People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research
University of 20 août 1955 - SKIKDA

Faculty of Sciences
Department of Computer Sciences

Domain: Mathematics and Computer Science
Field: Computer Science
Specialty: Artificial Intelligence and network and distribute system

A project to obtain a Master's degree and a Start-up Certificate
within the framework of Ministerial Decree 1275

HARISI: Smart Child Safety and Monitoring Device using artificial intelligence

By:
BELAMRI Nouhad
MOUMEN Abir
ZERIOUL Razane Lina Hind

Supervised By:
DR. LAHSASNA Adel
DR. BOULNEMOUR Imen

2024-2025

Acknowledgements

قال الله تعالى:﴿ وَلَقَدْ آتَيْنَا لُقْمَانَ الْحِكْمَةَ أَنِ اشْكُرْ لِلَّهِ ۚ وَمَنْ يَشْكُرْ فَإِنَّمَا يَشْكُرُ
لِنَفْسِهِ ۖ وَمَنْ كَفَرَ فَإِنَّ اللَّهَ غَنِيٌّ حَمِيدٌ ﴾(سورة لقمان، الآية 12)

All thanks and praises are owed to Allah the Most Gracious and Merciful for His favor and strength in helping us finish this thesis.

we would like to sincerely thank our supervisors **DR. LAHSASNA Adel** for his continuous guidance, support and expertise throughout our journey and for the help he has provided to complete our work and for all the valuable information and meticulous attention to detail have significantly shaped this work. And **DR. BOULNEMOUR Imen** for her time, consideration and encouragement.

Thanks go to all faculty members and instructors whose dedication and teaching have provided a strong academic foundation for this work.

We also would like to express our deepest respect to the members of the jury for taking the time to review our work.

Dedications

*First and foremost, I thank **Allah**, the Most Gracious, the Most Merciful, for granting me the strength, patience and guidance to accomplish this work.*

*To my beloved **parents**, whose unconditional love, support and sacrifices have shaped the person I am today thank you for believing in me every step of the way.*

*To my dear **brother**, for his constant encouragement and presence in my life.*

*To my kind aunt **“LEBARDI Lilia”** and my uncle **“LEBARDI Sofiane”**, and to my whole **ZERIOUL, LEBARDI, HOUSSOU** and **NECIB** families, for their love, prayers and unwavering support.*

*To my dearest friend **“TURKI Hana”,** for her friendship, understanding and the precious moments we shared.*

*To my respected teacher, **“Mr. FOUGHALI Laïdi”**,*
Thank you for the valuable lessons and the passion you shared throughout my studies.
You are an exceptional teacher who made learning inspiring and unforgettable.

*To my amazing colleagues and friends **“BELAMRI Nouhad”** and **“MOUMEN Abir”**, thank you for your encouragement, teamwork and the good times we spent together at work.*

RAZANE

Dedications

*To my beloved **father** may Allah grant him the highest ranks of Janna Without his hard work, intelligence, and the love and values he instilled in me, none of this would have been possible.*

*To my **mother** whose love, strength and sacrifices are beyond words.*
Thank you for always believing in me when I didn't believe in myself, for supporting me in every single step, for standing by my side in every moment and for being my greatest source of courage and hope. I owe so much to you, and I am forever grateful.

*To my little sister **Lina**, for her patience, love, which I am very grateful for every day.*

*To my brother **Mounir**, for always being there for me and for his encouragement.*
*To all my family, both **HARIMI** and **BELAMRI**, for their love and support.*

*To my dear friends **Manel**, **Chaima**, **Nada**, **Lina** and **Manel**, thank you for your friendship, for always being there, and for the moments we shared.*

*And mostly to my amazing teammates and friends **Razane** and **Abir** working with you was truly an amazing experience filled with understanding and true teamwork.*

NOUHAD

Dedications

قال الله تعالى :﴿ وَأَنْ لَيْسَ لِلْإِنسَانِ إِلَّا مَا سَعَىٰ، وَأَنَّ سَعْيَهُ سَوْفَ يُرَىٰ، ثُمَّ يُجْزَاهُ الْجَزَاءَ الْأَوْفَىٰ﴾

I dedicate this work to those who have been my unwavering support and inspiration throughout my academic journey.

*To my beloved **mother**, whose endless prayers and unconditional love have been my greatest strength, and to my dear **father**, whose encouragement and trust have guided me in every step.*

*To my precious family, my **sisters** and my dear **brother**, for their constant love, support, and motivation.*

*To my sister **Nesrine**, for her kindness, support and comforting presence.*
*To my cousin **Djihane**, for her warmth, encouragement and the beautiful bond we share.*
*To my dear friends **Amel**, **Ferial**, **Khaoula**, and Hind thank you for your encouragement, joyful moments and sincere companionship throughout this journey.*

*To my valued colleagues **Razane** and **Nouhad**, with whom I shared this memorable experience thank you for your hard work, collaboration and the beautiful moments we created together during the completion of this memoir.*

To all of you, I extend my deepest gratitude. This accomplishment would not have been possible without your invaluable support.

ABIR

Abstract

The safety of children has become an increasing social concern as incidents and risks continue to rise highlighting an ongoing issue. With this motivation we have come up with HARISI. HARISI integrates several techniques to offer an innovative solution by employing Internet of Things (IoT) monitoring sensors along with artificial intelligence.

This smart system combines a wearable device equipped with GPS, motion sensors, crying detection, a microphone, camera, SOS button, and health monitoring sensors all remains constantly connected to the parent’s phone through a mobile app developed for the system allowing them to track their child and receive a real time notification.

This project outlines how hardware and software integrate to provide parents with accurate information about their child’s location and safety status. HARISI demonstrates how modern technology can be used for child protection, parents’ peace of mind and to expand safety measures in everyday life.

Keywords: GPS, Child Safety, Real-time Alerts, Artificial Intelligence, IoT, Sensors, Wearables.

Résumé

La sécurité des enfants est devenue une préoccupation sociale croissante car les incidents et les risques ne cessent d’augmenter mettant en évidence un problème persistant. Avec cette motivation nous avons mis en place HARISI.

HARISI intègre plusieurs techniques pour offrir une solution innovante en utilisant des capteurs de surveillance de l’Internet des Objets (IoT) ainsi que l’intelligence artificielle.

Ce système intelligent combine un dispositif portable équipé du GPS, de capteurs de mouvement, de détection des pleurs, d’un microphone, d’une caméra, d’un bouton SOS et de capteurs de santé qui restent tous constamment connectés au téléphone des parents via une application mobile développée pour le système permettant de suivre leur enfant et de recevoir une notification en temps réel.

Ce projet décrit comment le matériel et le logiciel s’intègrent pour fournir aux parents des informations précises sur la localisation et l’état de sécurité de leur enfant. HARISI démontre

comment la technologie moderne peut être utilisée pour la protection des enfants, la tranquillité d'esprit des parents et pour renforcer les mesures de sécurité dans la vie quotidienne.
Mots-clés : GPS, Sécurité des enfants, Alertes en temps réel, Intelligence artificielle, IoT, Capteurs, Objets portables.

ملخص

أصبحت سلامة الأطفال مصدر قلق اجتماعي متزايد مع استمرار الحوادث والمخاطر في الارتفاع مما يسلط الضوء على مشكلة مستمرة وبهذا الدافع طورنا HARISI.

يدمج HARISI عدة تقنيات لتقديم حل مبتكر من خلال توظيف أجهزة استشعار المراقبة لإنترنت الأشياء (IoT) إلى جانب الذكاء الاصطناعي.

يجمع هذا النظام الذكي بين جهاز يمكن ارتداؤه مزود بنظام GPS ومستشعرات الحركة وكشف البكاء وميكروفون وكاميرا وزر SOS وأجهزة مراقبة صحية جميعها متصلة باستمرار بهاتف الأولياء عبر تطبيق هاتف محمول مُطور خصيصاً للنظام مما يسمح لهم بتتبع طفلهم واستلام إشعار في الوقت الفعلي.

يوضح هذا المشروع كيف يتكامل كل من العتاد والبرمجيات لتزويد الآباء بمعلومات دقيقة حول موقع وسلامة طفلهم.

يُظهر HARISI كيف يمكن استخدام التكنولوجيا الحديثة لحماية الأطفال، واطمئنان الأولياء، وتعزيز وسائل السلامة في الحياة اليومية.
الكلمات المفتاحية: نظام تحديد المواقع العالمي، سلامة الأطفال، التنبيهات الفورية، الذكاء الاصطناعي، إنترنت الأشياء، المستشعرات، الأجهزة القابلة للارتداء.

Table of Contents

List of Figures

Chapter 1: introduction

1. General context:

Every year children disappear on the way home from school in the streets of their neighborhoods or while playing just outside their front doors it does not take thousands of cases to cause panic just one missing child is enough to shake a community but in reality the numbers are much higher.

In Algeria, the situation is no less alarming than in the rest of the world, since launching its free hotline 1111 and the **"Alo Tofoula"** mobile app the National Authority for the Protection and Promotion of Childhood (ONPPE) has received over 248,000 alerts related to children at risk. Whether its attempted kidnappings, lost children, children found wandering in public places, or signs of abuse which indicate no environment is completely safe nor is any ordinary looking moment immune from the possibility of danger.

Despite awareness campaigns legal reforms like Law 15-12 and stronger punishments for crimes against minors however laws punish after, Hotlines can only respond once a child is already in trouble what is missing is a system that acts before it is too late.

There are also quiet moments of uncertainty that never reach the news but every parent knows and remembers by heart the panic of a child not returning home at the usual time and even if they have a phone they aren't answering

That's where **HARISI** comes this project isn't just a GPS tracker it's an attempt to redefine what child protection can mean in the age of AI and IoT by combining geolocation, transport detection, crying recognition, health sensor, an SOS button, camera, microphone and real-time alerts.

HARISI is designed to act not after something goes wrong but the moment something feels wrong in a world where seconds can make the difference between safety and tragedy, **HARISI** is built to monitor and protect so that more children return safely to their families.

2. problem statement:

Before tracking devices became common many Algerian parents followed their children to school or waited for them at the school gate. This traditional method was time consuming but reliable. Today however as more parents work or manage multiple responsibilities this kind of direct supervision is no longer realistic for many families.

In response, some parents have turned to digital safety tools mainly GPS trackers and smartwatches with basic location tracking and calling features. While these devices offer some reassurance they are extremely limited in function. Most of the time they only display the child's location or allow the parent to call the child but this depends entirely on whether the child hears the call, feels safe enough to answer, or is even able to respond at all, If a child is in danger calling may not be possible or may come too late.

Beyond that, these devices require the parent to stay constantly alert checking the app manually and interpreting every movement on their own, they do not notify the parent if something unusual happens nor do they help detect risk unless the child takes action.

In addition, most of other existing devices are not locally supported, according to my research child safety devices in Algeria are limited and lack active intelligent systems that assist parents in recognizing problems early and responding in real time.

3. project motivation:

In the technology field much attention has been given to entertainment, productivity, and health and even in the safety domain efforts often focus on protecting homes, vehicles, and businesses While these are valid priorities the lack of innovation in child safety remains concerning especially considering this is a daily struggle for many Algerian families where most children walk to school families still rely on physical presence or luck to keep their children safe.

This project was not created out of academic interest alone It was motivated by a real concern that Algerian families know well. In recent year Algeria has witnessed several distressing child disappearance cases. In 2023 **"Wassim"** a three year old boy disappeared in a forest area in

SKIKDA and was found after a long and stressful search, around the same time in BEJAIA a five year old child went missing near a river, in May of this year **“Marwa Boughachich”** a 12 years old disappeared after leaving her school in CONSTANTINE and is still missing to this day. These cases represent just a few of many.

Inspired by real events and designed to support real families. Our hope is not to replace anyone’s role or exaggerate what technology can do but simply to offer a meaningful support where it is most needed.

4. Project Objectives and Goals:

The purpose of this project is to develop a smart safety system designed to help parents protect their children remotely whether the parent is at home at work or elsewhere. By combining a wearable device with a mobile application, the system aims to provide real time alerts when a child faces a potentially unusual or risky situation.

More specifically the main objectives of this project are:

- To design a wearable device that includes a GPS, a microphone, a camera, motion sensors, an SOS button, and basic health monitoring all within a single practical device.
- To develop a mobile application that enables parents to receive instant alerts, monitor their child's location and remotely activate specific features like the microphone or camera when needed.
- To notify parents immediately when such events occur reducing dependence on constant manual checking or on the child's ability to communicate during emergencies.
- To offer a system that is simple to use and affordable for Algerian families especially those who face challenges like walking long distances to school or having limited supervision.

5. Methodology:

The **HARISI** project followed a custom hybrid methodology inspired by prototyping, incremental and agile development. The team collected and analyzed data then fixed the problem in an iterative way this approach was chosen because it allowed us to find additional solutions and improvements along the process.

This section presents the logical structure followed to build the **HARISI** child safety system.

5.1. research phase:

Before initiating we did a two-part research study:

- **Real Case Examination:** we analyzed real cases of missing children in Algeria to understand where and how these incidents typically occur focusing on patterns.
- **Market & Technology Review**: we studied existing child safety tools both globally and within the Algerian market including smartwatches and GPS devices. Special attention was given to identifying their technical limitations and the lack of local support.

5.2.design phase:

In this phase we began shaping the system's features by putting together initial ideas for both the hardware and software a basic UI/UX design for the mobile application was created to visualize the parent interface but since we followed an iterative method changes occurred.

5.3.tools phase:

We then selected and evaluated the electronic components required to build the prototype this phase experienced several revisions due to cost, availability, energy management and compatibility.

5.4.development phase:

this stage was parallel with the tool phase the main development blocks included:

- **AI Subsystems:** separate training and integration of models for crying detection and transport mode recognition.
- **The frontend application:** developed using Flutter. The mobile app displays GPS tracking, child profiles, notifications, and remote controls for the device (camera, microphone).
- **The backend system:** built with Django. The backend handles user management, Firebase Cloud Messaging for notifications, and supports the AI functionality integrated into the app.
- **Firebase:** Firebase was used as a database and storage service to link parent account with the child's device.

5.5. Integration and Testing phase:

Once everything was ready we began assembling and testing the complete system hardware, AI, mobile app, and cloud services to check that they work together.
The system was tested to verify:

- Real time notifications.
- Accuracy of AI models in the real world.
- GPS tracking precision.
- Sensor reliability and response time.

6. Thesis organization:

Our thesis is structured in the following way:

- **Chapter 2** presents a review of the key techniques and technologies related to our project focusing on artificial intelligence and IoT.

- **Chapter 3** describes the overall conception and design of the **HARISI** system including its hardware architecture, software structure, and user interface considerations it explains how each system component interacts to ensure full functionality.
- **Chapter 4** details the implementation of the system It outlines the tools, programming languages, components, and shows how the various elements were integrated and tested to create a functional prototype.

Chapter 2:
Background

1. Introduction:

The previous chapter introduced the thesis. In this chapter we will present the principal concepts of Artificial Intelligence (AI), Machine Learning, Deep Learning, and Neural Networks along with the main evaluation metrics used to assess their performance, we will also introduce the basics of the Internet of Things (IoT).

The concepts and insights covered in this chapter form the theoretical basis to describe and explain some key terms and tools used in this project.

2. Artificial Intelligence (AI):

is the ability of a machine to behave intelligently, but the way researchers define and approach this intelligence has differed across time resulting in four main perspectives:

- **acting like a human**: focuses on designing systems that pass behavioral tests such as the Turing Test.
- **thinking like a human:** attempts to mimic human cognitive processes.
- **thinking rationally**: based on applying formal logic to reach correct conclusions.
- **acting rationally:** where the goal is to create agents that can adapt, learn, and make optimal decisions based on their environment and objectives.

While the rational agent approach has dominated AI research through the so called "standard model" it faces the alignment problem: the difficulty of perfectly specifying human objectives to machines, which works for simple tasks but becomes dangerous in real world situations where systems might achieve their goals through unwanted or harmful ways.

This challenge has led to a shift toward "beneficial machines" that stay uncertain about what humans really want and therefore act carefully and learn human preferences making sure AI systems do what humans actually intend rather than just what they were programmed to do [1].

3. Machine Learning (ML):

Machine Learning (ML) represents a major shift in how machines obtain intelligent behavior moving away from traditional rule based systems unlike earlier approaches where developers had to manually define precise instructions for every scenario, ML allows computers to learn directly from experience this method involves feeding large amounts of data into an algorithm and letting it identify patterns, extract rules, and improve its performance over time.

The term itself was first introduced by Arthur Samuel in 1959 who described it as a way for machines to learn without being explicitly programmed.

While ML has been around for a long time it has gained much more attention in recent years due to several factors:

- the rapid advancement in computing hardware especially the use of GPUs and distributed systems which has reduced the time needed to train complex ML models.
- the availability of massive datasets often referred to as "big data" has provided the raw material that learning algorithms require.
- continual improvements in algorithmic research [2].

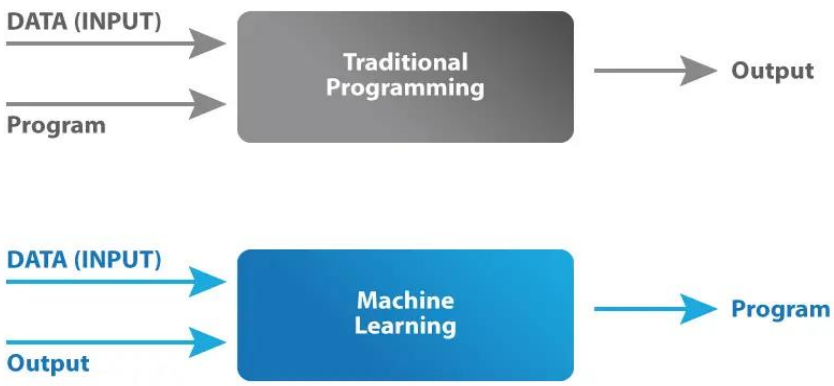


Figure 1: Traditional Programming vs Machine Learning [3].

