case Name	Notify Parent of Dangers
Participating Actors	Parent
Flow of Events	1. The watcher continually watches and identifies objects 2. Identified objects are used to detect the possible dangers 3. Detector tries to detect toddler, adults smoke, fire, sharp objects, open doors and windows, and source of light. 4. Danger is detected considering the toddler and other objects that could cause danger. 5. Three minutes duration of the highlighted event is recorded. 6. The parent is notified according to the danger together with the record.
Entry Condition(s)	- The parent is successfully paired with the system
Exit Condition(s)	- Notification is delivered to the parent successfully
Quality Requirements	- Detection should be on 24/7 together with notification - If the connection failure occurs between the devices, the parent is notified accordingly

3.5.1.5 Scenario 5

Use Case Name	Analyse Audio
Participating Actors	Parent
Flow of Events	1. The noise and voice are continually detected 2. The detected voice and/or noise is analysed to check if it is above the threshold of being high pitched 3. Voice or/and noise is determined to be high pitched 4. It is decided that it can indicate a danger. 5. Three minutes duration of the highlighted event is recorded. 6. The crying pattern is reported for the report stage
Entry Condition(s)	- The parent is successfully paired with the system
Exit Condition(s)	- Audio is analysed successfully - The crying pattern is extracted successfully.
Quality Requirements	- Analyser should be on 24/7 together with notification

3.5.1.6 Scenario 6

Use Case Name	Get Reports of Toddler’s Behaviour
Participating Actors	Parent
Flow of Events	1. Toddler, objects, noises, and voices are detected 2. Detected data are analysed in terms of activity level of the toddler, sleeping patterns of the toddler, and crying patterns of the toddler 3. According to the analysis; an inclusive report is generated 4. The report is saved to the reports section of the parent 5. The parent is selected the list reports option 6. The parent is selected the report that he/she desires to display 7. The parent examines the report he/she selected 8. The parent exits the report screening mode
Entry Condition(s)	- The parent is successfully paired with the system
Exit Condition(s)	- The parent successfully displays the report and exits the report screening mode
Quality Requirements	None

3.5.2 Use Case Model

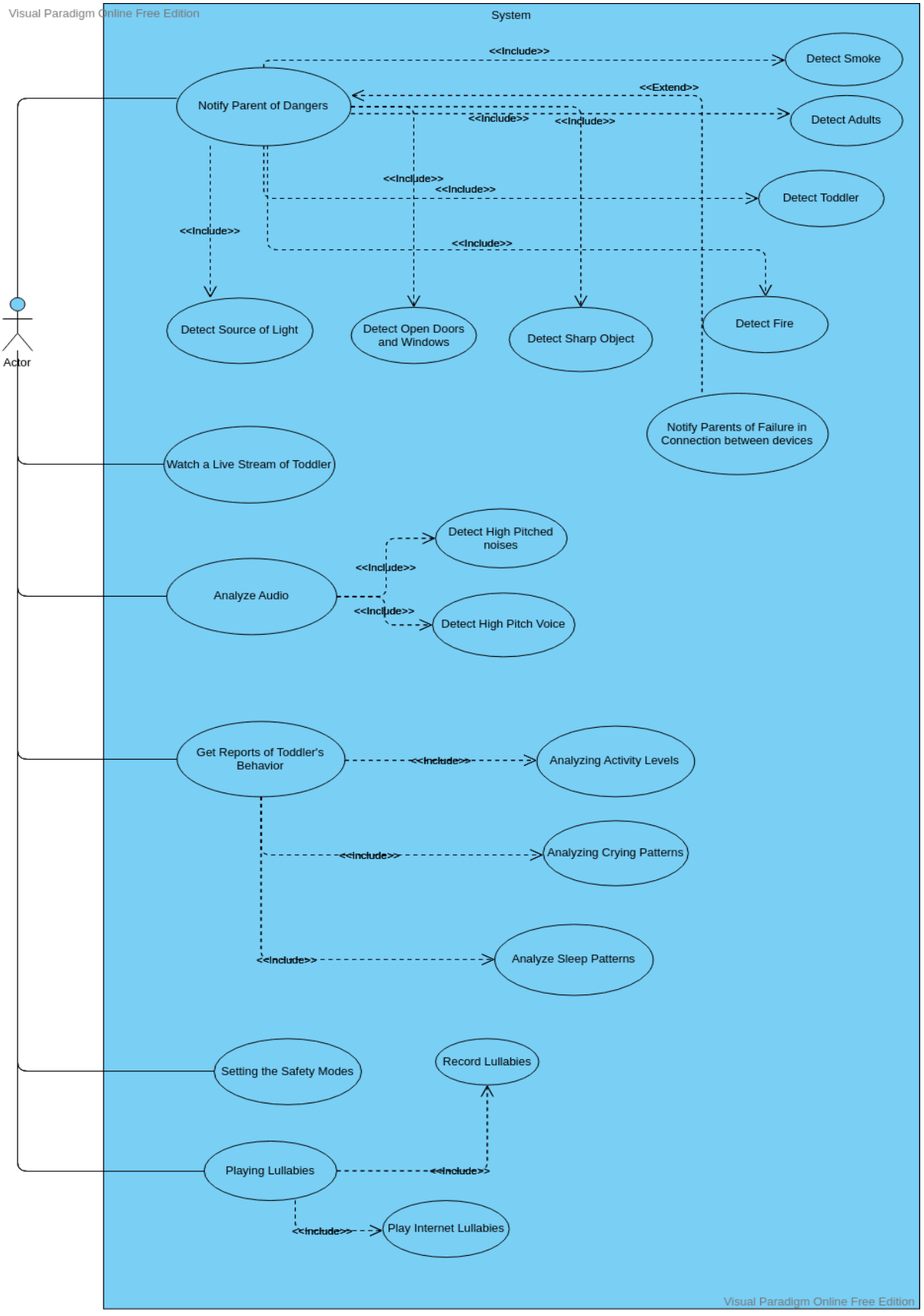

Figure 1: Use Case Diagram.

In the use case diagram we capture the main use cases for our system. First use case in the main use case of our system: Notifying the parents of danger. This includes detecting any form of sharp objects, fire, smoke, etc. It also includes any open doors or windows or a source of light in the night. We take into consideration that the devices used can be disconnected or the system can be unable to perform its task in certain conditions so we notify the repents of such issues too. The parents will also be able to know if there is any unusual high noise or if the baby is crying. Additionally, the parent will get a report of the toddler's activity and crying. One more use case would be playing lullabies that are either recorded or downloaded from the internet. Finally, the parents will be able to set how strict they want the system to be as well as watch a live stream of the toddler's room.

3.5.3 Object and Class Model

- The clearer versions of diagrams can be found in the github account of Vanny:
    - https://github.com/esattok/vanny

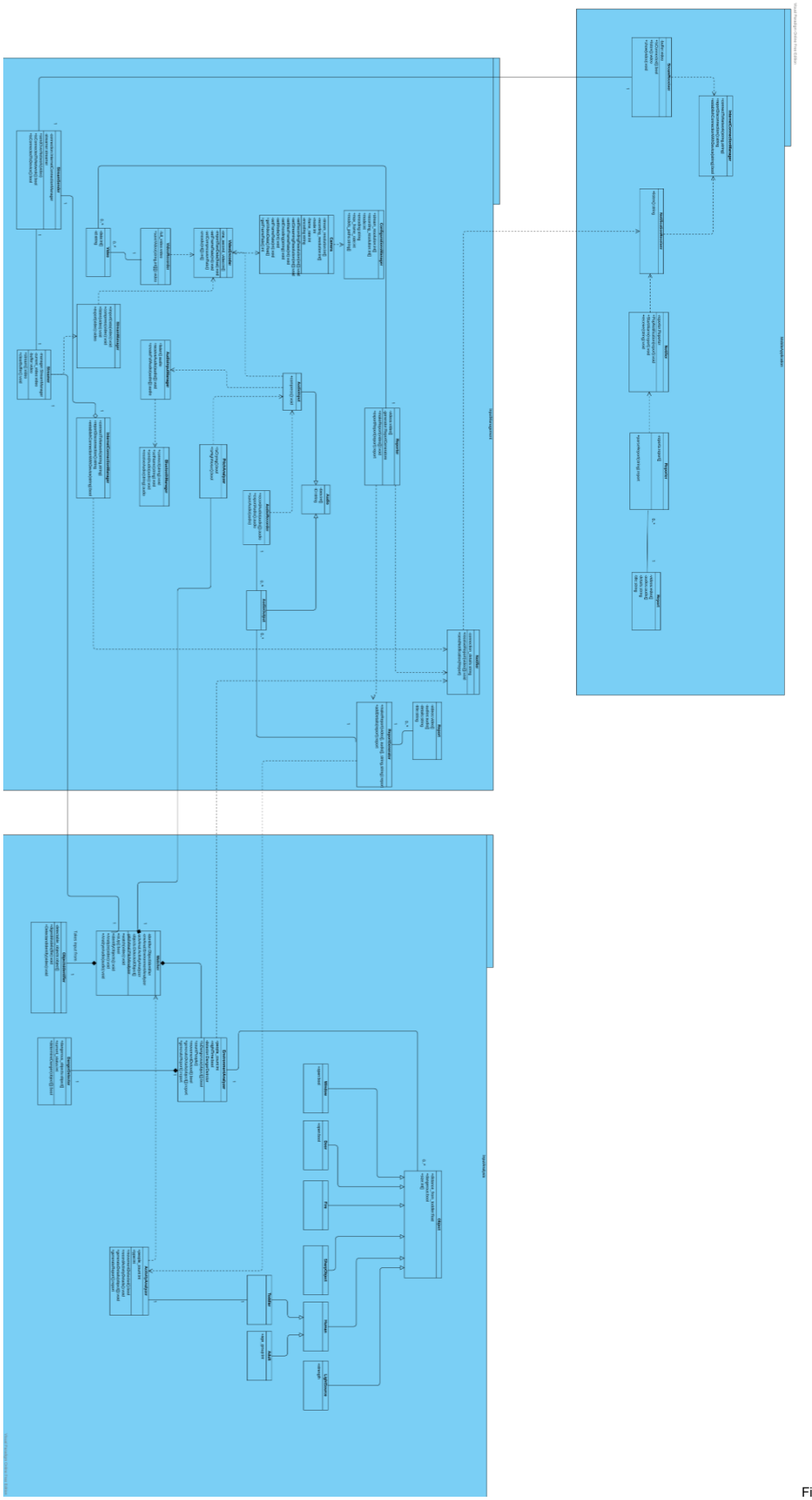

Figure 2: UML Class diagram.

Considering how sophisticated the system would be, we constructed quite sophisticated class models in accordance with the OO principles. The system will consist of three packages that will be explained in the following sections. These packages were separated based on the task they perform and they communicate with each other through specific classes.

3.5.3.1 Input Management Package:

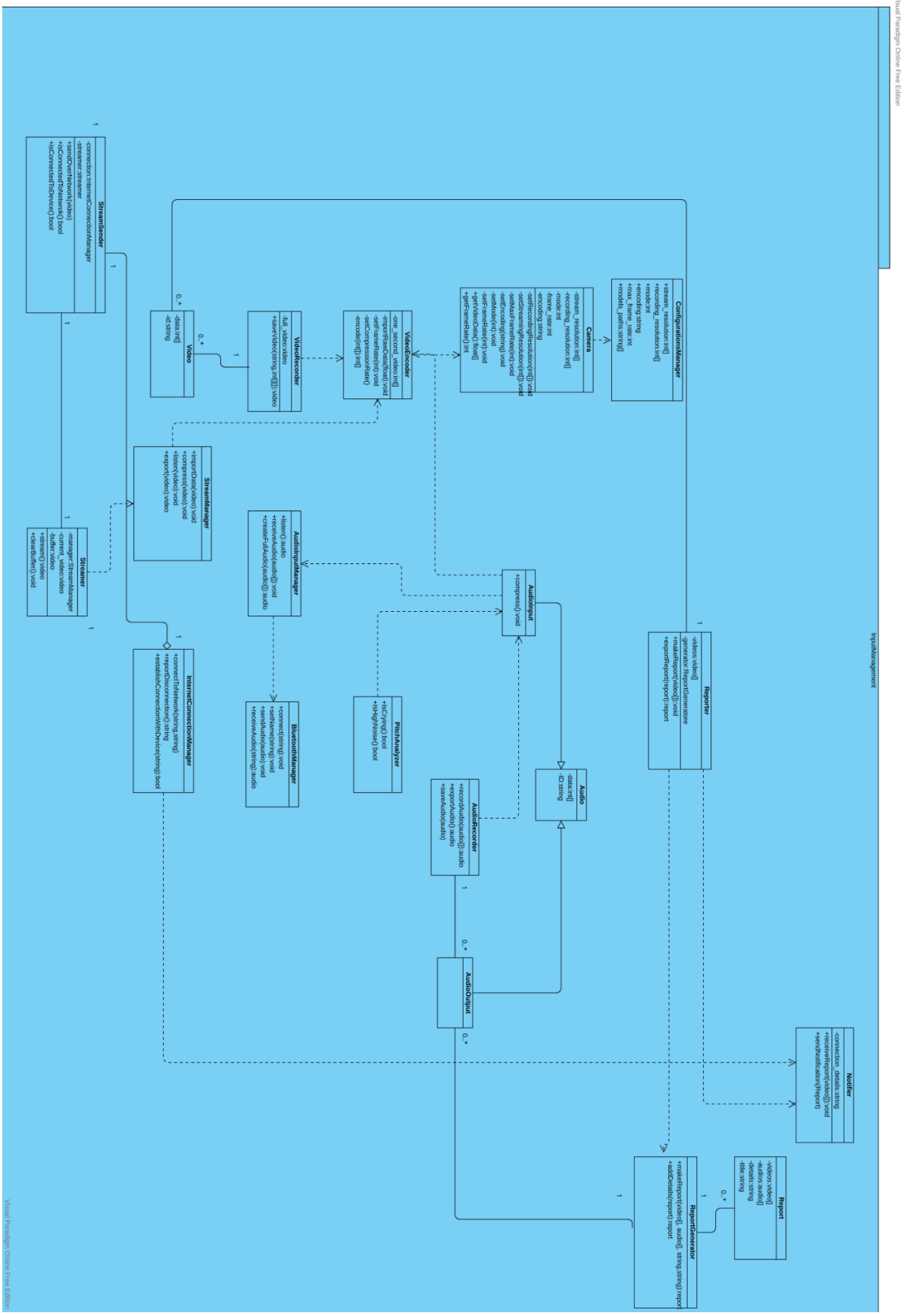

Figure 3: “Input Management” package.

This package has all the classes that deal with all forms of input, and perform related data manipulations or report this data. Mainly these classes will take configuration from the configuration from class then the camera class will deal with how the camera would receive the videos. Then the video will be separated and encoded and streamed to the mobile application and to be analysed later. Overall, this package deals with hardware and low level processing.