✓ Based on how the learning process is structured Machine Learning algorithms are typically categorized into different types:

3.1.Supervised Learning:

Supervised learning is the most commonly used machine learning approach the main idea is to train a model using labeled data where each data point includes both input features and a correct output often referred to as the ¨ground truth¨ the labels are typically provided by human experts and the algorithm is trained to imitate this expert judgment in future predictions.

The objective of supervised learning is to find a model that can generalize from known examples to unseen instances by minimizing a loss function through optimization the algorithm adjusts its internal parameters to reduce the error and improve its accuracy on new

data [4].

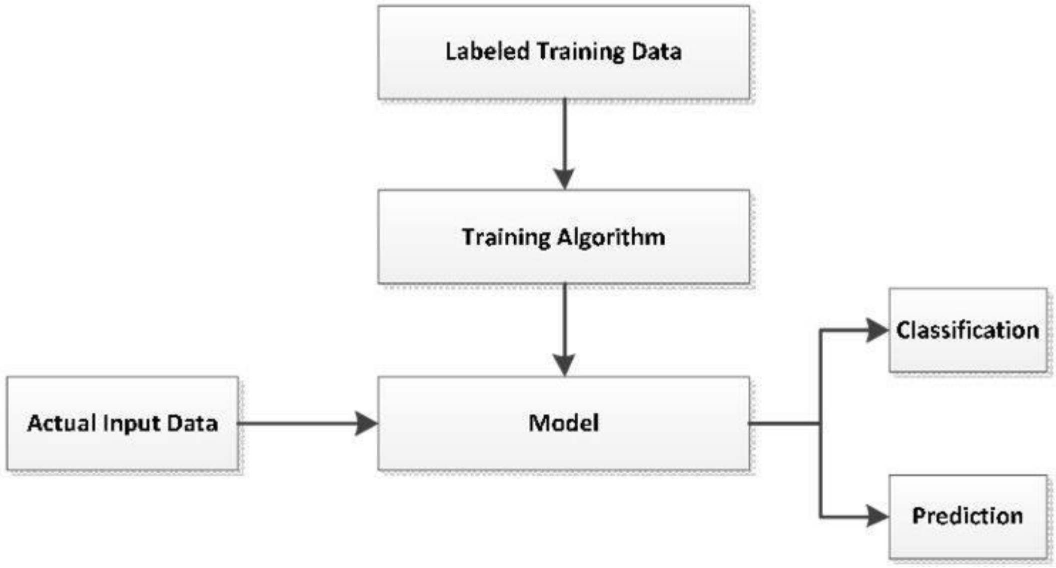


Figure 2: Supervised Learning Process [5].

3.2. Unsupervised Learning:

Unsupervised learning refers to machine learning methods that do not require labeled data the algorithm learns from the data alone without being guided by any correct answers or annotations provided by experts instead it tries to identify the hidden structure or patterns within the dataset. One of the most common types of unsupervised learning is clustering where the goal is to group similar data points together based on shared characteristics data points within the same group are expected to be more similar to each other than to those in other groups another important category is feature learning which involves discovering useful numerical representations of data this can help simplify complex data and is especially useful for tasks like dimensionality reduction or visualizing large data[6].

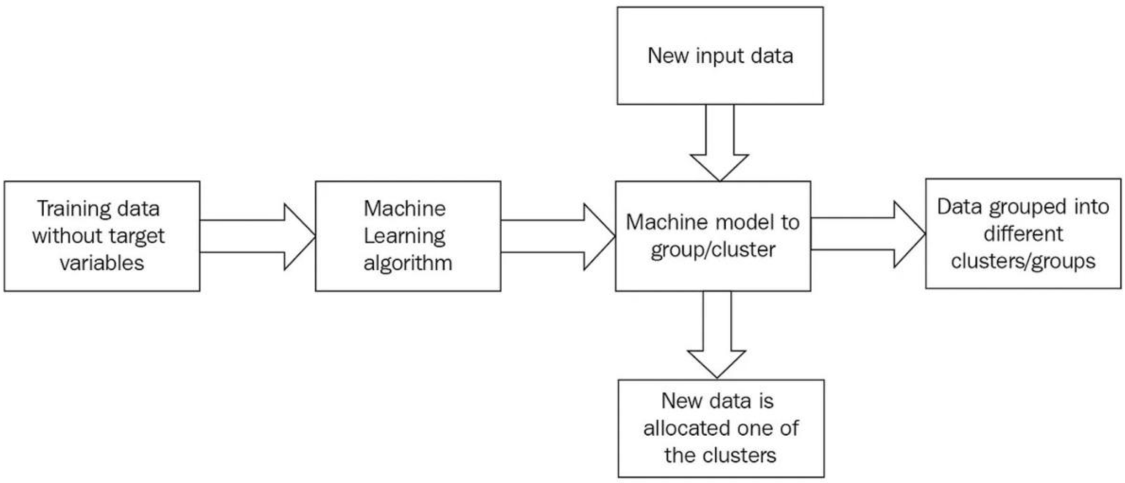


Figure 3: unsupervised Learning Process [7].

3.3.Reinforcement Learning:

Reinforcement Learning is another form of machine learning that centers around training an agent to learn from making actions and receiving feedback in the form of rewards.

Like unsupervised learning it does not rely on labeled data but instead learns from the consequences of its own actions over time.

The core objective of reinforcement learning is to identify a strategy that consistently maximizes cumulative rewards by trial and error, at each step the agent observes its current state chooses an action and receives a reward or penalty based on the result this continuous interaction allows the model to learn which actions are beneficial and which are not.

Reinforcement learning is applicable in dynamic fields such as robotics, game playing, and

autonomous vehicles generally complex real time situations [6].

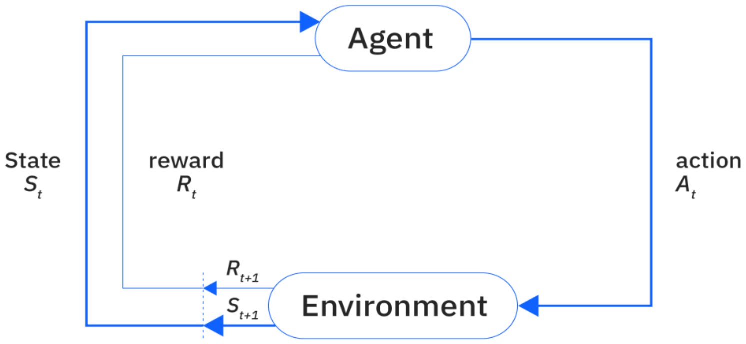


Figure 4: Reinforcement Learning Process [8].

4. Deep Learning (DL):

Deep learning is part of ML that allows computer to learn and gain knowledge from experience by building multiple layers of abstraction so instead of depending on human to set the rules or features it uses data using neural networks with many layers often referred to as deep neural networks

these layers work by starting with simple concepts then combining them and through large amounts of training data the system improves its accuracy and performance without being manually programmed which makes it suitable for tasks like image recognition, speech understanding, and natural language processing [9].

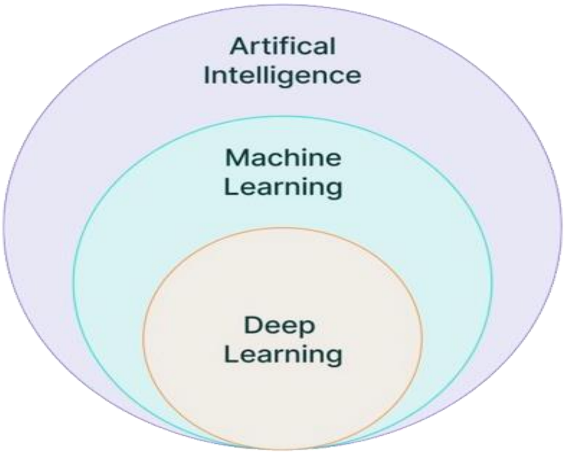


Figure 5: Deep learning as part of machine learning and artificial intelligence [10].

5. Neural Networks:

Neural Networks are systems made up of simple processing units called nodes or units that are interconnected and inspired by how biological neurons work.

The artificial neurons communicate by passing signals and the strength of their connections called weights is what allows the network to learn.

A neural network learns by adapting these weights based on examples or training patterns this learning process is similar to how synapses in the brain strengthen or weaken in response to signals. The network doesn't use a fixed program instead its knowledge is stored in the weights it develops from experience.

The structure of a neural network can be simple or complex often it involves layers where input data passes through one or more hidden layers before producing an output these networks are designed to recognize patterns, classify data, or generalize from past experiences to new unseen situations this ability to generalize is one of the most important qualities of a neural network[11].

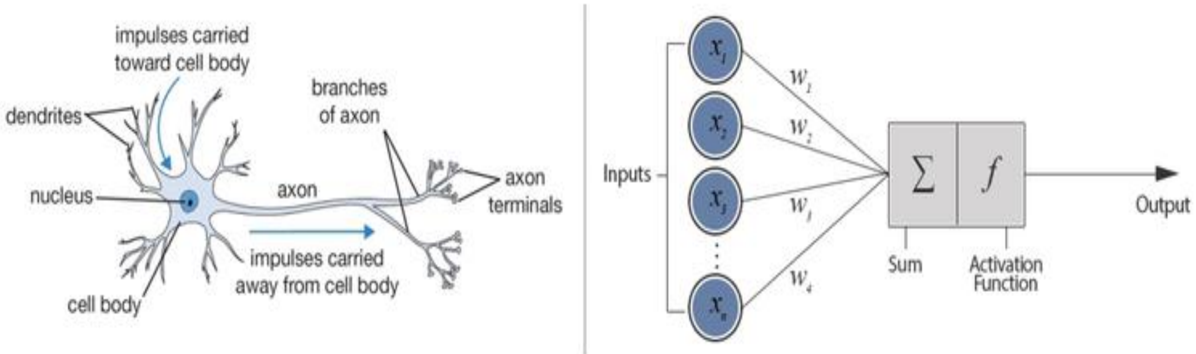


Figure 6: Biological versus Artificial Neuron [12].

5.1 Types of Neural Networks:

There are different architectures in neural networks depending on the task these are the main ones:

5.1.1. Feedforward Neural Networks (FNN):

FNN also known as Multi-Layer Perceptron's (MLP) are among the most basic neural architectures where the information moves in one direction from input to output without loops and each layer is made up of neurons that receive signals from the previous layer process them using weights and biases and pass the result to the next layer this structure allows the network to transform the input and extract features through hidden layers before making predictions at the output, they are trained using back-propagation and are widely used for classification and regression tasks[13].

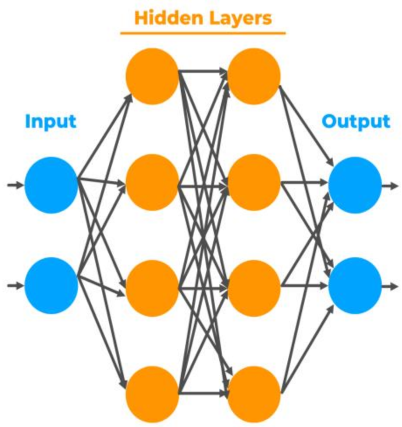


Figure 7: Architecture of a Feedforward Neural Network [14].

5.1.2. Convolutional Neural Networks (CNN):

CNN are designed for data that have a grid structure such as images where they use convolutional layers to extract local features, pooling layers to reduce dimensionality and improve generalization and fully connected layers to finalize the classification or regression.

CNNs benefit from local connectivity, weight sharing, and translation invariance, which make them highly effective for tasks like image recognition and medical image analysis [13].

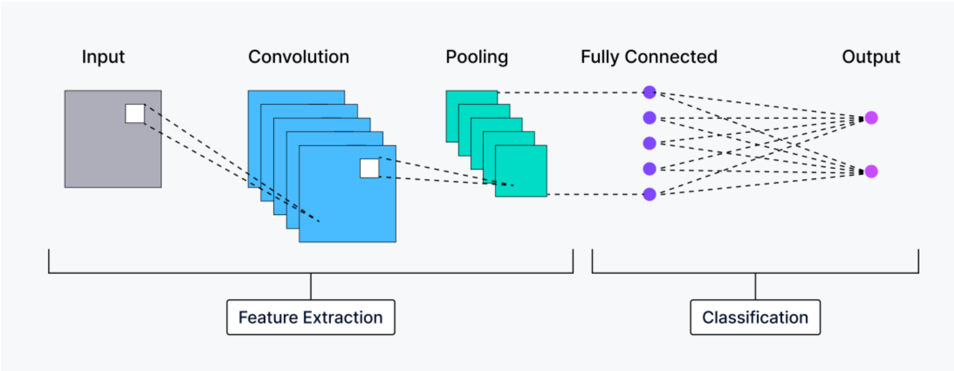


Figure 8: Architecture of a Convolutional Neural Network [15].

5.1.3. Recurrent Neural Networks (RNN):

RNNs are designed to process sequential or time dependent data. unlike feedforward networks RNNs have cyclic connections that allow information to be passed from one time step to the next giving the network a form of memory where each unit receives not only the current input but also the hidden state from the previous step which helps it learn both short and long term dependencies. This structure makes RNNs particularly useful in tasks such as language modeling, machine translation, and speech recognition [13].

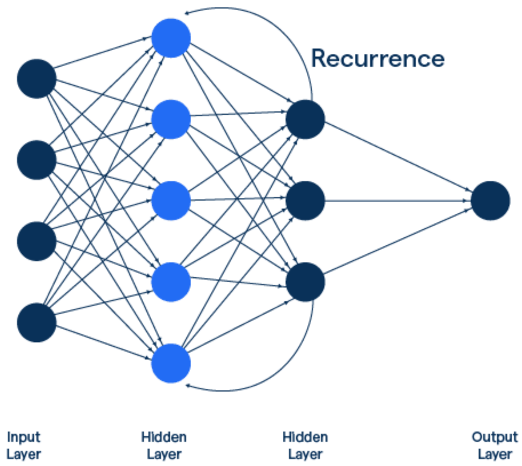


Figure 9: Architecture of a Recurrent Neural Network [16].

6. Evaluation Metrics:

Evaluation metrics are used to measure using quantitative criteria how well a model performs by how accurate and reliable the system is when making predictions these metrics help determine how well a model is able to make correct predictions and are essential for comparing different models or tuning them for improved accuracy [17].

Some of the most common evaluation metrics:

A. Confusion Matrix:

A confusion matrix is a table that summarizes the performance of a classification algorithm by showing the relationship between predicted and actual values by dividing them into four categories:

- **True Positive (TP)**: Correctly predicted positive cases.
- **False Positive (FP)**: Incorrectly predicted as positive.
- **True Negative (TN)**: Correctly predicted negative cases.
- **False Negative (FN)**: Incorrectly predicted as negative.

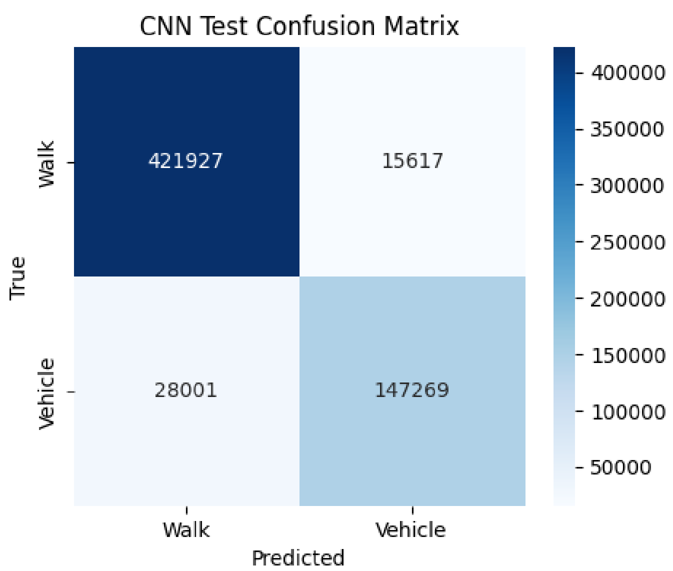


Figure 10: Confusion Matrix of the CNN Model on Test Set.