3.5.3.2 Input Analysis Package:

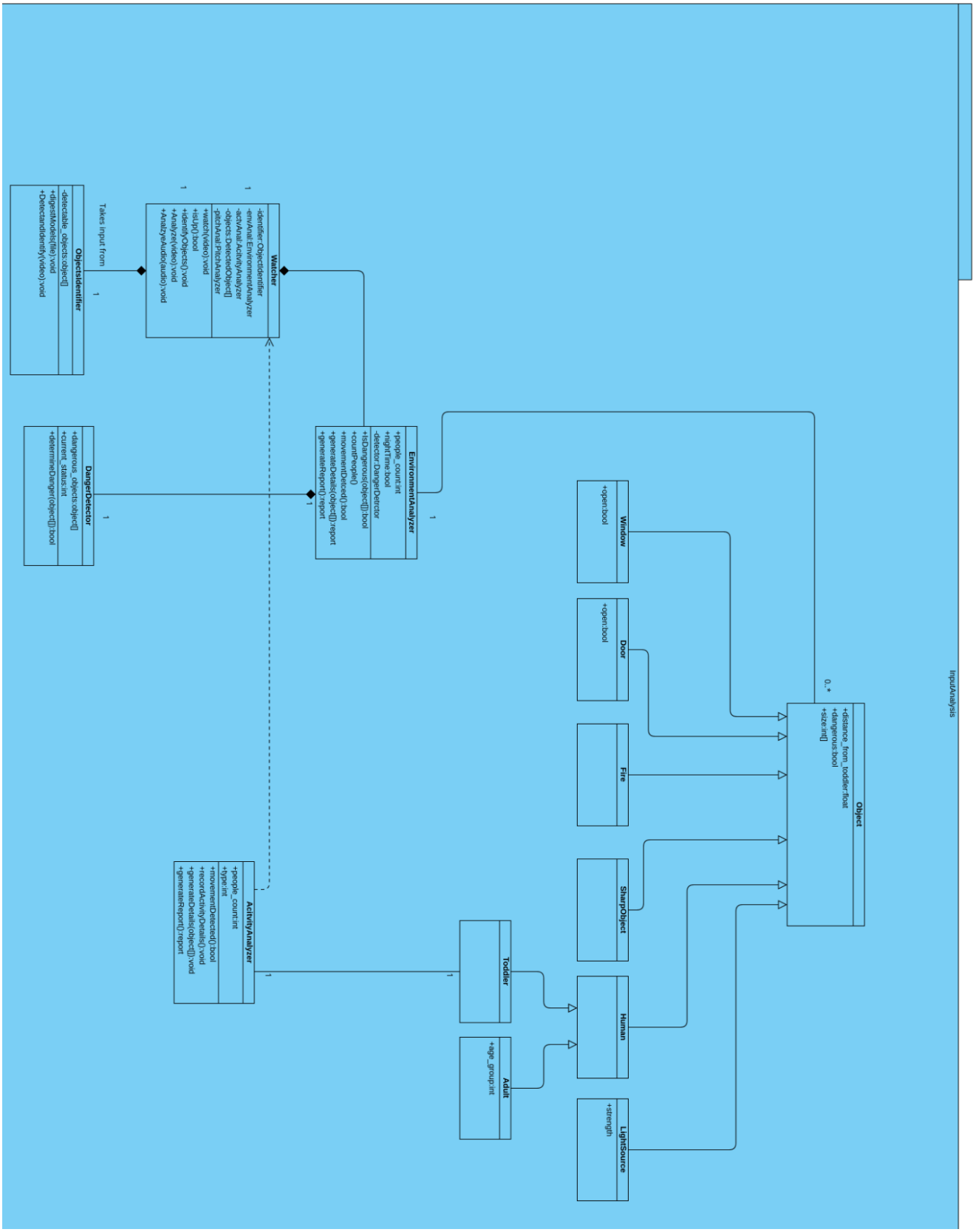

Figure 4: “Input Analysis” package.

Following the processing of the input, the data gets sent to classes of this package where all forms of captured data, video or audio, gets analysed here for dangers, and for activity. This package will have the classes that load the models and use them to detect any dangers in the input fed from the “Input Management” package. It will also perform analysis on the activity of the toddler, like amount of physical activity and crying. This package also defined the objects of interest to our system, i.e dangerous objects, entrance to the room, and other people around the toddler. The notifications of all kinds will be generated here and then sent to the mobile application using the “Notifier” class in the “Input Management” package.

3.5.3.3 Mobile Application Package:

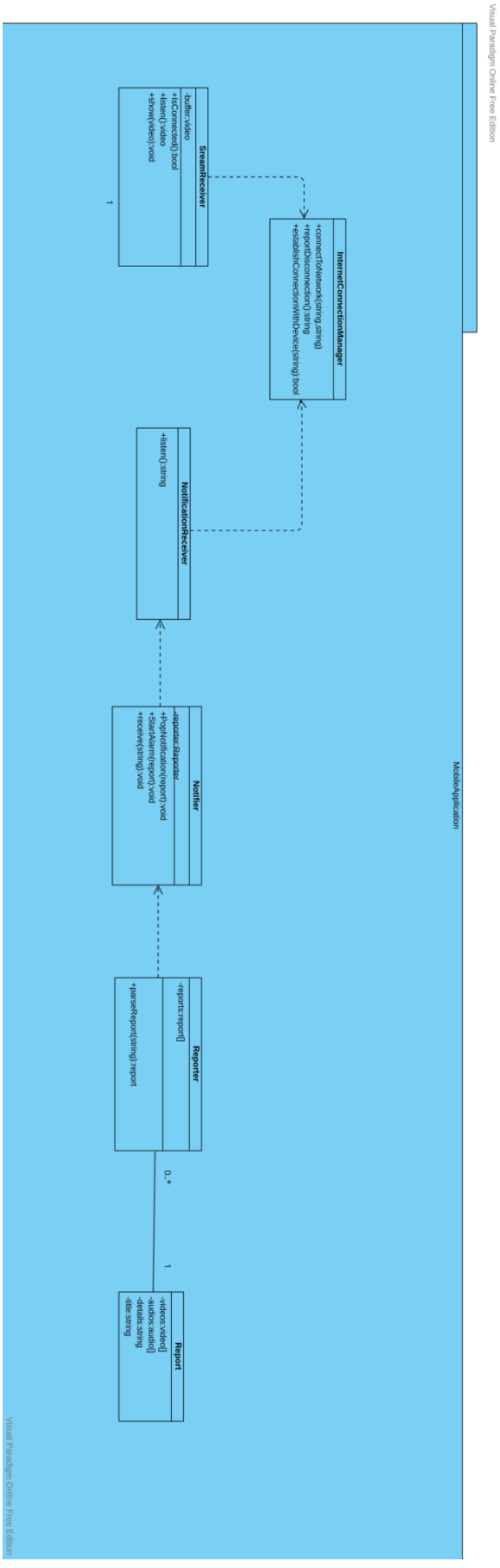

Figure 5: “Mobile Application” package.

This package will be written, unlike the other packages, in Java using Android Studio. This package represents the application where we need to establish a connection to the Raspberry PI device and then listen for any notifications and receive reports. This package also includes the “StreamReceiver" class that receives the live stream from the camera and shows it to the parent.

3.5.4 Dynamic Models

3.5.4.1 Detect Danger Activity Diagram:

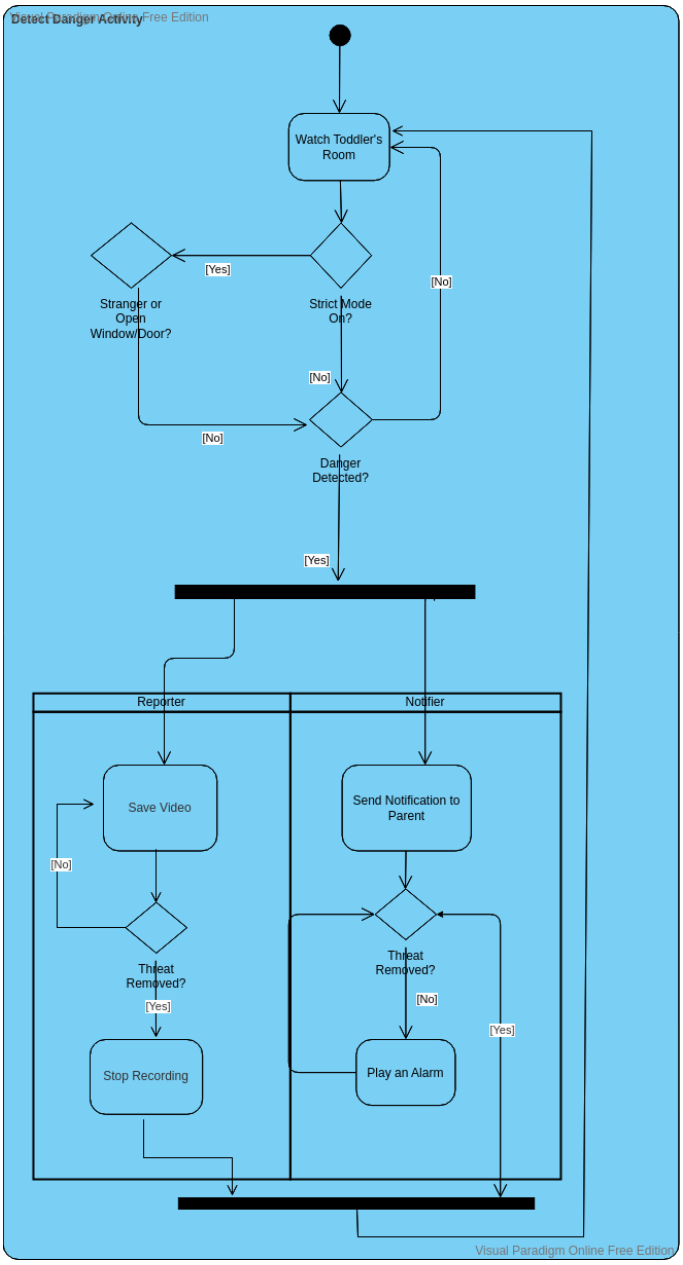

Figure 6: Detect Danger Activity Diagram.

In this activity diagram we can see how the system works while detecting danger. First the system watches the toddler's room, if the parent chooses strict mode, then all open doors and windows and strangers will be treated as dangers and will be immediately reported. Afterwards, whether the system is in strict mode or not, the system looks for any danger, if found two concurrent flows of activities will occur. First, the "Notifier" element of the system will send a notification to the parent, then waits for a short period of time, in case the danger is not removed, the system panics and starts playing alarm on the mobile phone until the danger is removed. The second flow of activities would be the "Reporter" element where a video of the last few minutes will be saved until the threat is removed. FInally, in case the system does not detect any danger or if the danger is removed the system goes back to its initial activity, which is watching the room.

3.5.4.2 Watching System State Machine Diagram:

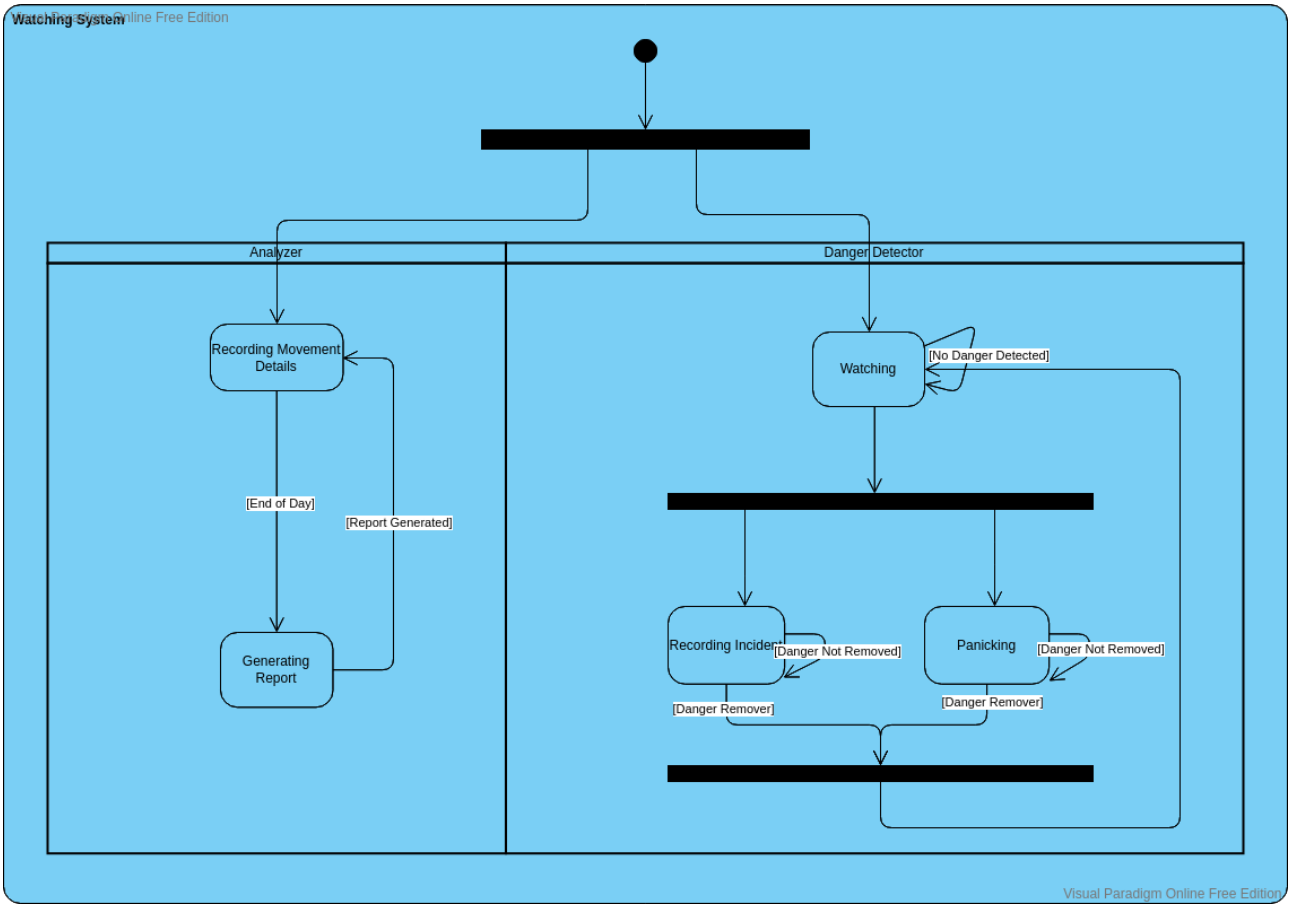

Figure 7: Watching System State Machine Diagram.

In this diagram we see the overall states of the whole system, including the mobile application. The system is normally in two concurrent states: recording movement details for analysis and reporting at the end of each day, and watching state. System stays in the watching state as long as no danger is detected. Once danger is detected, similar to the activity diagram above, the systementers two concurrent states: recording the incident, and panicking, as long as the danger exists, once it is removed the system goes back to watching state. Panicking state includes notifying and alarming the parents.