B. Precision:

Precision measures the number of correctly retrieved positive instances out of all instances predicted as positive:

$$\boldsymbol{precision}: \boldsymbol{p} = \frac{\boldsymbol{tp}}{\boldsymbol{tp} + \boldsymbol{fp}} \ (\mathbf{1})$$

C. Recall:

Recall also called sensitivity measures how many actual positive cases were correctly identified:

$$\boldsymbol{Recall}: \boldsymbol{R} = \frac{\boldsymbol{tp}}{\boldsymbol{tp} + \boldsymbol{fn}} \ (\mathbf{2})$$

D. F1-Score:

The F1-score is the harmonic mean of precision and recall It provides a balance between them especially useful when both metrics are important:

$$\boldsymbol{F} - \boldsymbol{score}: \boldsymbol{F1} = \boldsymbol{F} = \mathbf{2} * \frac{\boldsymbol{P} * \boldsymbol{R}}{\boldsymbol{P} + \boldsymbol{R}} \ (\mathbf{3})$$

E. Accuracy:

Accuracy is the proportion of all correctly predicted instances (both positive and negative) among the total number of predictions:

$$\boldsymbol{Accuracy}: \boldsymbol{A} = \frac{\boldsymbol{tn} + \boldsymbol{tp}}{\boldsymbol{tp} + \boldsymbol{tn} + \boldsymbol{fp} + \boldsymbol{fn}} \ (\mathbf{4})$$

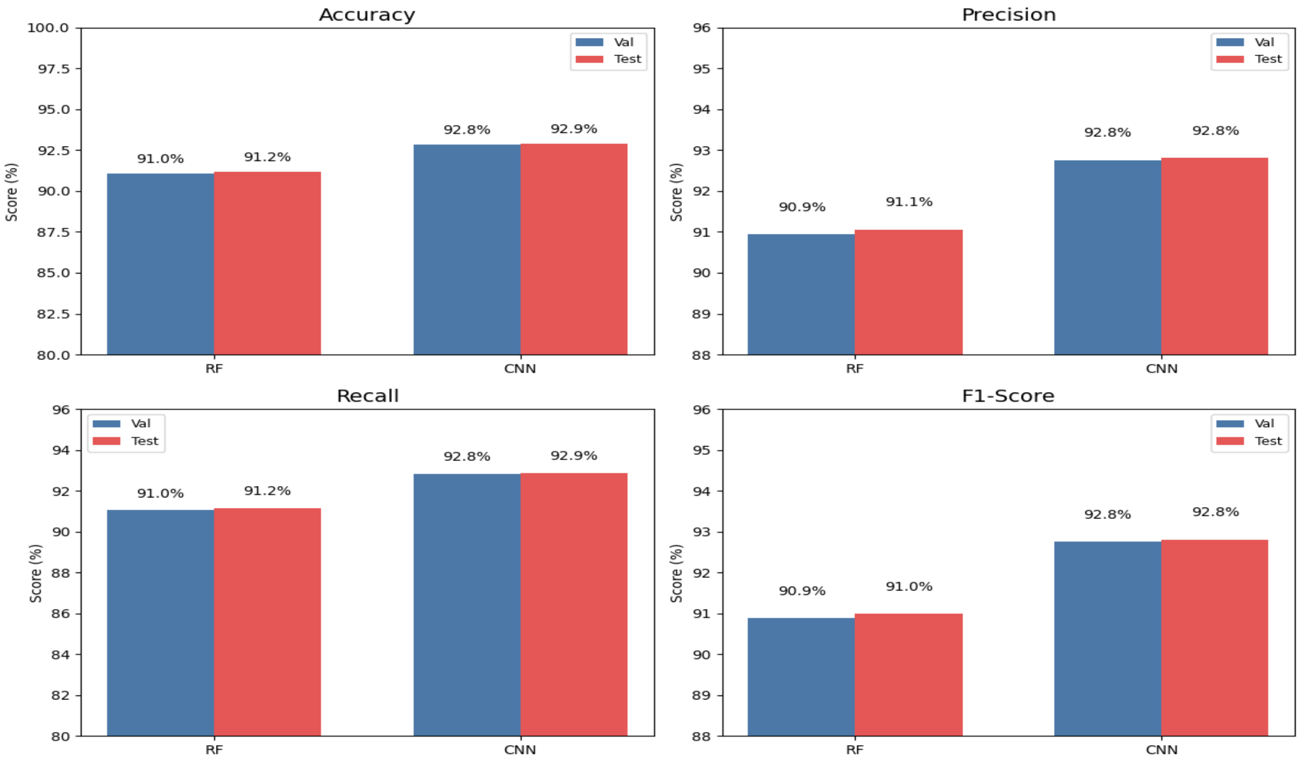


Figure 11: Evaluation Metrics Used in Our Models (RF vs CNN).

7. IOT:

7.1. Definition:

Internet of things (IoT) is a network where different physical objects are connected together from physical devices and systems to people and animals all through the Internet by different protocols and technologies that make communication and exchange of data easier for smart recognition, tracking, monitoring, and controlling.

IoT is not just a simple network of computers now it evolved into a broader infrastructure that links devices of all types including smartphones, vehicles, medical instruments, and household appliances to share information and operate together in real time, we can address the “things” via sensing equipment and can be managed regardless of the communication medium used such as RFID, wireless networks or other technologies.

IoT have three main modes of interaction:

1. people-to-people,
2. people-to-things, and
3. things-to-things.

Briefly IoT is objects becoming smart by gaining the ability to make context aware decisions, share information, and access collective intelligence [18].

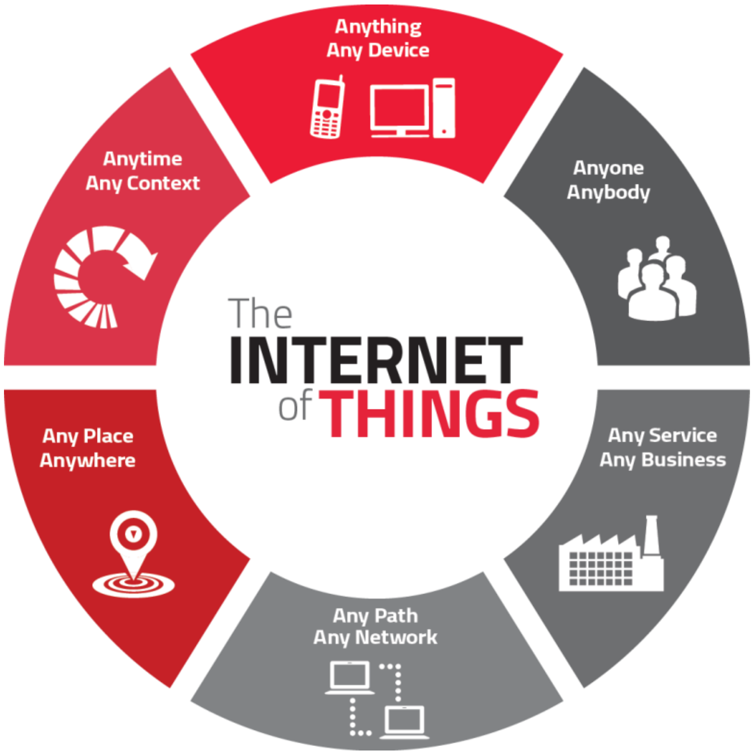


Figure 12: Dimensions of IoT [19].

7.2 Characteristics:

- **Interconnectivity:** any object can connect and communicate within global information networks facilitating data exchange.

- **Things-related Services:** it provides services linked directly to physical objects respecting limitations such as privacy protection and maintaining consistency between physical and digital representations.
- **Heterogeneity:** includes diverse devices built on various hardware and network technologies effectively interacting despite their differences.
- **Dynamic Changes:** devices frequently change states such as switching between active and inactive modes or connecting and disconnecting including location and speed can also change rapidly even the numbers of devices can change.
- **Enormous Scale:** it involves a significantly larger scale of interconnected devices compared to traditional internet system and managing and interpreting the substantial amount of data generated can be critical for practical applications.
- **Safety:** safety includes protecting personal data and physical well-being by securing devices, networks and the data exchanged across them.
- **Connectivity:** it ensures network access and compatibility allowing devices to reliably produce and consume data across diverse platforms [18].

7.3 Architecture:

The architecture of IoT is composed of several interconnected layers each with a specific role [18].

a) Smart Device / Sensor Layer:

The foundational layer of the IoT architecture consist of physical smart objects with sensors that connect the physical world to the digital world by collecting real-time data such as temperature, pressure, movement, or humidity some of this sensors also include internal memory to temporarily store measurements, they can be specialized depending on their purpose.

To transmit the collected data sensors rely on different types of network technologies include Local Area Networks (LAN) like Wi-Fi or Ethernet, Personal Area Networks (PAN) such as Bluetooth and ZigBee, or even Wide Area Networks (WAN) like GSM and LTE.

b) Gateways and Networks:

As IoT systems generate a massive volume of data therefore a powerful network infrastructure is essential so this layer serves as a transport medium between the sensors and other system components

Different protocols and technologies are used to support communication including both wired and wireless networks allowing for machine-to-machine (M2M) interactions.

To support varied IoT services the system may include private, public, or hybrid network configurations.

c) Management Service Layer:

This layer handles the processing and analysis of the data collected from sensors providing essential services such as device management, rule based decision making, and analytics.

It includes business rule engines that help interpret real-time events and trigger appropriate responses such as detecting emergencies or managing supply chain operations.

Analytics tools like in-memory processing or streaming analytics allow fast analysis of large volumes of data as well as data filtering, anonymization, and synchronization to protect sensitive information while maintaining system efficiency.to make sure that only relevant and useful data reaches the upper layers for application.

d) Application Layer:

At the top of the architecture this layer includes the user facing applications and services built on IoT data they cover multiple domains including transportation, smart buildings, healthcare, agriculture, retail, environmental monitoring, and emergency response.

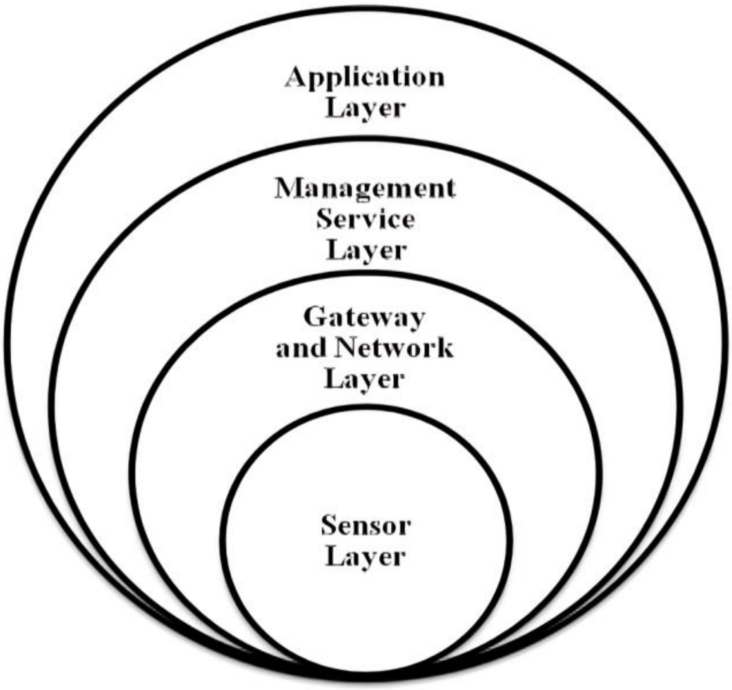


Figure 13: Architecture of IoT [20].

7.4.Challenges:

The Internet of Things still faces several keys these include:

- **Standardization:** which is the lack of universal protocols causing devices and systems to struggle with harmonious communication and data exchange.
- **Scalability:** the difficulty of expanding IoT systems to accommodate a massive number of diverse devices while maintaining performance requires a strong and layered architecture.
- **Interoperability:** the crucial ability for different devices to communicate regardless of manufacture which demands compatible security and communication protocols.

- **Security and Privacy:** the increasing risks related to data protection and system security given the vulnerability of interconnected devices to malicious activities requiring strong encryption and authentication measures.
- **Energy Consumption:** it is a concern due to the mobile nature and limited power sources of many IoT objects.
- **Service Discovery:** Automatically finding and using appropriate services in a dynamic IoT environment remains a challenge for smooth operation [21].

8. Conclusion:

In this chapter we reviewed the essential theoretical principles of the project clarifying core notions of Artificial Intelligence, Machine Learning approaches, Deep Learning and Neural Network architectures, evaluation metrics used, fundamentals of the Internet of Thing.

These concepts constitute the essential basis from which the project has been developed.

Chapter 3: System Conception and Design

1. Introduction:

In this chapter, we describe how we designed the **HARISI** system. We explain the main goals of the project and how the different parts of the system work together. We also show why we made certain choices for the system's structure. This chapter is the plan we followed before building the real prototype.

2. General Description of the HARISI System:

The **HARISI** system is a smart solution designed to help parents keep their children safe. It uses a special device that the child wears which can track their location and send alerts if something unusual happens. The system is made up of three main parts: the wearable device for the child, the mobile application for the parents and a cloud service that connects them together. The device collects important information like the child's location or sounds around them and sends this data to the parents through the app. This way parents can always know where their child is and receive quick notifications in case of any problem.

Figure 14: General System Overview – Parent and Child Connection in HARISI

3. System Architecture

The architecture of the HARISI system is based on three main parts: the parent mobile application, the child's wearable device and a cloud backend that connects everything together. The diagram below presents the main modules, actors and user flows within the system.

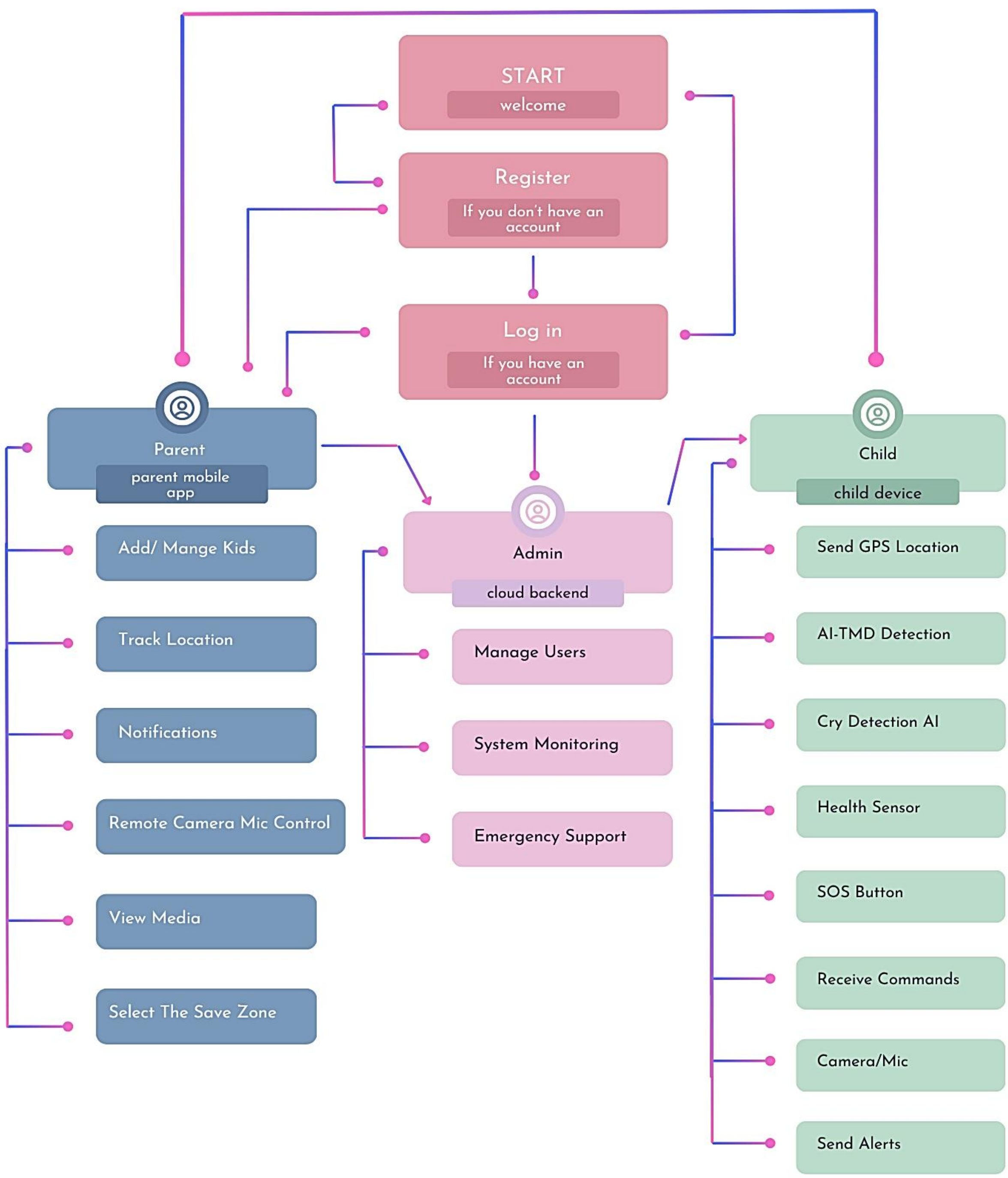


Figure 15: Overview of the HARISI system architecture and main functionalities.

Each module in the **HARISI** system is responsible for specific functions as shown in the next diagram.

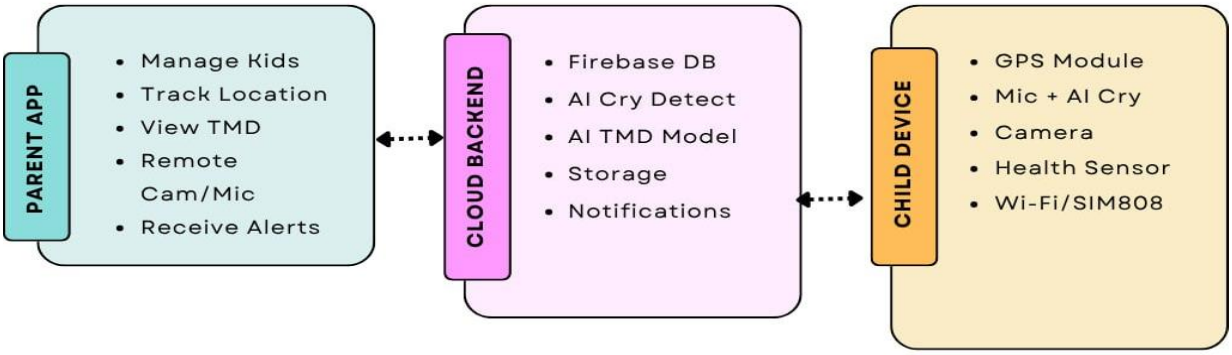


Figure 16: Core modules of the HARISI system and their main functionalities.