3.5.5 User Interface - Navigational Paths and Screen Mock-ups

Figure 8: Login Page

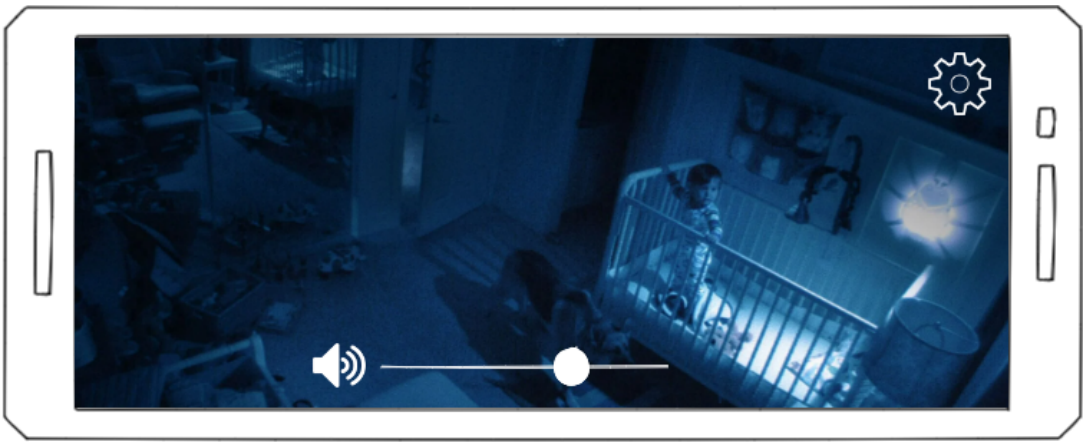

Figure 9: Live Video Footage

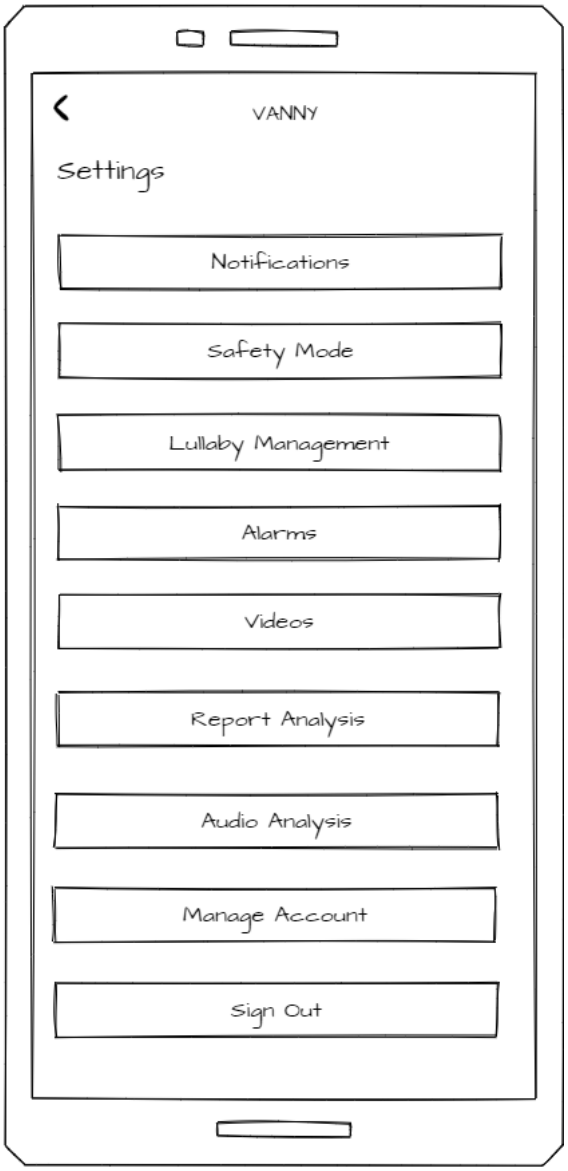

Figure 10: Settings Page

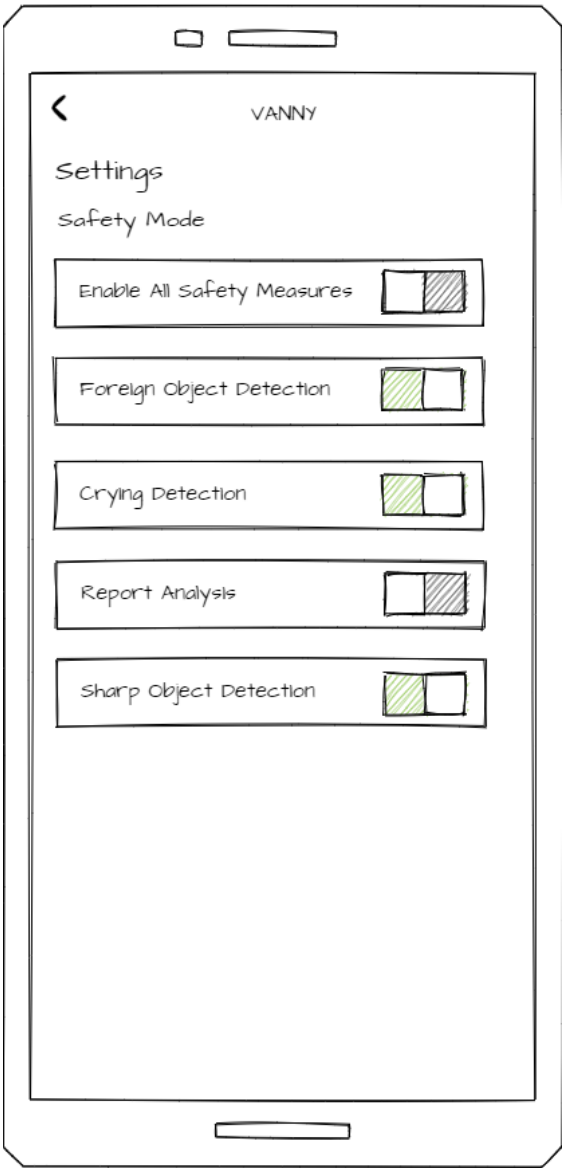

Figure 11: Safety Mode Page

Once the user logs in and pairs with the device, they will be able to monitor the baby with the live streaming and they can access settings from that screen. The settings will help you adjust which notifications and options the user wants to enable according to their likings. These include safety mode where they can turn off or turn on specific functionalities. It also has a video section where a user can view old videos and gain insight based on the analysis of the video. There will also be a report analysis based on the toddler's actions and movements in the room