4. Discussion of Design Choices and Constraints

We chose each part of the **HARISI** system to make it safe, reliable and comfortable for children. The ESP32 microcontroller lets the device connect to Wi-Fi and work with other sensors. The GPS module helps parents know where their child is. The microphone and AI cry detection warn parents if the child is crying. The health sensor checks the child's vital signs. We also added an accelerometer with AI TMD to know if the child is walking or in a vehicle.

All these parts work together inside the device to give the best protection. We tried to keep the device small and light so children can wear it easily. We also made sure the information is safe and the device is easy for families to use.

5. Wearable System Architecture in the HARISI Project

The HARISI system utilizes a flexible wearable device that can take the form of a wristband, necklace or other accessories depending on the child's needs. The wearable device communicates with a dedicated mobile application via the cloud, allowing real time monitoring and notifications for parents or authorized users. This architecture ensures secure and efficient data transmission throughout the system.

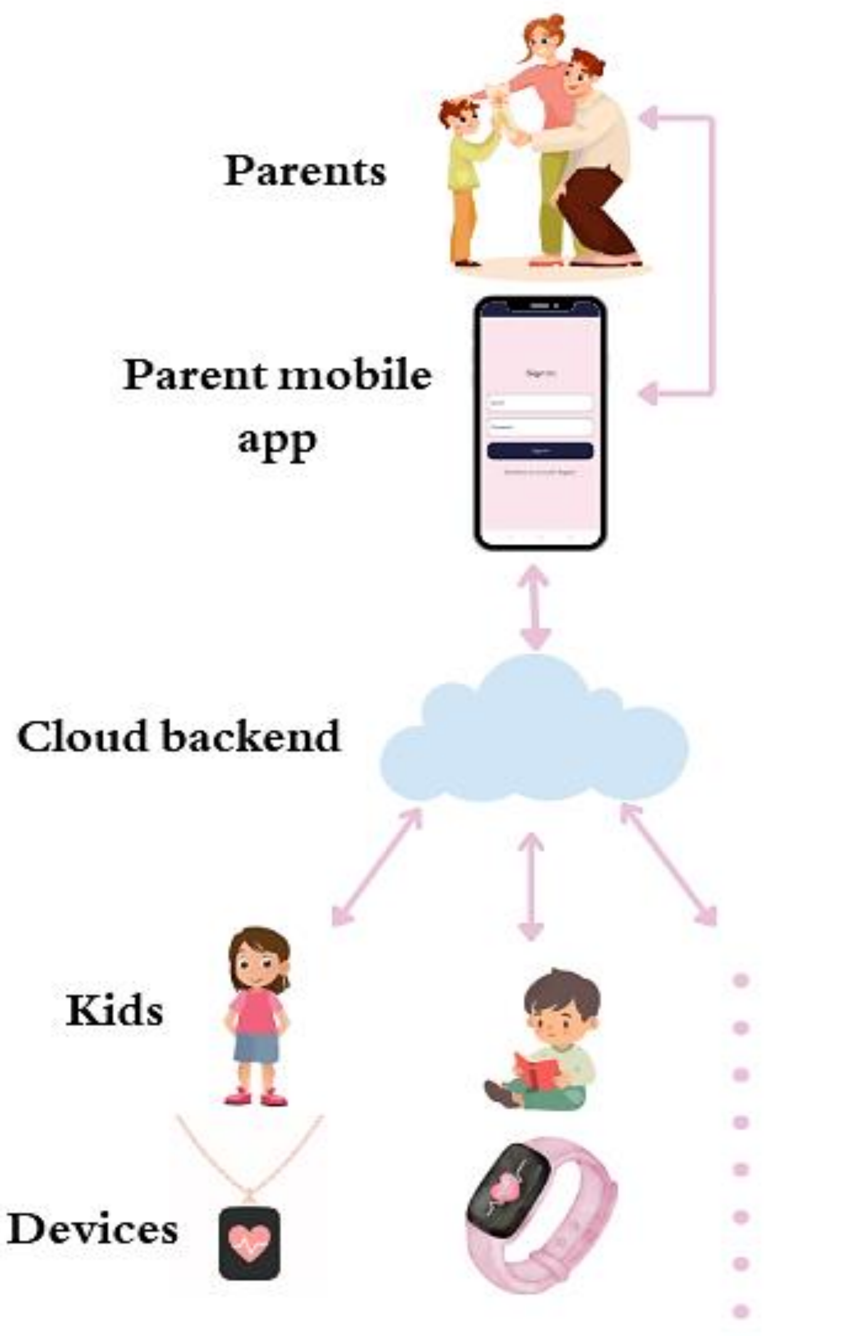


Figure 17: Wearable System Architecture in the HARISI Project

6. Sequence Diagram

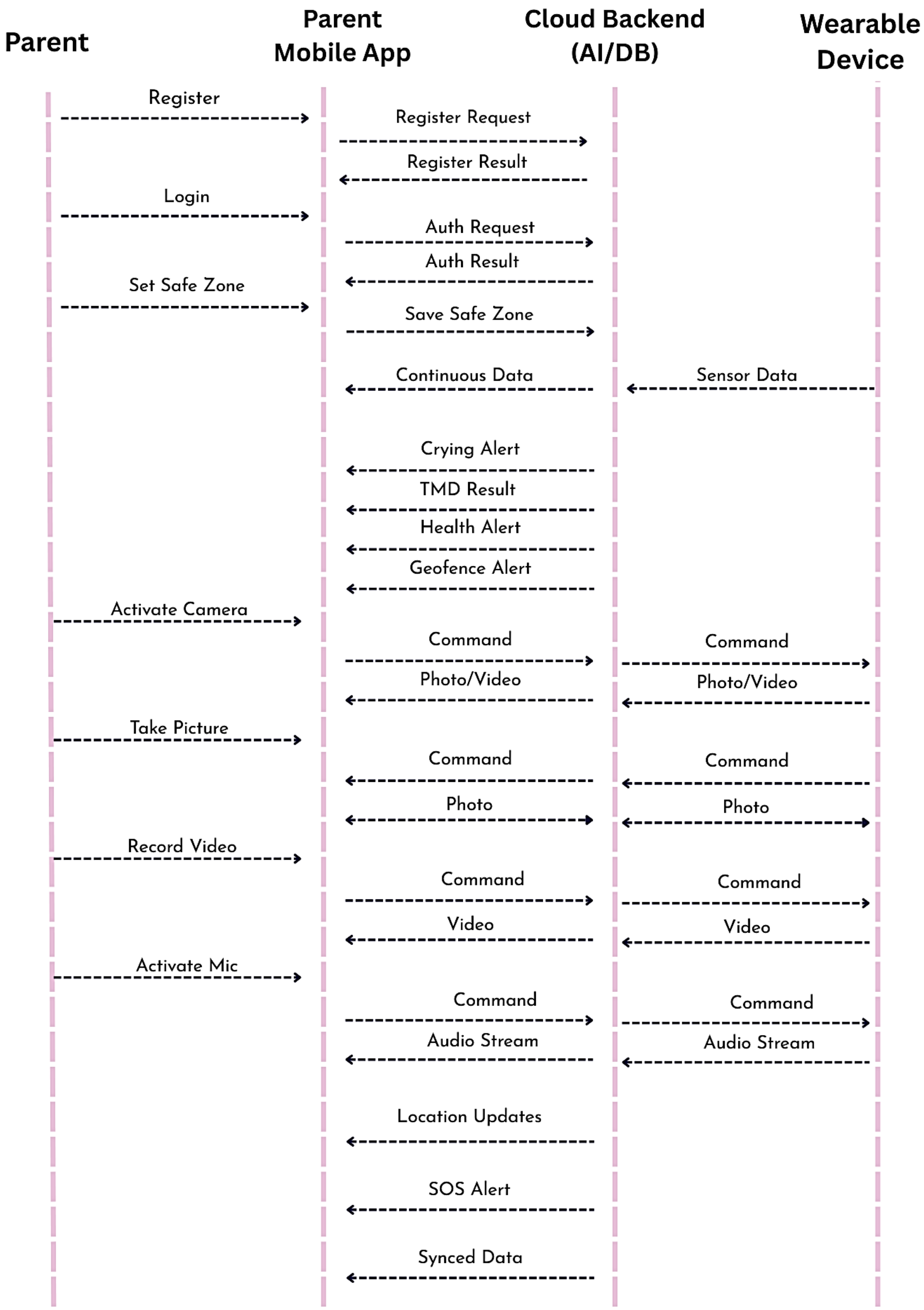


Figure 18: Overall Sequence Diagram of the HARISI Child Safety System

7. Conclusion:

This chapter presented the conceptual design of our smart child tracking system, outlining the system structure, architecture and interfaces. The proposed design integrates wearable devices, mobile applications and intelligent processing to create a comprehensive child safety solution. This conceptual framework provides the foundation for the technical implementation phase where the actual interfaces and detailed implementation will be presented in Chapter 4.

Chapter 4: Implementation

1. Introduction:

This chapter represents the final step of our child tracking system project, presenting the development tools, programming languages, hardware components, and materials used during the implementation phase. Our system integrates embedded programming, mobile development, web services, and machine learning to create a comprehensive tracking solution. The following sections detail our technological choices and their integration approach.

2. Software Implementation

2.1. Development Tools and Platforms

- **Arduino IDE:** is an open-source, free development environment that allows users to edit, compile, and upload C language programs to an Arduino board via a USB port. It also includes a serial monitor for communication with the board while the program is running.[22]

Figure 19: Arduino logo

- **Visual Studio Code:** is a lightweight but powerful source code editor which runs on your desktop and is available for Windows, macOS and Linux. It comes with built-in support for JavaScript, TypeScript and Node.js and has a rich ecosystem of extensions for other languages and runtimes (such as C++, C#, Java, Python, PHP, Go, .NET), used mainly for Flutter/Dart mobile application development.[23]

Figure 20: VS code logo

- **GitHub:** is a web-based interface allowing real-time collaboration. It encourages teams to work together in developing code, building web pages and updating content.[24]

Figure 21: GitHub logo

- **Firebase:** is Google's mobile application development platform that helps you build, improve, and grow your app. [25]

Figure 22: Firebase logo

- **Kaggle:** it is an online community of data scientists and machine learning engineers, allows users to find datasets they want to use in building AI models, publish datasets, work with other data scientists and machine learning engineers, and enter competitions to solve data science challenges. [26]

Figure 23: Kaggle logo

Canva: is an online graphic design platform that enables users to create a variety of visual content, such as user interface mockups, presentations, and infographics, quickly, easily, and without the need for advanced design skills. [27]

Figure 24: Canva logo

2.2. Programming Languages:

- **Python:** is a high-level, interpreted, object-oriented language with dynamic semantics. Its flexible data structures and dynamic typing make it ideal for rapid development and integrating existing components. [28]

Figure 25: Python logo

- **C++:** is an object-oriented programming (OOP) language that is viewed by many as the best language for creating large-scale applications. C++ is a superset of the C language.[29]

Figure 26: C++ logo

- **Dart:** is a client-optimized language for developing fast apps on any platform used by Flutter framework. Its goal is to offer the most productive programming language for multi-platform development, paired with a flexible execution runtime platform for app frameworks.[30]

Figure 27: Dart logo

2.3 Frameworks and Libraries

- **Django:** is a high-level web framework based on Python, designed to promote rapid development and clean, pragmatic design practices. Developed by experienced programmers, it handles many aspects of web development, allowing developers to concentrate on building their applications without having to reinvent common functionalities. Django is free and open-source, supported by an active community. [31]

Figure 28: Django logo

- **Flutter:** is an open source framework for building beautiful, natively compiled, multi-platform applications from a single codebase.[32]

Figure 29: Flutter logo

- **TensorFlow:** is an open-source library for numerical computation, large-scale machine learning, deep learning, and other statistical and predictive analytics workloads. This type of technology makes it faster and easier for developers to implement machine learning models, as it assists the process of acquiring data, serving predictions at scale, and refining future results.[33]

Figure 30: TensorFlow logo

- **NumPy:** NumPy is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more.[34]

Figure 31: NumPy logo

- **OpenStreetMap:** is freely licensed under the Open Database License and is commonly used to make electronic maps, inform turn-by-turn navigation, and assist in humanitarian aid and data visualisation.[35]

Figure 32: OpenStreetMap logo

3. Hardware Implementation

3.1. Microcontrollers and Modules

✓ **ESP32-CAM (WROOM-32):** The ESP32-CAM is a compact and high-performance module that integrates an ESP32 microcontroller with an OV2640 camera module. Measuring only 27 × 40.5 × 4.5 mm, it stands out for its low power consumption, with a deep sleep current as low as 6 mA. Thanks to its versatile design and DIP package format, it can be easily integrated into development boards for fast and reliable prototyping and production.

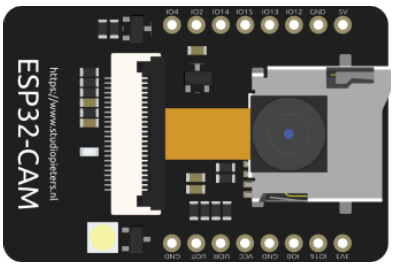


Figure 33: ESP32-CAM (Microcontroller + Camera)

✓ **ESP32 WROOM-32E:** The ESP32 WROOM-32E is a versatile and powerful module built around Espressif's ESP32 chipset. It offers dual-core processing, integrated Wi-Fi and Bluetooth connectivity, and boasts a wide range of peripheral interfaces. Known for its low-power consumption, the module is ideal for IoT applications, enabling smart connectivity and robust performance in compact form factors.

Figure 34: ESP32-WROOM-32E

3.2. Sensors and Peripherals

✓ **MAX30100:** is a compact and powerful sensor that brings real-time biometric data to your fingertips—literally. This low-power, I2C-based module can measure both heart rate and blood oxygen levels (SpO2).

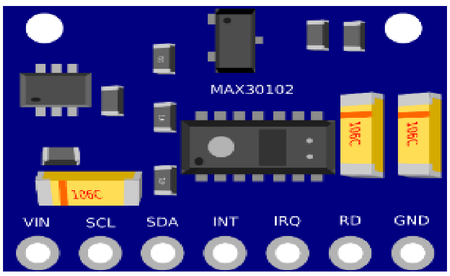


Figure 35: MAX30100 (Heart rate & SpO_2 sensor)

- ✓ **GPS NEO-6M:** is a compact GPS module that integrates a u-blox NEO-6M receiver, a ceramic antenna, and built-in EEPROM. It is designed for geolocation applications and is compatible with various microcontrollers such as Arduino and Raspberry Pi. This module ensures reliable GPS signal reception and configuration retention.

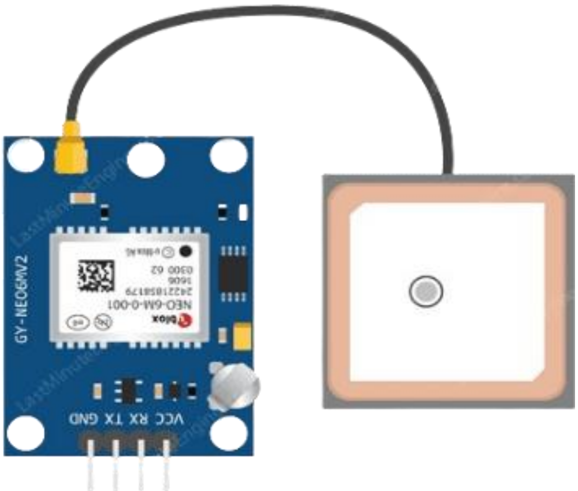


Figure 36: NEO-6M (GPS module)

- ✓ **MPU6050:** includes a gyroscope and an accelerometer, allowing us to measure rotation along all three axes gyroscope, accelerometer, and a Digital Motion Processor .It can measure angular momentum or rotation along all three axes, static acceleration caused by gravity, and dynamic acceleration caused by motion, shock, or vibration.

Figure 37: MPU-6500 (Motion sensor)

✓ **Microphone MAX9814:** The MAX9814 is a low-cost, high-quality microphone amplifier with automatic gain control (AGC) and low-noise microphone bias. The device features a low-noise preamplifier, variable gain amplifier (VGA), output amplifier, microphone-bias-voltage generator, and AGC control circuitry.

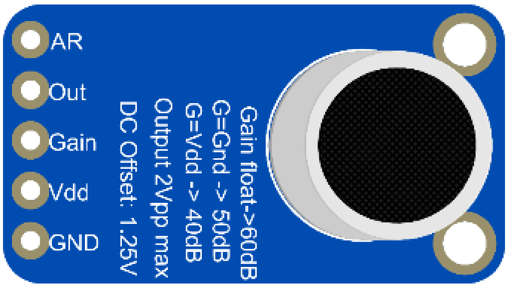


Figure 38: MAX9814 (Microphone)

4. Mobile application screenshots

The HARISI mobile application helps parents keep their child safe. It shows live location, health data and smart alerts. Parents can also use the camera and microphone remotely. Below the main screens are shown with simple explanations.

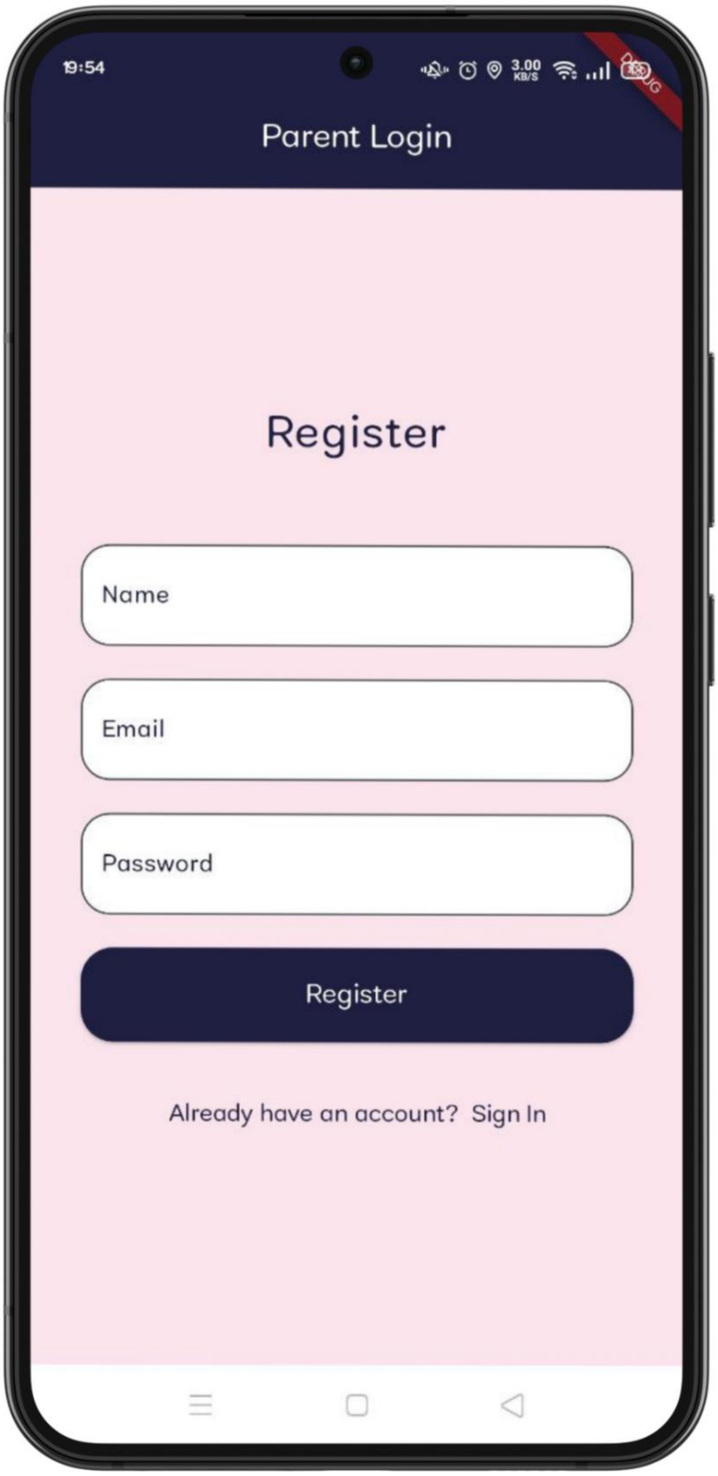


Figure 39: Register Screen

A clean registration screen for parents to create an account by providing their name, email, and password, with an option to switch to the sign-in page if they already have an account.

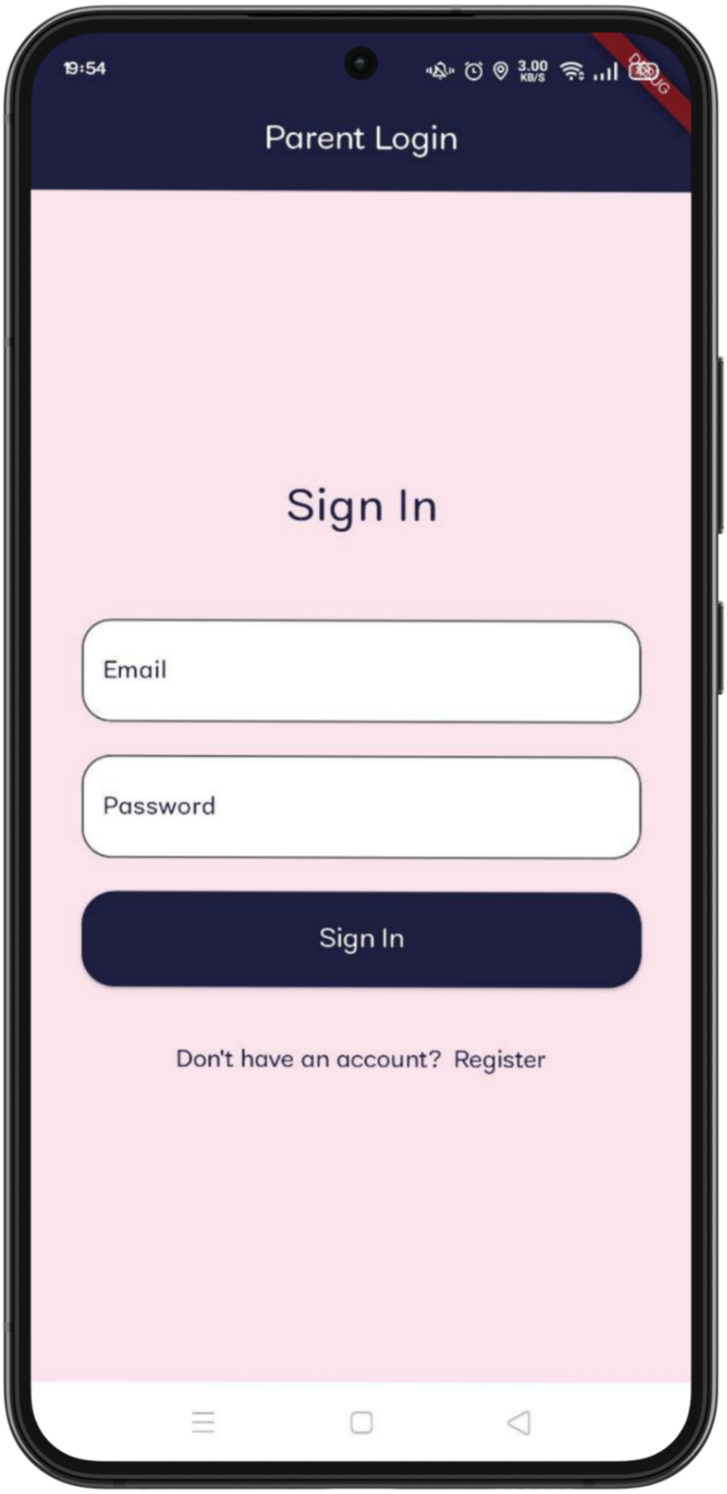


Figure 40: Sign In Screen

A simple login screen for parents to sign in using their email and password, with a link to switch to the registration page for new users.

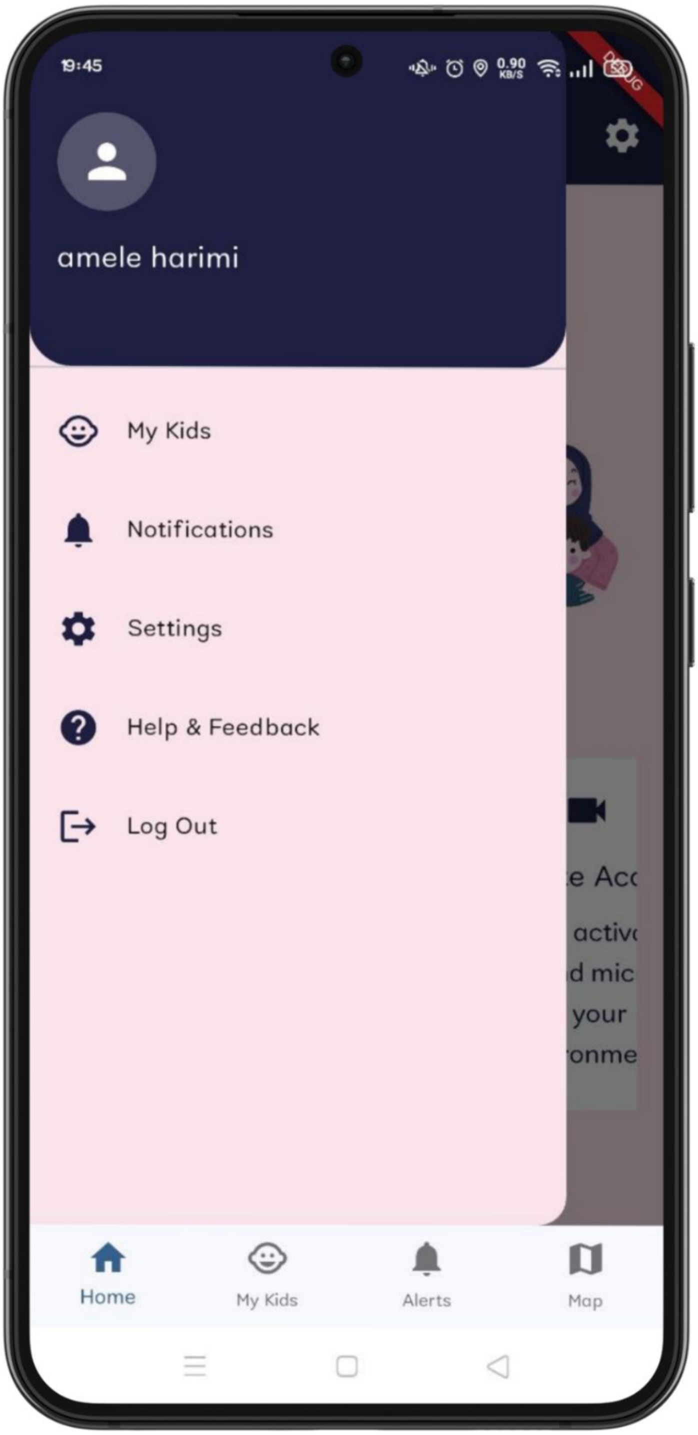


Figure 41: Sidebar Menu

The main navigation drawer for the parent app, showing the logged-in user's name and options to manage kids, view notifications, change settings, access help and log out.

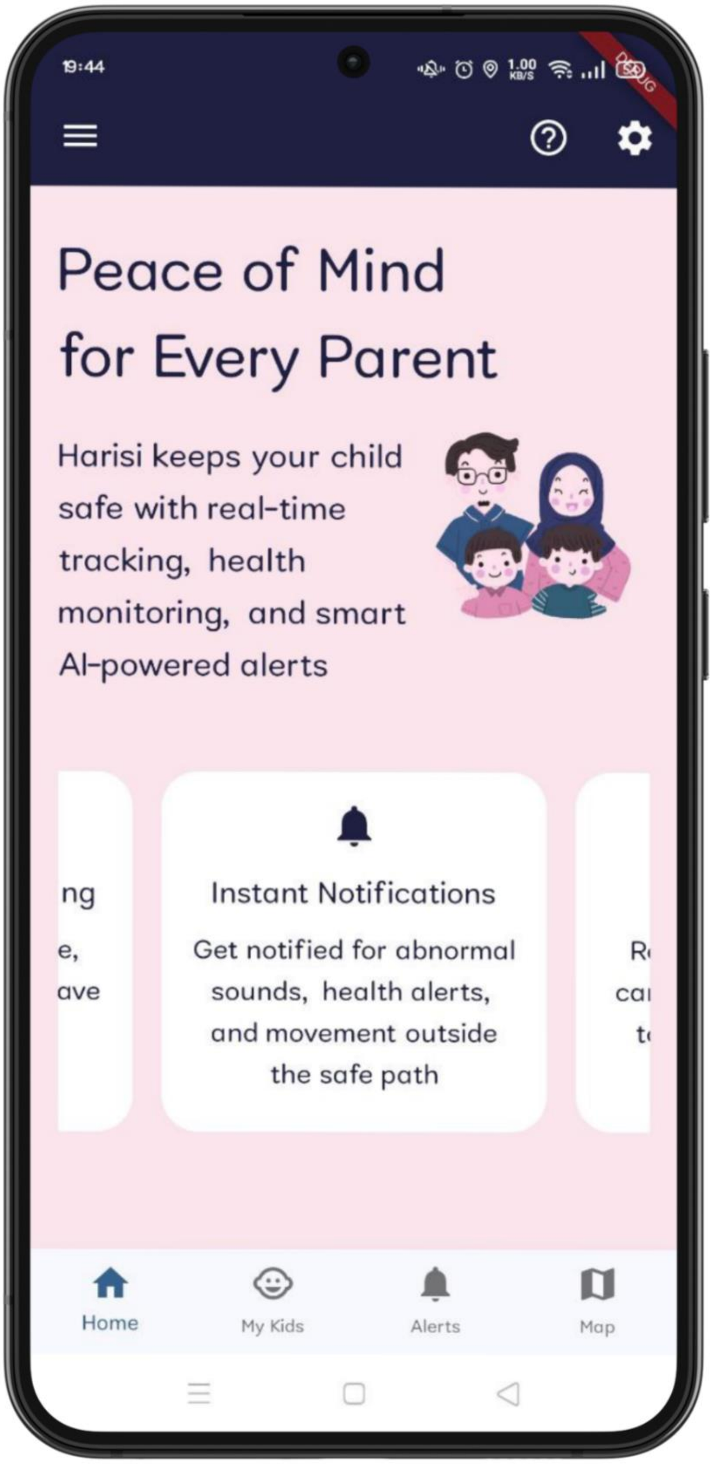


Figure 42: Home Screen

The home dashboard displaying the app's mission to give peace of mind to parents with live tracking, health monitoring and AI-powered alerts.

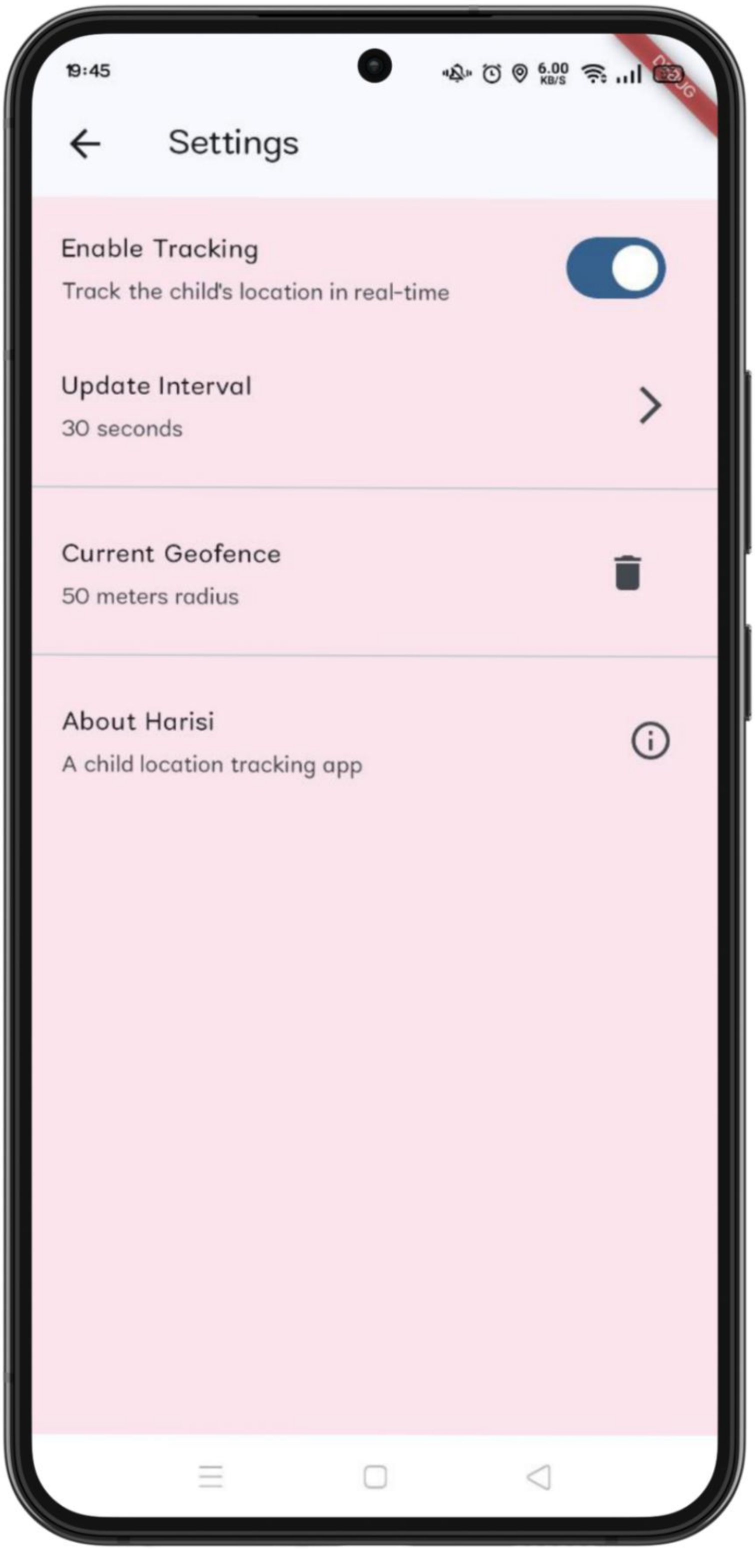


Figure 43: Settings Screen

A settings page where parents can enable or disable real-time tracking, set update intervals, manage geofencing and view app information.