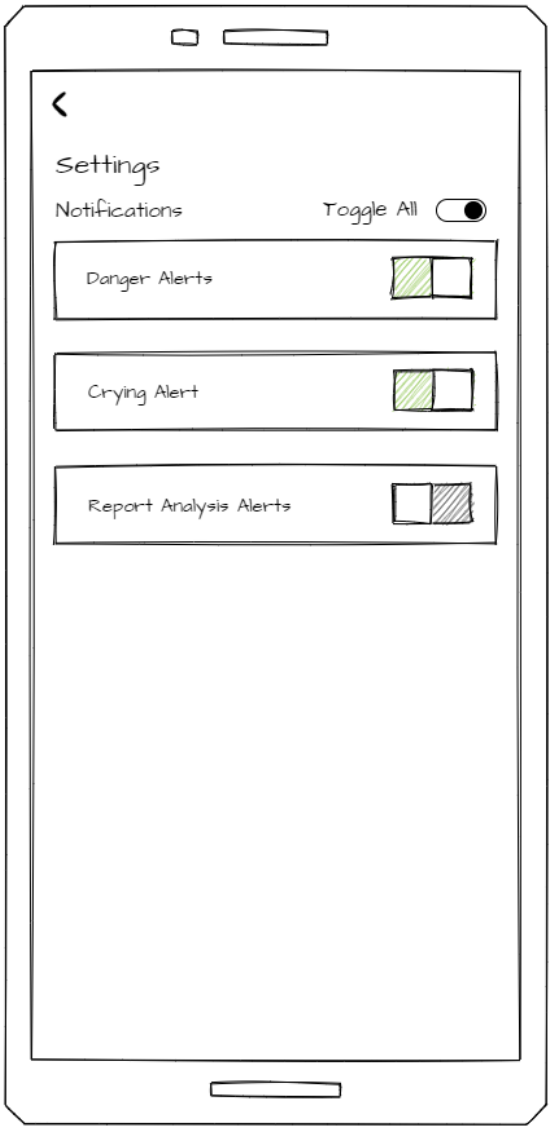

Figure 12: Notifications Page

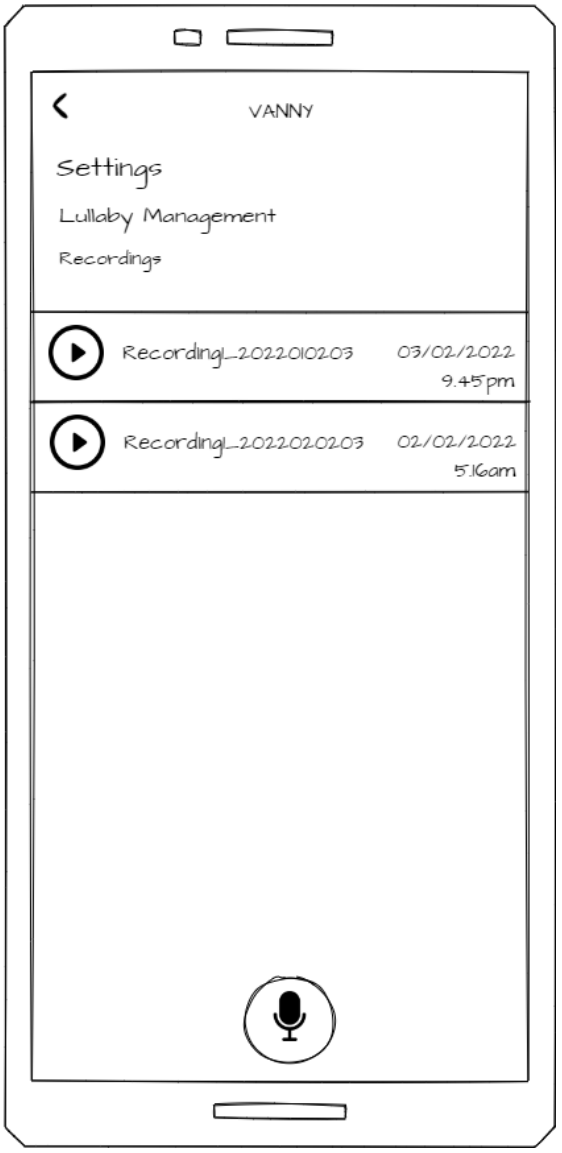

Figure 13: Lullaby Management Page

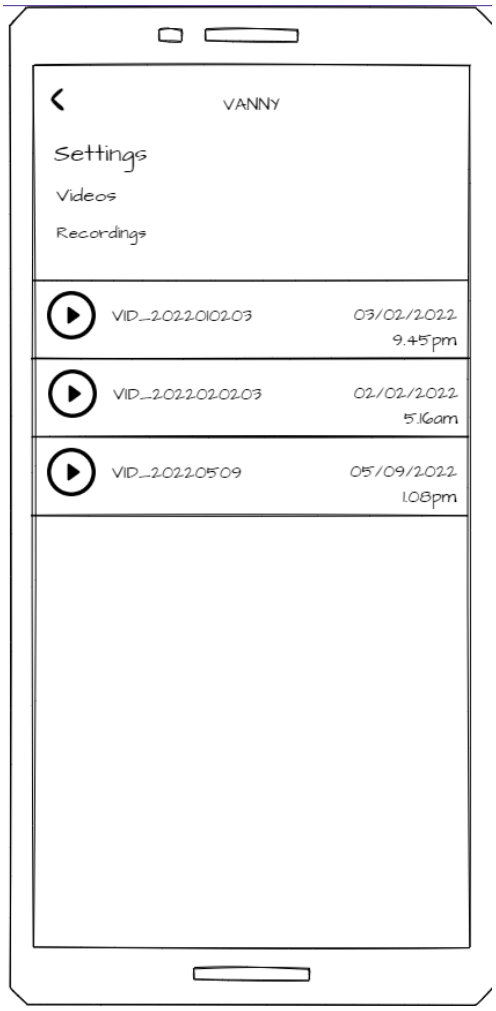

Figure 14: Videos Page

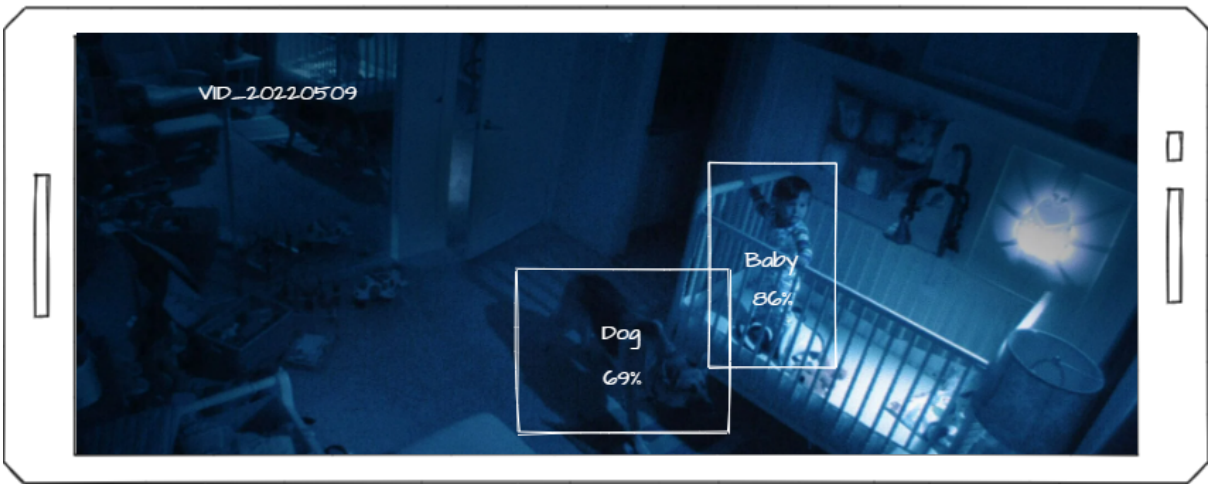

Figure 15: Videos Analysis Page

4. Other Analysis Elements

4.1. Consideration of Various Factors in Engineering Design

In this analysis section, the factors of concern for Vanny are listed. These concerns are as follows; economic factors, data privacy factors, distraction concerns, application misused concerns.

4.1.1 Economic Factors

Vanny is not the first application that aims to enable the parents to monitor and be sure about their babies and toddlers. Even though there are some applications in this market, Vanny improves the weaknesses of those applications and makes the necessary feature additions that increases the effectiveness and usability and therefore provides an enhanced system for the users. The objective of the application is to provide all the features by a minimum price that can be afforded by the users.

However, a possible problem is that in this large market Vanny will have several competitors that have large user populations. On our side we have hardware cost for our application and also computational costs for the functionalities. In case the user majority decides not to spend money and use our application but they prefer the ones that have popularity in the market there happens a danger on our side. The cause of the danger is especially the hardware cost. However, Vanny will try to provide the best performance and usability in the market that is possible and try to be the one which will be chosen.

4.1.2 Data Privacy Factors

Vanny uses streaming to monitor the toddlers of the parents, records the noise and voice in the environment and also enables the parents to record their voices to be used as lullabies that will be sent to the toddlers if desired. Those are the issues that can be considered carefully in order not to violate any regulation in terms of data security and privacy. To be in the safe zone in terms of the data security and privacy GDPR (General Data Protection Regulation) and KVKK (Kişisel Verilerin Korunması Kanunu) regulations must be considered as the main directive.

In our application we do not store the videos of the toddler but instead we are streaming to the parent and we record if an highlighted event occurs. This record is a three minute record and it is deleted by the parent when it is not necessary anymore and will not be stored on our side. Also the parents are granted all kinds of access to the resources that the application has in terms of data.

Moreover the system also provides data security in case an intruder tries to penetrate into the system since all the data is kept locally which makes it safer in terms of any hacking condition.

4.1.3 Distraction Concerns

Our hardware devices will be placed in the room of the toddler or the baby which means the devices such as camera, microphone, and speaker will be in the sight of the toddler 24/7.

That situation can cause some concerns regarding the distraction of the toddler since he/she is at an age that is so susceptible to environmental factors. In case of the night vision the concern might increase since this time the camera needs to use its lighting to watch in the night vision which distracts the toddler's attention to the light in a night time in which the toddler should be having a deep sleep.

Although there are some concerns regarding the issue, those can be overcomed by a good coverage of the hardware devices and by embedding those devices in a proper setting so that it looks natural to the toddler which decreases the possibility that the hardware is too much stand out to the toddler.

4.1.4 Application Misuse Concerns

Although Vanny's target audience is parents and its intended use is to provide a virtual caregiver for babies or toddlers, the system is also open to use for different purposes. For this reason, using it for different purposes may cause ethical problems. In this sense, since there is no control mechanism, users can use Vanny in public areas in violation of privacy.