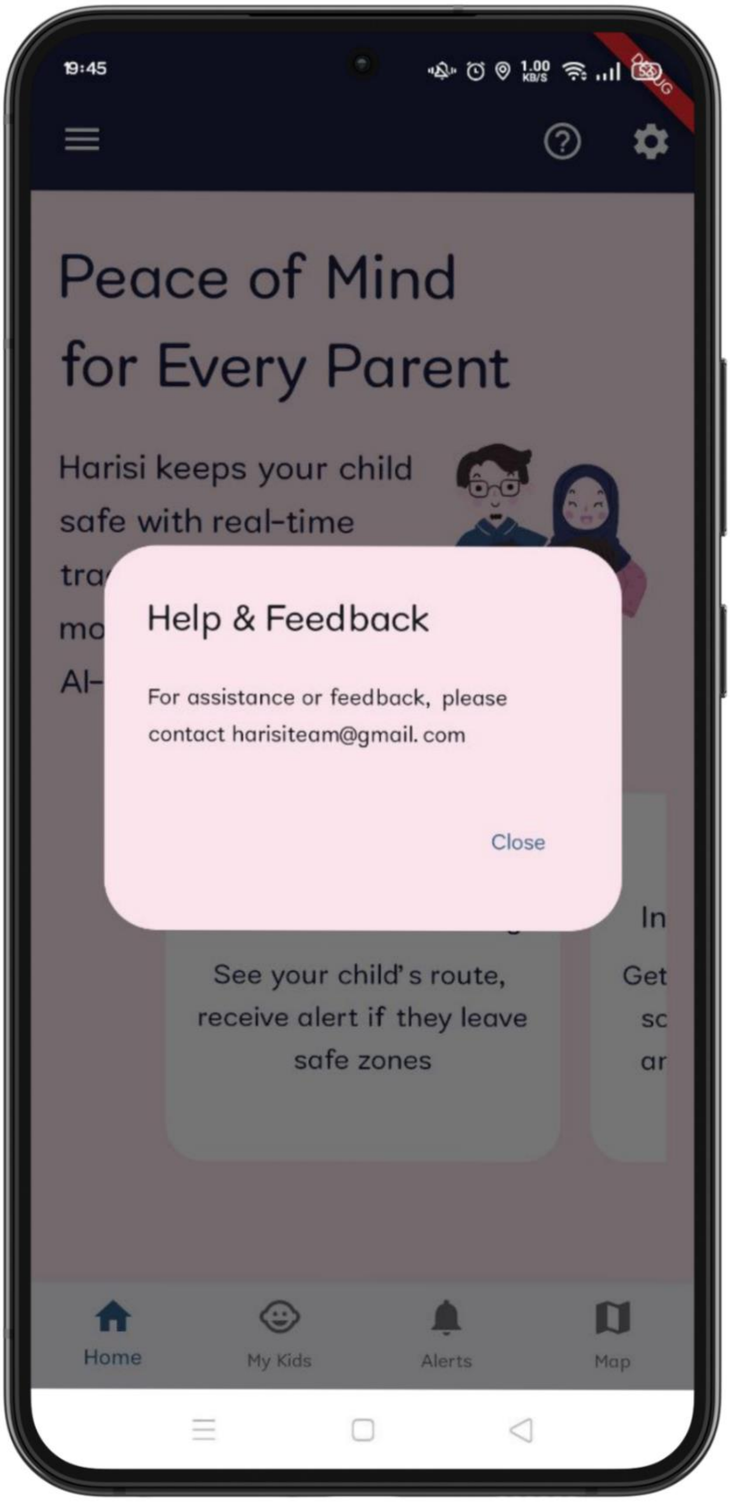


Figure 44: Help & Feedback

A simple modal providing contact information for users to get assistance or share feedback with the support team.

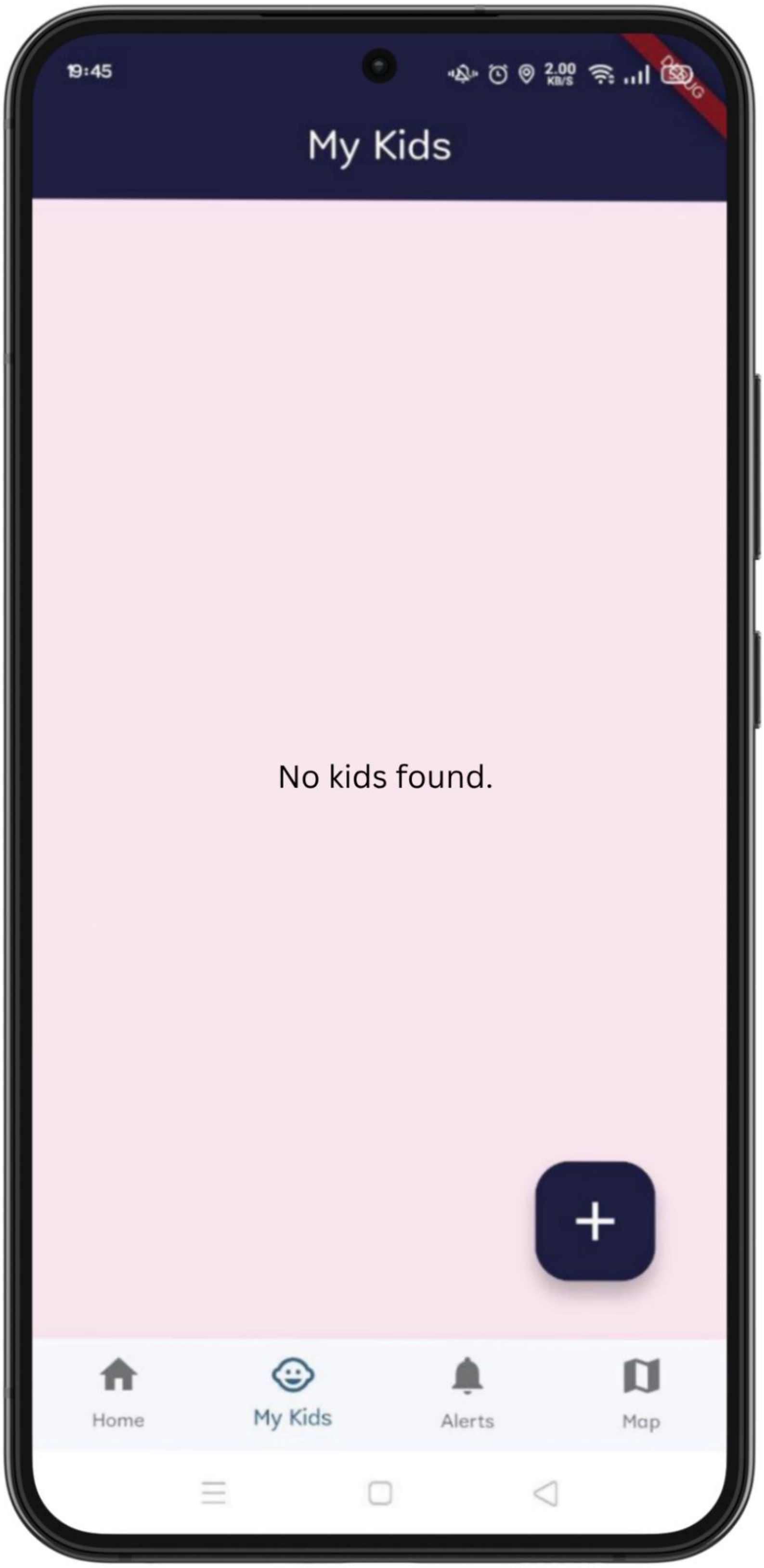


Figure 45: My Kids Screen

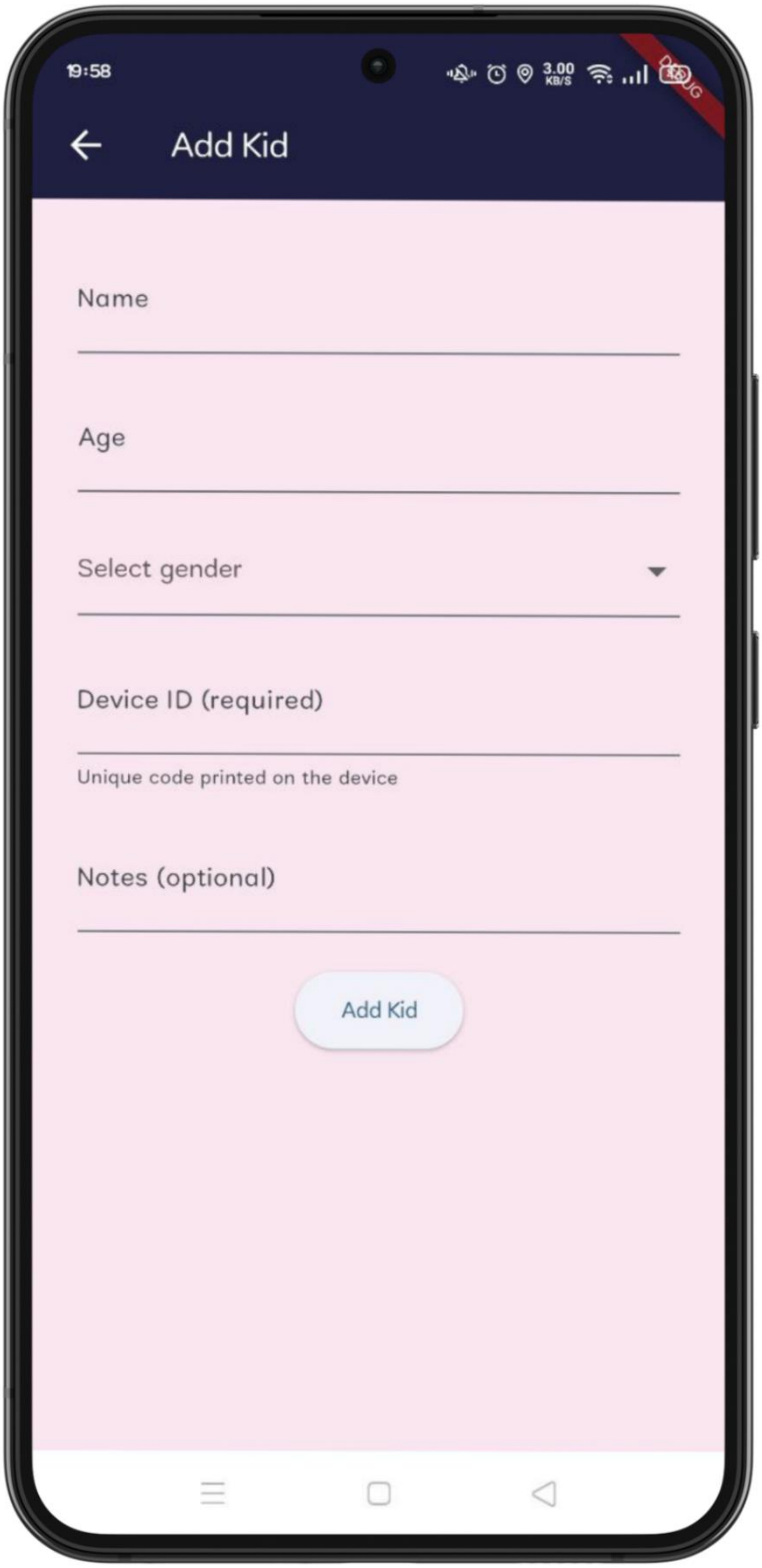


Figure 46: Add Kid Screen

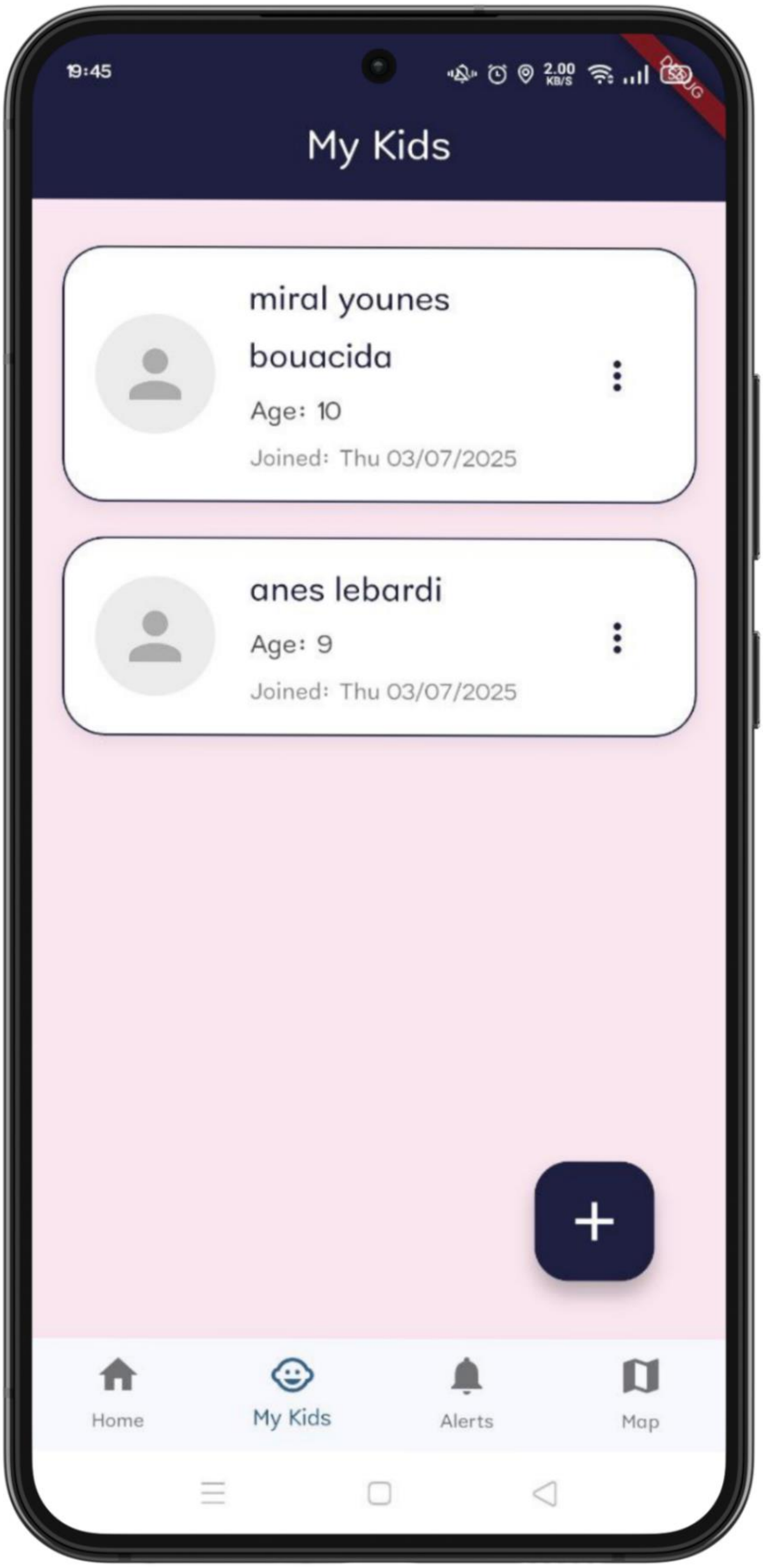


Figure 47: My Kids Screen (with list of kids)

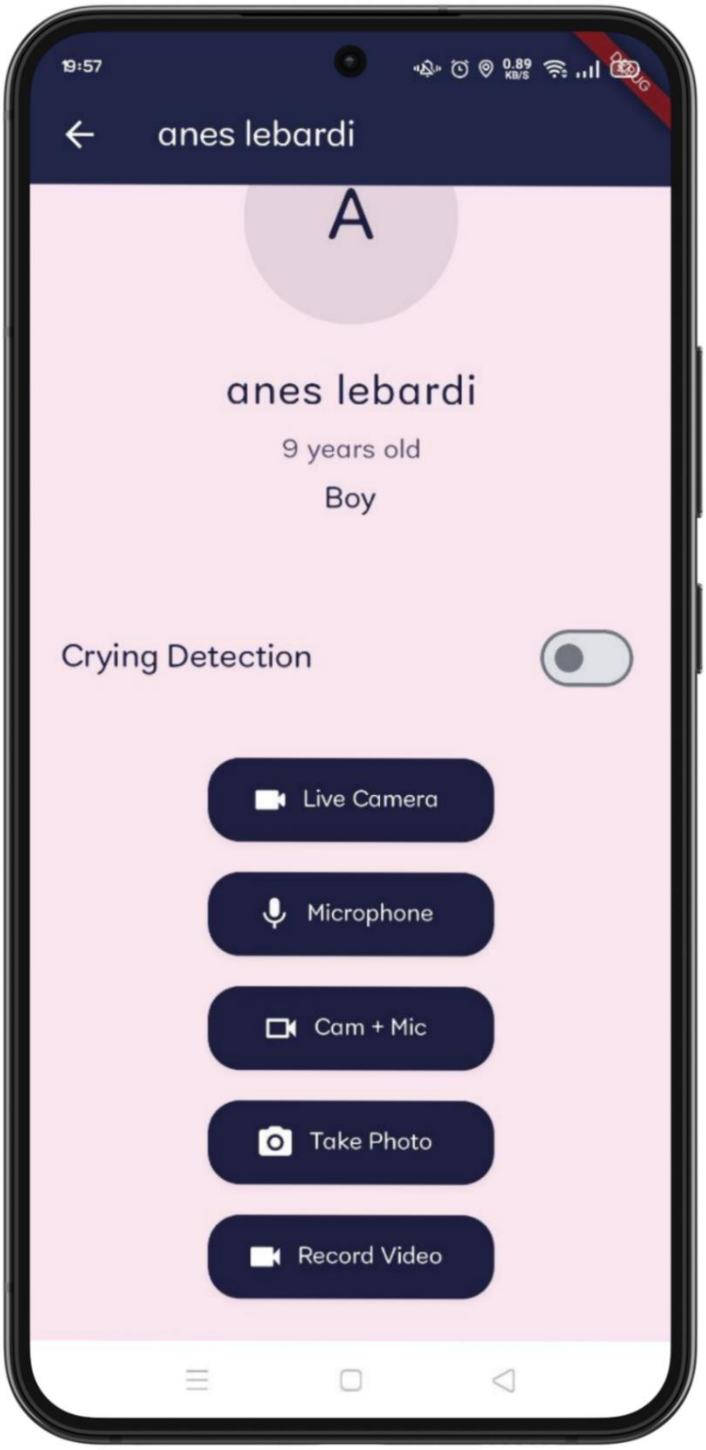


Figure 48: Kid Profile Screen

At first **(Figure 45)**, the parent has no kids on the ***My Kids*** page. They tap the **"+"** button to add a kid **(Figure 46)** by writing the name, age, gender, and device ID. After that, they see a list of kids **(Figure 47)**. The parent can open each kid's profile **(Figure 48)** to see details and turn on the camera or microphone. They can also edit or delete a kid anytime.