	Effect Level	Effect
Economic Factors	8	The competitors with high popularity might dominate the market in this field and cause economical issues that prevent the enhancements on the side of Vanny.
Data Privacy	4	Data security and privacy should be granted to the user even in case the followed regulations change.
Distraction Concerns	9	The hardware should not be distracting for the toddler especially in the night vision.
Application Misuse	7	Application can cause undesired and unethical consequences when misused.

Table 1: Various Factors in Engineering

4.2. Risks and Alternatives

4.2.1 Data Transfer Error for Camera

For Vanny, the angle of the camera must be properly determined so that the data can be provided correctly. The camera's field of view should cover the interior of the room and objects as much as possible. At the same time, it is important that the calculations are correct, as the camera angle is necessary to determine the distance between the objects and the baby or toddler.

4.2.2 Image Quality Of The Camera

If the image quality of the camera is not good enough, images may not be detected and parents may not be informed. For Vanny, image acquisition and processing is the heart of the system. Therefore, a camera with high image quality is an important factor for the system.

4.2.3 Detecting Parents Incorrectly

Vanny will use ML algorithms to identify the baby or toddler's parents. However, the face recognition algorithm developed for the baby or toddler to recognize their parents may not always work correctly. An error may occur in this regard. In this case, the system may not recognize the parents and send a false notification, or may recognize a non-parent face as a parent and not send a notification when it should.

4.2.4 Library Version Mismatch

There are several libraries we will use for Vanny. Among them, OpenCv and Tensorflow will be the core libraries. In this case, the versions of the libraries used for the project may not match. At the same time, the continuity of the system may not be ensured due to version incompatibility as a result of updating the libraries used over time.

	Likelihood	Effect On the Project	B Plan Summary
Data Transfer Error for Camera	High	Calculation Errors	Providing calculations with images taken from different angles.
Image Quality Of the Camera	Low	Wrong Notifications	Suggesting a new camera model or limiting the system's operation and camera image quality for high quality images.
Detecting Parents Incorrectly	High	Wrong Notifications	Revising the algorithms used and controlling the success rates.
Library Version Mismatch	Low	Functions related to the library may not work correctly.	Following updated versions or using alternative libraries.

Table 2: Risks and Alternatives

4.3. Project Plan

While models and diagrams represent the technical side of a system, when they are well-constructed they can serve as a guide for the business side of the project. Based on that we split our project plan into different main WBS that mirror our design and use cases. We will have the following major deliverables/milestones:

1. Set up the hardware and processing the input from camera
2. Detecting the toddler with high accuracy.
3. Detecting objects and adults with high accuracy.
4. Audio analysis.
5. Mobile application development.
6. Data optimization and video streaming.

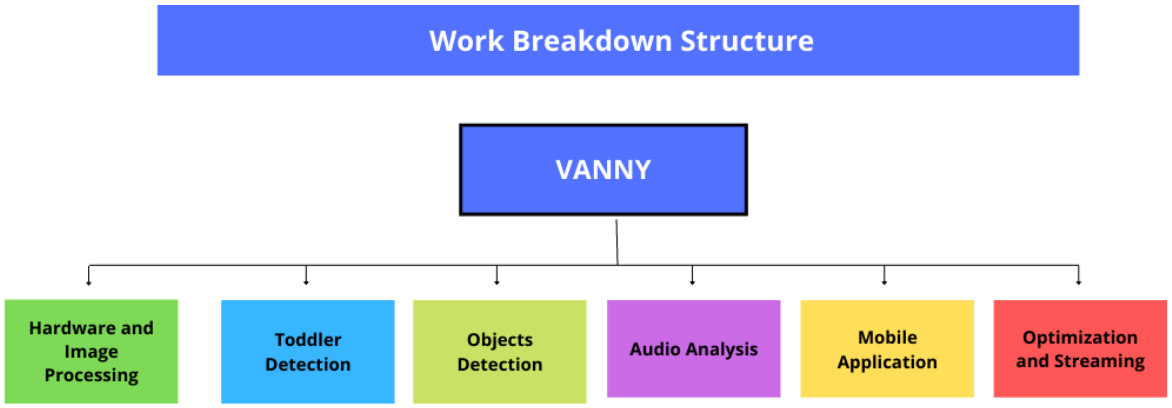

Figure 16: High-level work Breakdown structure

- The break down of each WBS and its explanation are the following:

W.P 1 : Hardware Setup and image Processing.	
Start Date: Week 0	**End Date**: Week 2
Leader: Abdul Razak Daher Khatib	**Members Involved**: Elif Alsac
Objectives: *Our project depends on the image processed using the hardware, namely Raspberry PI and the camera, that require setup. This will be the foundation of our work.*	
Tasks: Task 1.1 Take input from camera: *This task requires the hardware to be properly set up then the camera's basic code to be implemented*. Task 1.2 Encode the videos: *This requires basic manipulations on the data to encode in different formats.*	
Deliverables: D 1.1: Code of basic functionality.	

Table 3: W.P 1 : Hardware Setup and image Processing description.

W.P 2 : Toddler Detection.	
Start Date: Week 3	**End Date**: Week 5
Leader: Esad Tok	**Members Involved**: Wasim Akram
Objectives: *The main focus of our project is the toddler and therefore detecting it with high certainty is crucial for the service to work as intended. This will be the first and most crucial step on the Machine Learning side.*	
Tasks: Task 2.1 Find proper dataset: This task is potentially the hardest and most important part since the certainty will depend on the quality of the datasets provided to the system. Task 2.2 Train the ML library to produce models: Training the Machine Learning library to produce the models to be used later in the code.	
Deliverables: D 2.1: A TensorFlow Lite model.	

Table 4 W.P 2 : Toddler Detection description.

W.P 3 : Object Detection.	
Start Date: Week 6	**End Date**: Week 20
Leader : Esad Tok	**Members Involved**: All 4 members of the team
Objectives: *Similar to the package before it, this package is about finding the datasets and feeding it to the Machine Learning library to produce the appropriate models needed for the task of detecting all other objects. This can take weeks to accomplish high certainty rates.*	
Tasks: Task 3.1 Finding proper datasets: This task includes finding appropriate datasets for each object we are required to detect, this will probably be very time consuming. Task 3.2 Train the ML library to produce models: Training the Machine Learning library to produce the models to be used later in the code.	
Deliverables: D 3.1: TensorFlow Lite models of each of the objects.	

Table 5: W.P 3 : Object Detection description.

W.P 4 : Audio Analysis.	
Start Date: Week 13	**End Date**: Week 15
Leader: Elif Alsac	**Members Involved**: Wasim Akram
Objectives: *This package will deal mainly with detecting crying and loud noises in the toddler's environment.*	
Tasks: Task 4.1 Detecting loud noises: This task will use AI to detect high pitched noises and then generate a report. Task 4.2 Detecting crying: This task will use AI to detect crying noises in the room of the toddler and report it.	
Deliverables: D 4.1: Code that uses AI to detect high pitched noise from the environment. D 4.2: Code that uses AI to detect crying in the room.	

Table 6: W.P 4 : Audio Analysis description.

W.P 5 : Mobile Application.	
Start Date: Week 13	**End Date**: Week 20
Leader: Wasim Akram	**Members Involved**: Abdul Razak
Objectives: *This package will deal with the user interface; A mobile application that establishes connection with the phone over WIFI and communicates with it.*	
Tasks: Task 5.1 Building a mobile application with basic functionalities: A simple mobile application will be built that can show reports and notifies and always the user. Task 5.2 Build connectivity function of the mobile application: In this task the device will pair with the Raspberry PI over the internet in order to keep the parent's updated regarding the situation of their toddler. Task 5.3 Enable the reception of video in real time to the phone : In this task the application will receive the live stream of the camera over WIFI. This task is the most challenging in this package and the reason this task spread along several weeks.	
Deliverables: D 5.1: Full functional mobile application that can communicate with the Raspberry PI.	

Table 7: W.P 5 : Mobile Application description.

W.P 6 : Optimization and Streaming.	
Start Date: Week 0	**End Date**: Week 20
Leader: Abdul Razak Daher Khatib	**Members Involved**: All of the 4 team members.
Objectives: *In order to make the Raspberry PI use the ML models and report instantaneously to the parents, the optimization of the data and proper encoding, compression, and parsing is critical. This work will spread throughout the semester since there can always be a place for optimization. Streaming is in the same package since the most difficult element of streaming is the encoding and the size of the data sent.*	
Tasks: Task 6.1 Proper encoding: This task is about finding the sweet-spot where the video is compressed as much as possible while retaining the necessary resolution. Task 6.2 Data compression: This requires basic manipulations on the data to encode in different formats. This will make saving the data on the Raspberry PI possible and the streaming seamless. Task 6.3 Live streaming: The last task is about streaming the live video to the mobile application, this task will depend on the other tasks and how efficient they are, the better the optimization is the better the live stream will be.	
Deliverables: D 6.1: Efficient encoding and compression. D 6.2: Real time streaming of the toddler's room.	

Table 8: W.P 6 : Optimization and Streaming description.

4.4. Ensuring Proper Teamwork

In any group project, it is extremely important that every member of the team contributes to the project equally. To ensure the wellbeing of the project we needed to decide several factors about the project management. According to the needs of those several factors, we have decided the relevant necessary tools to make our team able to communicate, work, and develop in a proper and even way.

First of all we needed to decide on a communication medium to share our thoughts, and decisions related to the project. At first we assumed that WhatsApp would be enough for that purpose but then we thought that the communication medium should be oriented for our project specific discussions but not everyday chats. Using WhatsApp would create the feeling that we are on a casual communication and it would decrease the seriousness of the communication. Therefore we decided on using Slack as the communication medium for the project. Slack is a tool that is specialised in the industry of professional development which is the best fit for our application as well. Creating and using the proper channels of Slack we can better organise our communication and moreover considering the communication we can be sure that every member of the team participates in the discussions.

Using personal logs is proposed by the jury members of the course and it was an excellent idea to keep track of the work done by each member in the team. To keep the logs, we decided that each team member uses its own medium to record his/her log. In those logs we recorded our progress together with our aims regarding the tasks that we have taken. Since jury members and the supervisor of the team also have the access to those logs, the work done by the members can better be monitored. In addition to the personal logs, we decided to add an additional log for our team to our application that reflects the milestones and the work done in the project. It is also a good source to record the important points in our meetings that are worth mentioning.

Another important aspect of a development process is the version control. In that project we decided to use Git as the version control software. Using Git is a convenient way of ensuring proper teamwork in many aspects. First of all it enables us to keep track of several versions of the application and to better organise the features that are going to be added to the application using Git branches and Merge Requests. Using Merge Requests is also a good way for code reviewing since the remainder of the team is obliged to review the code that is on the Merge Request. If all the team members are in a consensus that the code is written in a proper way and it is working, then it can be merged to the main branch of the

project. It would also ease our work in a way that if we make a mistake in our application and break it, we can easily restore a previous working version of it by returning the relevant commit. We also believe that by observing the commits that are made by the team members, we can ensure that each team member is participating in the project evenly and everyone is putting his/her best for the application.

As the repository hosting service we used GitHub which is a popular repository hosting service that is used among big development teams. Each member of the team is granted the contributor privileges in the repository. The supervisor of the project also has the necessary privileges in order to keep track of the development and make necessary comments if needed. The other deliverables including the reports of the application are also placed in the repository to provide easier access to them.

We also needed a tool to assign tasks to the team members and systematically lead the development path. The tool we decided on was Github Issues. Using github issues we can distribute the work among the members and give proper task descriptions to the works stating the responsibilities of the member that would take the issue. It also enables any member to point out a bug or a feature needed in the application by creating a new issue in Github Issues. It provides systematic management to our project. Our objective is to make regular meetings, designate our milestones and decide the tasks and issues that need to be done to fulfil the milestones that are designated. This way, our supervisor can also observe our journey in this development and see our progress.

4.5. Ethics and Professional Responsibilities

- In order to avoid licence and copyright issues that might be encountered during the development, the open-source libraries will be preferred during the development. Similarly, all software tools that will be used will be free or properly licensed for our usage. All code excerpts copied from the internet or other sources will be referenced properly.
- The application will record the babies and toddlers with the parents consent. It will not be used in any public area which might cause some ethical and social issues. The application will run on a local network and only the devices that are authorised with a predefined password will be able to connect to the camera. Therefore, if any kind of security problem occurs in the local network, the data cannot not be obtained by the attackers.

- When processing the voice of the parent of the toddlers in case of sending the voice to babies, the record is only stored locally therefore it will not cause any problem regarding the sharing of the data with third parties.
- User data will be protected according to the GDPR (General Data Protection Regulation) and KVKK (Kişisel Verilerin Korunması Kanunu) regulations. Any recorded data that is unnecessary for the client and for the performance of the application will not be stored. It is planned to store the highlights and important records with approximately three minute periods will be stored instead of storing the whole record. Moreover, the stored data will be permanently deleted after a period of time such as 3 days unless the user chooses to keep it. Only the parents of the babies and toddlers will have access to the stored data and the live records and that data will not be shared with any third party organisation by any means.
- As team Vanny we also have ethical responsibilities towards the environment and most of the time, calculation requirements constitute considerable amounts of power consumption in the environment. Therefore in our project and calculations, we aim to implement our functionalities in a way that creates a minimum amount of energy consumption making our process sustainable.

4.6. Planning for New Knowledge and Learning Strategies

The project includes several elements that are new and undiscovered by us. Those should be learned by the members that are responsible with the relevant concepts. Therefore there should be useful learning strategies that we can make use of in the process of learning those new knowledge.

One of the biggest aspects in the project that we are unfamiliar with is the hardware specifications of the application. We need to use Raspberry pi 4 in our application together with a camera, speaker and microphone. Managing all those hardware using python is quite a deal. Setting up the Raspberry pi will also challenge us in our development project so we need some good learning strategies for those points. First of all there are many online resources available that enable us to use online learning for this objective. Forums like Stackoverflow can be a good resource since there are many developers just like us, that have faced similar problems before and we can learn from their mistakes and ideas. There is also a group member in our team that has knowledge about Raspberry pi so another learning strategy can be advising a peer in the team. We can also advise an instructor in our department to guide us in terms of hardware issues.

We are developing an Android application and there will be many new concepts for the members of the team that also a good amount of learning. We will use Android Studio for the client side of the application and Java as the programming language. Learning Android also requires an online learning strategy and the best resource for us seems to be the official documentation of Android. Using their documentation and API we can get a good knowledge that can help us on our development. We also have a group member in our team that has information about Android so again advising a peer can be a good learning strategy in this issue as well.

One of the greatest issues in our development is that all of the team members in our team are unfamiliar in the industry of computer vision and machine learning. Our application is based on those concepts and all the team members are required to have a good amount of knowledge in those fields. In this sense we need to make a lot of literature reviews and need to see what are the convenient and proper implementations of the concepts that we are unfamiliar with. We also need to be familiar with the domain and for this purpose we need an expert opinion. Our innovation expert has a good knowledge and career in the field of machine learning, internet of things and computer vision so we can make use of his expert knowledge to get an understanding in the application as well as the solution domain. After we get enough knowledge in the application and solution domain we need to learn about the relevant tools that we are going to use in the field which are mainly OpenCV for computer vision and TensorFlow for machine learning. We are planning to use the official documentations for those python libraries as our main resource. In addition, we can make book reviews if needed and can use other online resources such as w3school to get familiar with them.

To conclude, there are several new concepts and knowledge that we are unfamiliar with and we need not only to be familiar with those concepts but also we need to be practical with them to get the most benefit from them with the highest possible efficiency. In order to accomplish those needs, we need useful learning strategies such as literature reviews, official documentations, peer advising, expert opinion, online learning and book reviews. By applying the relevant strategies and getting the most from those, we are also planning to develop our application in the most possible efficiency so that we can fulfil the non-functional requirements that we are seeking.

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