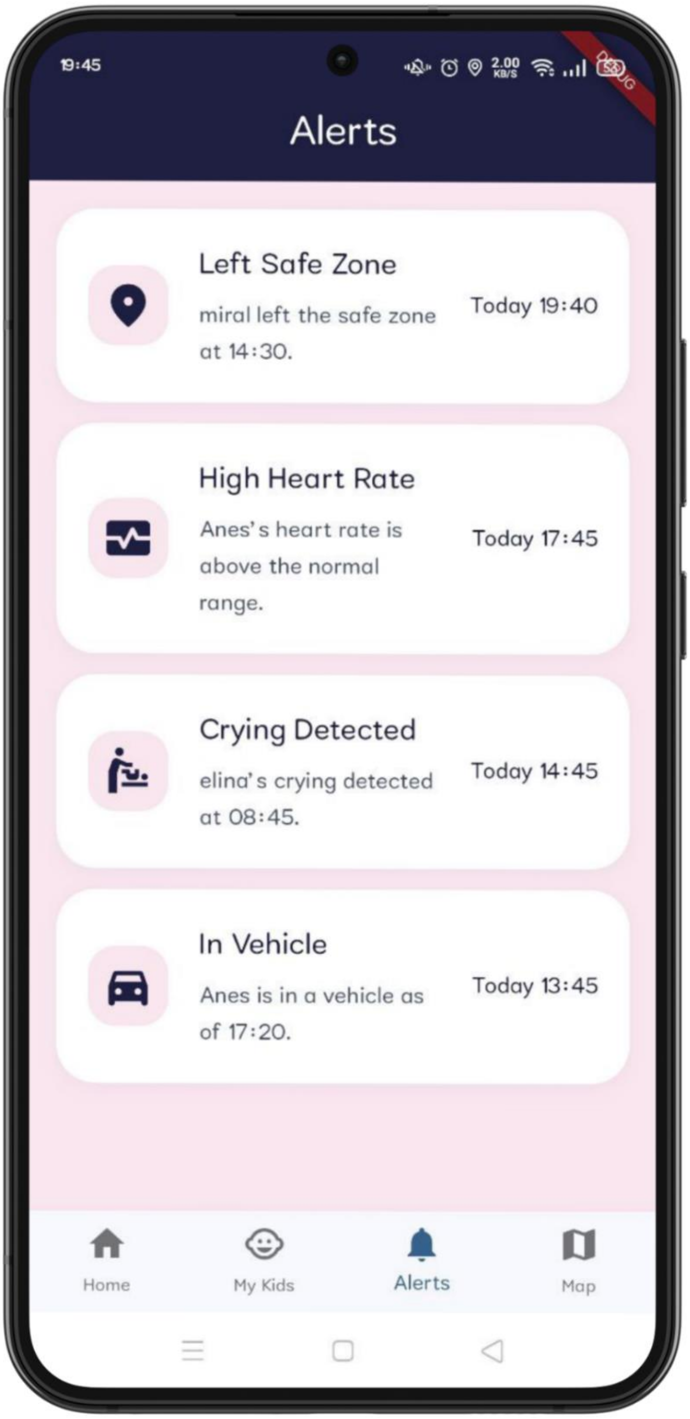


Figure 49: Alerts Screen

This screen shows all alerts. It tells parents if a child leaves a safe zone, has a high heart rate, is crying, or is in a vehicle, with the date and time.

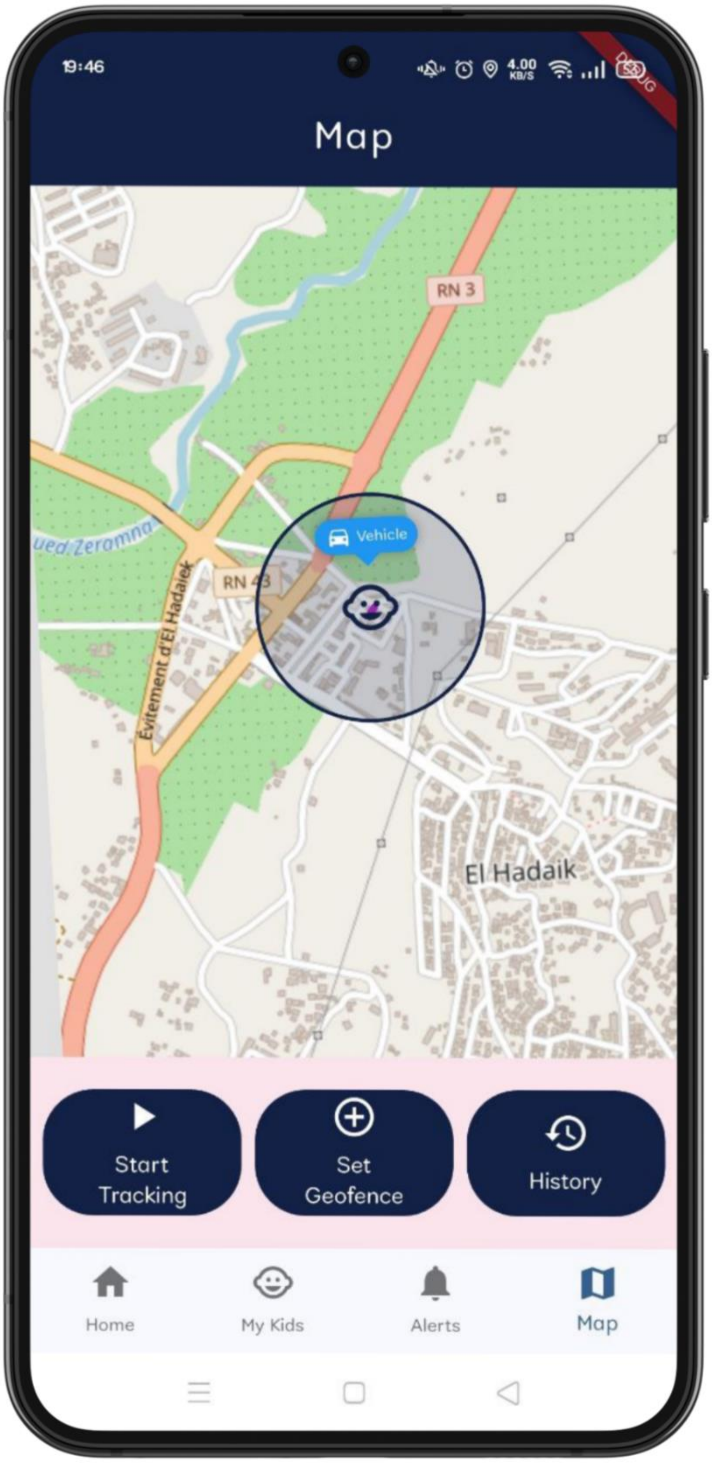


Figure 50: Map Screen

This screen shows the live location of the child on a map. Parents can see if the child is walking or in a vehicle. They can also start tracking, set a geofence or check the location history.

5. Prototype

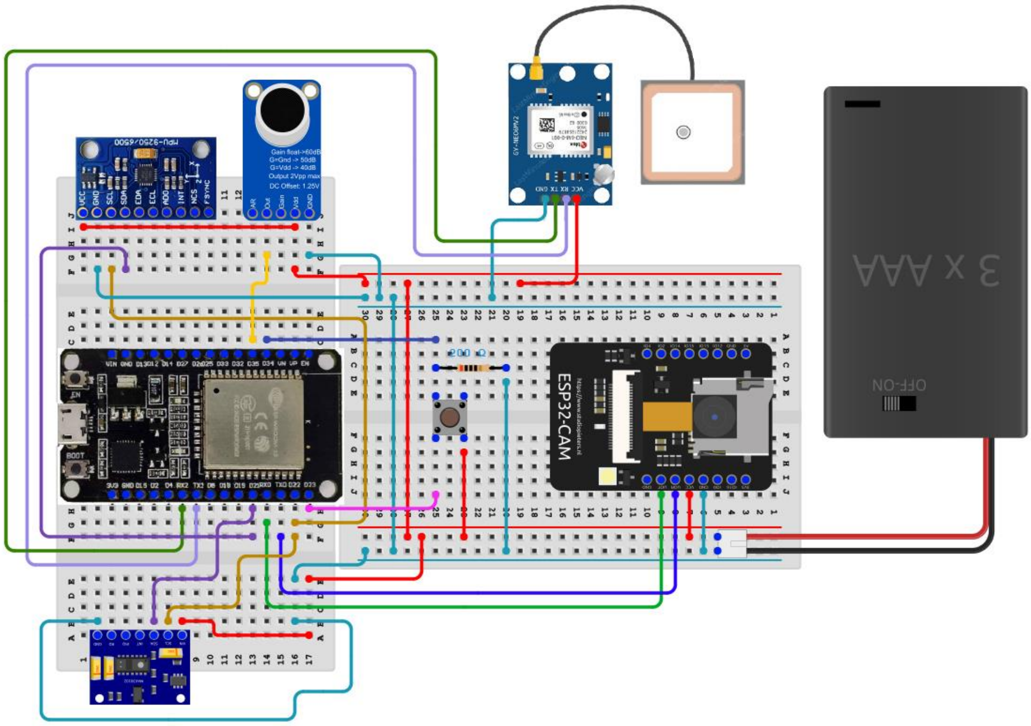


Figure 51: Circuit Design of the Prototype

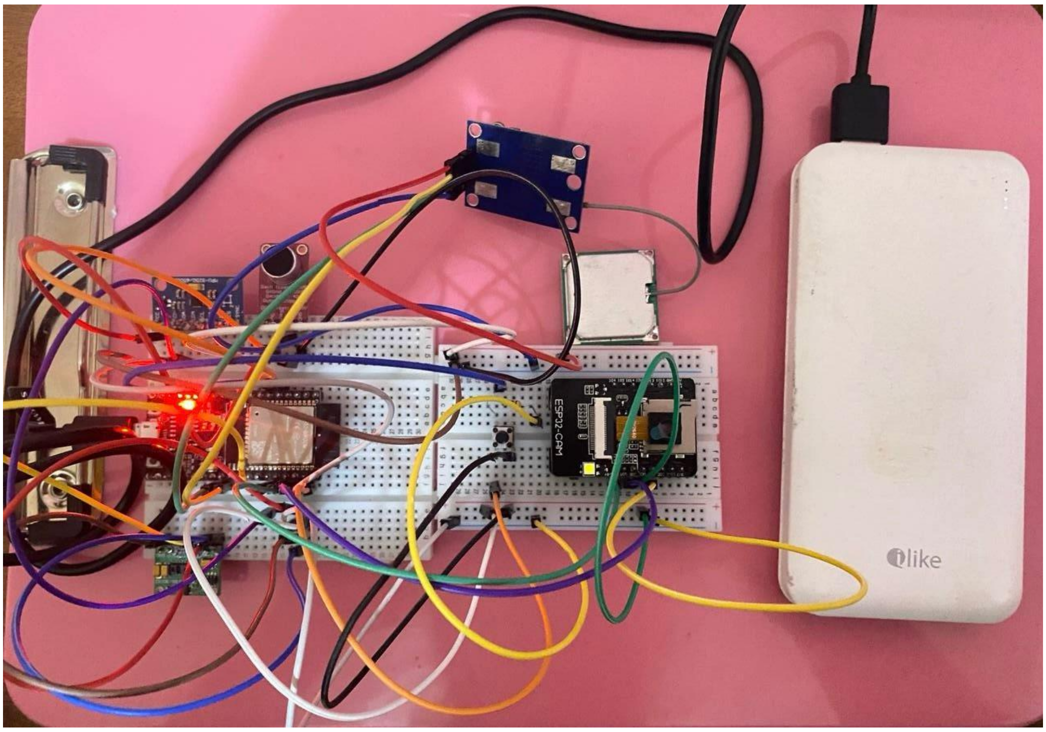


Figure 52: Breadboard Implementation of the Prototype

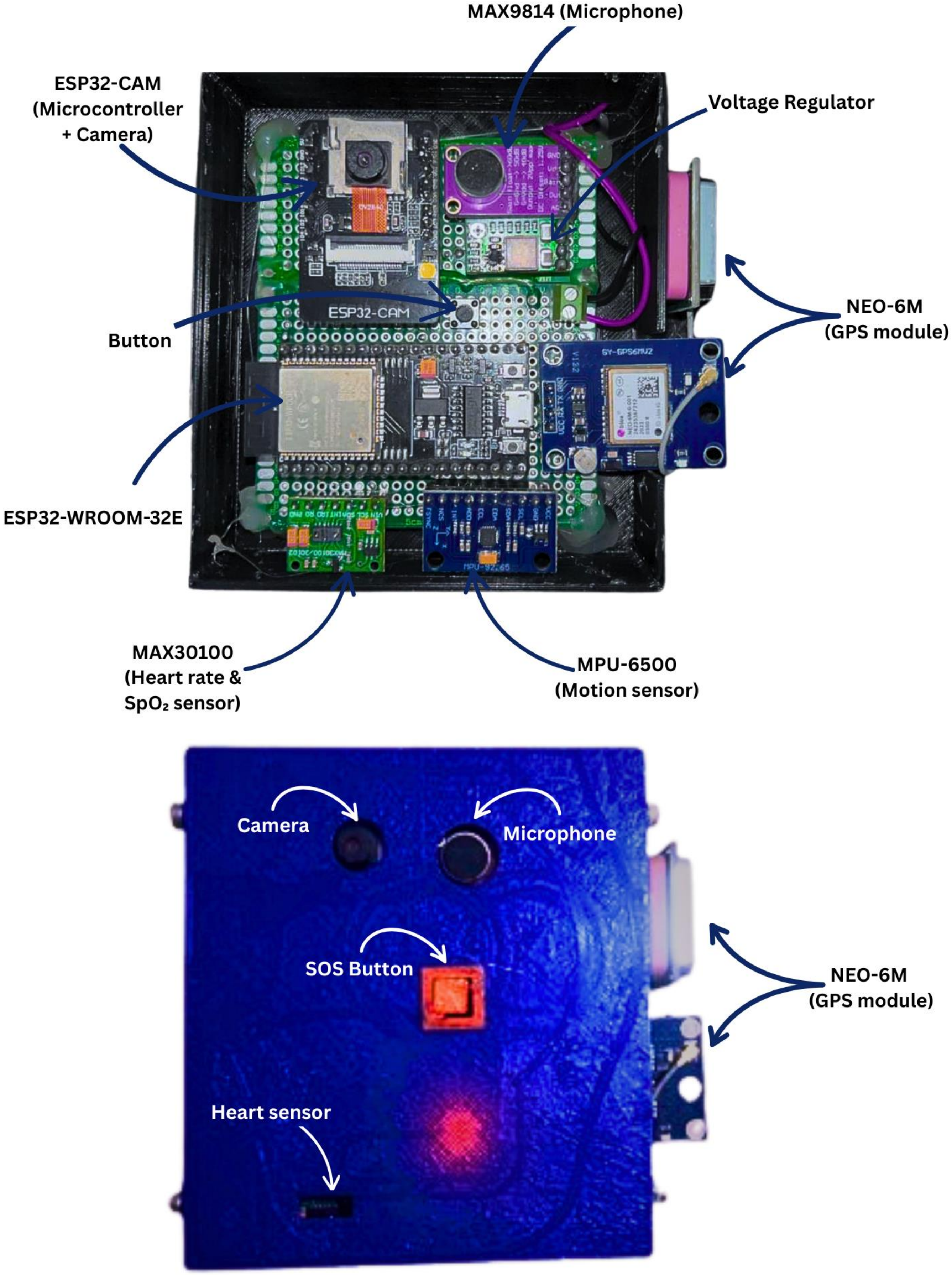


Figure 53: Final Enclosed Prototype

6. Website screenshots

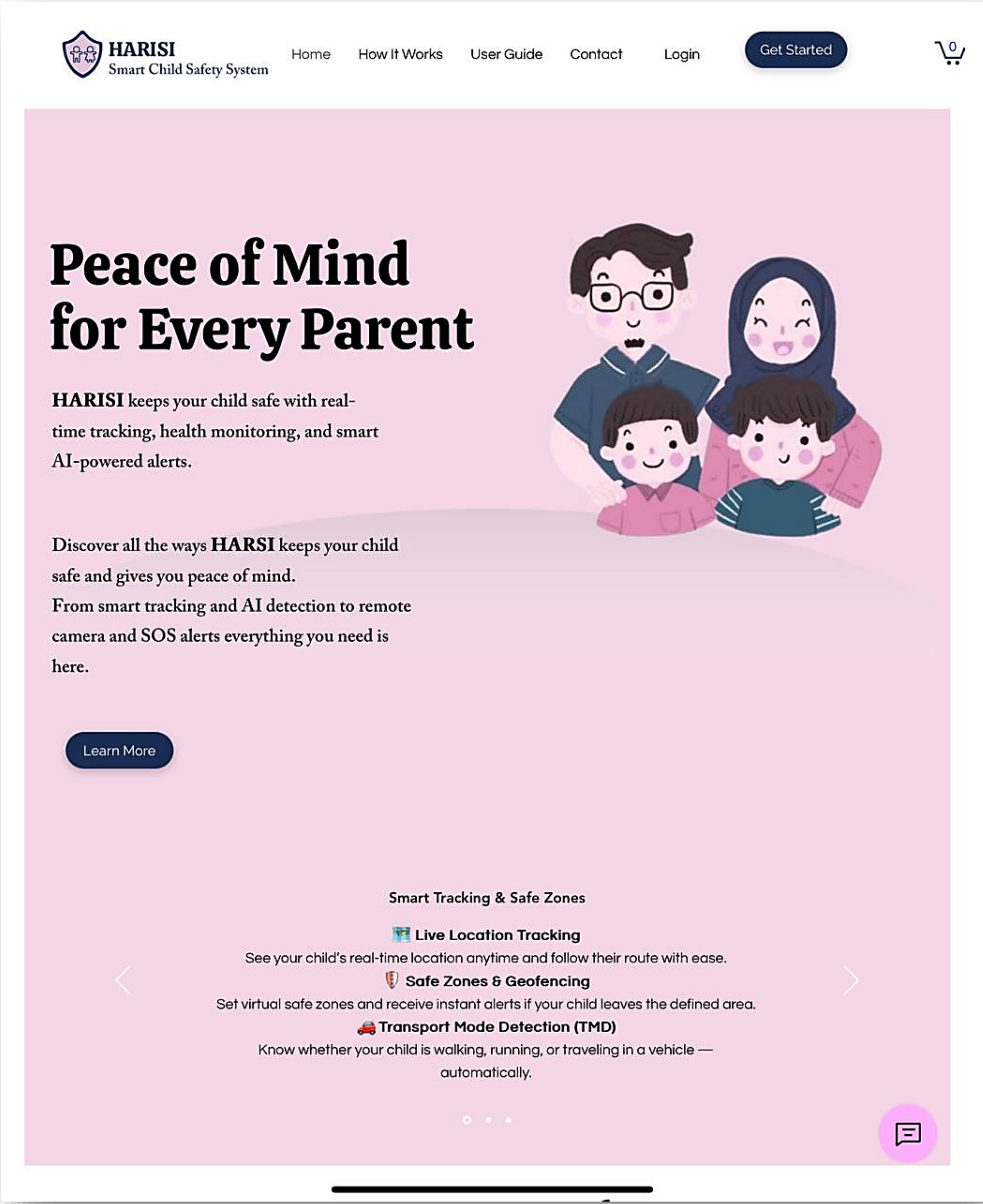


Figure 54: HARISI Home

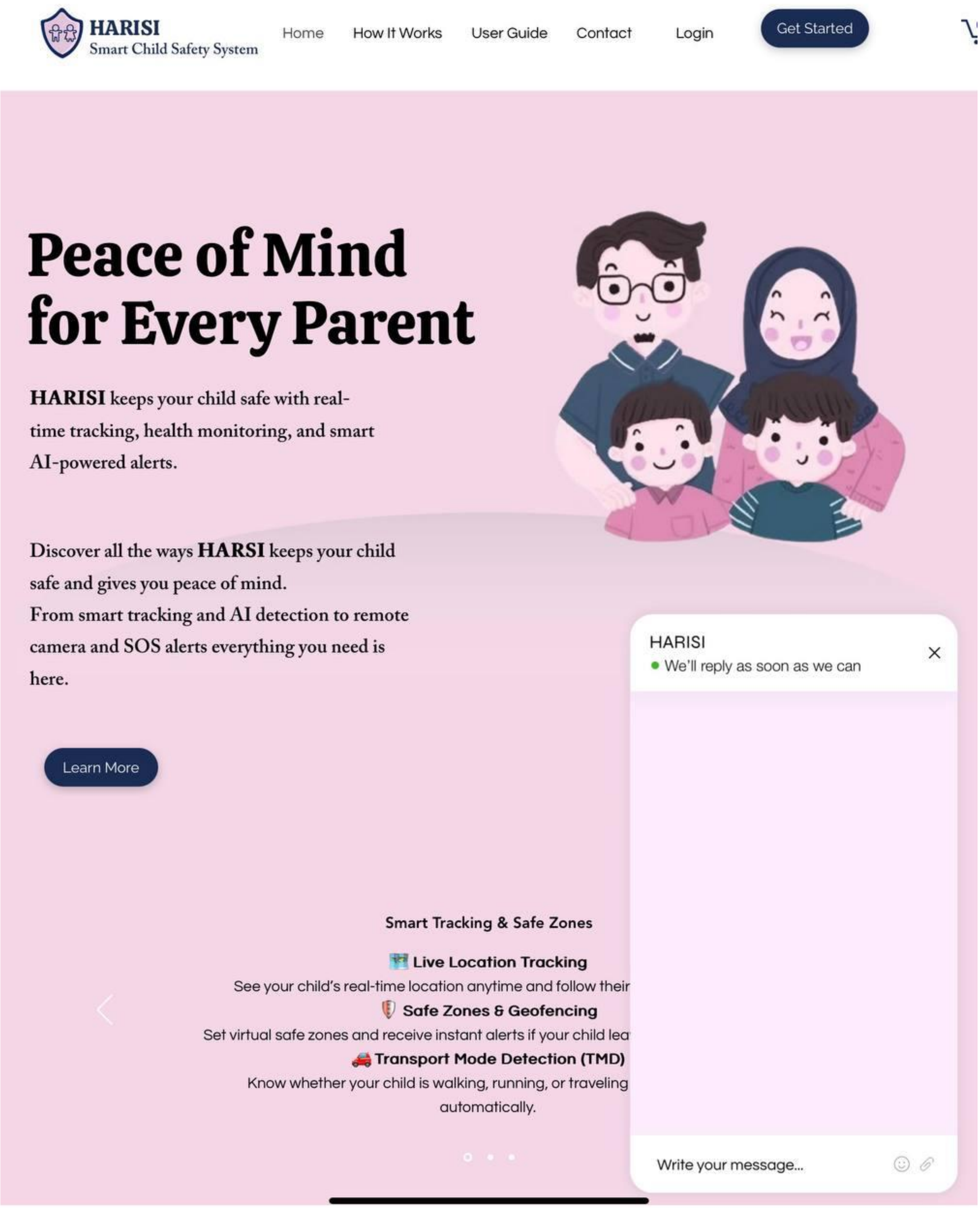
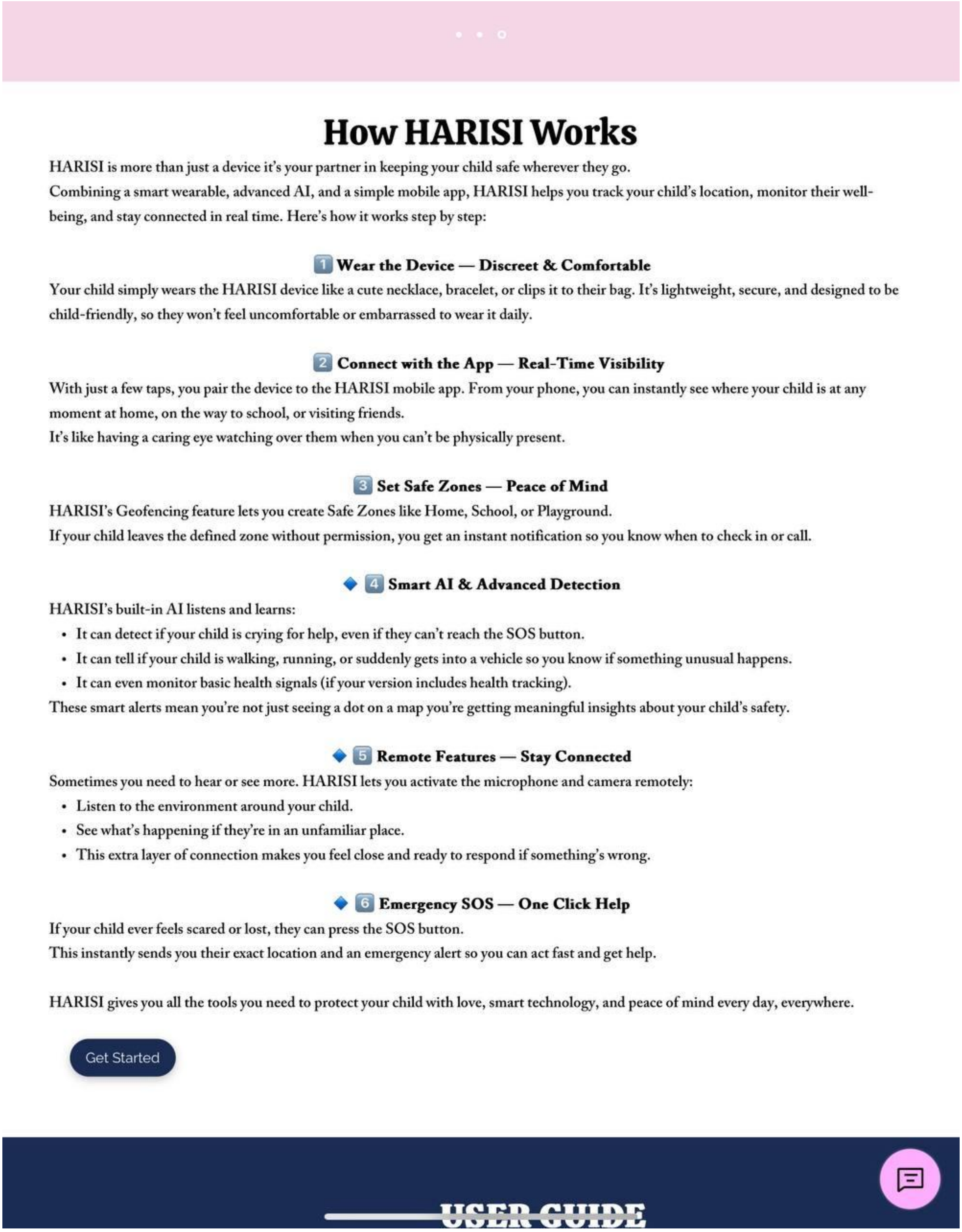


Figure 55: Home Page with Live Chat



How HARISI Works

HARISI is more than just a device it's your partner in keeping your child safe wherever they go.
Combining a smart wearable, advanced AI, and a simple mobile app, HARISI helps you track your child's location, monitor their well-being, and stay connected in real time. Here's how it works step by step:

1️⃣ Wear the Device — Discreet & Comfortable

Your child simply wears the HARISI device like a cute necklace, bracelet, or clips it to their bag. It's lightweight, secure, and designed to be child-friendly, so they won't feel uncomfortable or embarrassed to wear it daily.

2️⃣ Connect with the App — Real-Time Visibility

With just a few taps, you pair the device to the HARISI mobile app. From your phone, you can instantly see where your child is at any moment at home, on the way to school, or visiting friends.
It's like having a caring eye watching over them when you can't be physically present.

3️⃣ Set Safe Zones — Peace of Mind

HARISI's Geofencing feature lets you create Safe Zones like Home, School, or Playground.
If your child leaves the defined zone without permission, you get an instant notification so you know when to check in or call.

🔷 4️⃣ Smart AI & Advanced Detection

HARISI's built-in AI listens and learns:

- It can detect if your child is crying for help, even if they can't reach the SOS button.
- It can tell if your child is walking, running, or suddenly gets into a vehicle so you know if something unusual happens.
- It can even monitor basic health signals (if your version includes health tracking).

These smart alerts mean you're not just seeing a dot on a map you're getting meaningful insights about your child's safety.

🔷 5️⃣ Remote Features — Stay Connected

Sometimes you need to hear or see more. HARISI lets you activate the microphone and camera remotely:

- Listen to the environment around your child.
- See what's happening if they're in an unfamiliar place.
- This extra layer of connection makes you feel close and ready to respond if something's wrong.

🔷 6️⃣ Emergency SOS — One Click Help

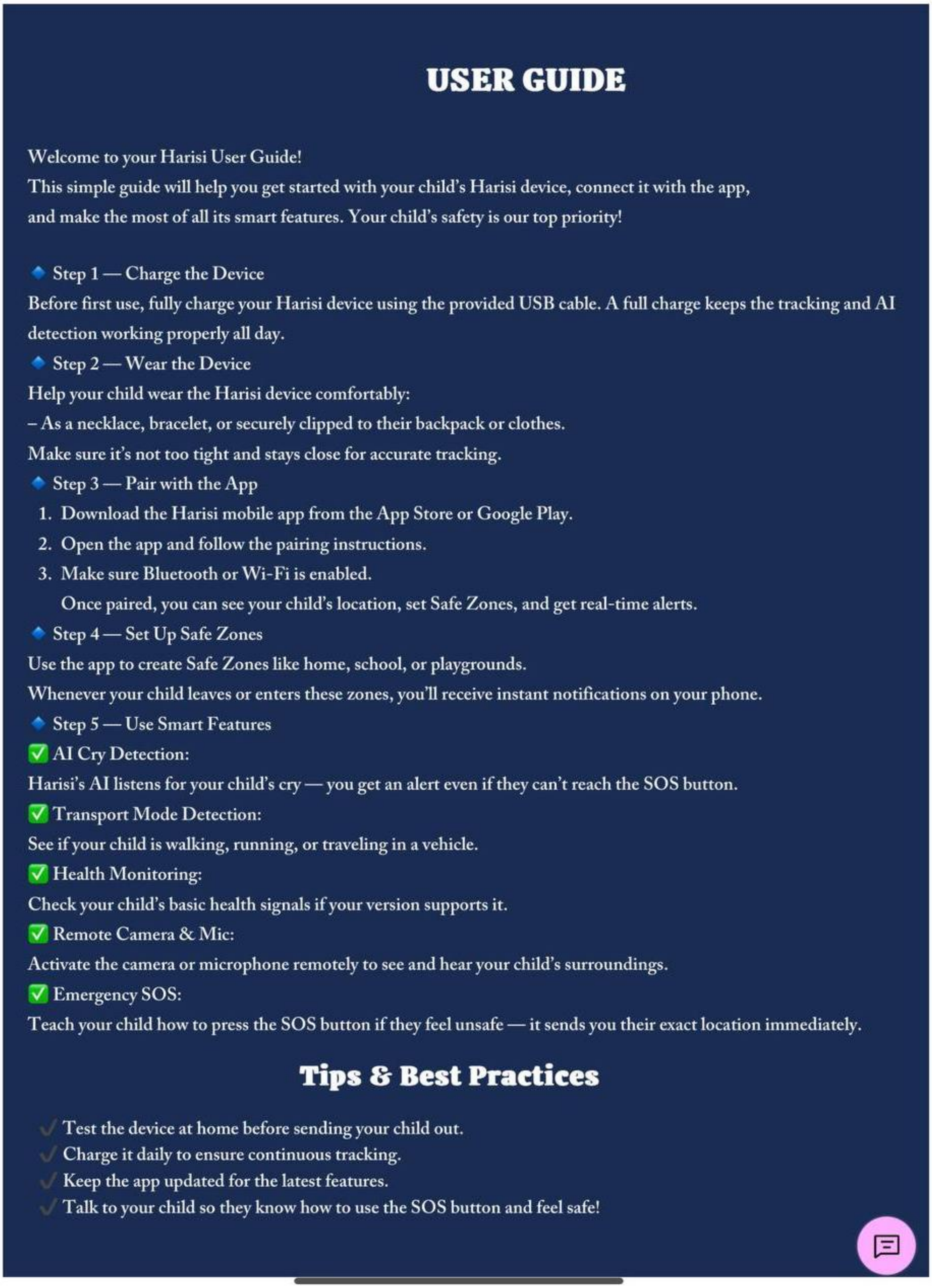
If your child ever feels scared or lost, they can press the SOS button.
This instantly sends you their exact location and an emergency alert so you can act fast and get help.

HARISI gives you all the tools you need to protect your child with love, smart technology, and peace of mind every day, everywhere.

Get Started

USER GUIDE

Figure 56: How It Works Page



USER GUIDE

Welcome to your Harisi User Guide!
This simple guide will help you get started with your child's Harisi device, connect it with the app, and make the most of all its smart features. Your child's safety is our top priority!

🔹 Step 1 — Charge the Device
Before first use, fully charge your Harisi device using the provided USB cable. A full charge keeps the tracking and AI detection working properly all day.

🔹 Step 2 — Wear the Device
Help your child wear the Harisi device comfortably:
– As a necklace, bracelet, or securely clipped to their backpack or clothes.
Make sure it's not too tight and stays close for accurate tracking.

🔹 Step 3 — Pair with the App

1. Download the Harisi mobile app from the App Store or Google Play.
2. Open the app and follow the pairing instructions.
3. Make sure Bluetooth or Wi-Fi is enabled.
   Once paired, you can see your child's location, set Safe Zones, and get real-time alerts.

🔹 Step 4 — Set Up Safe Zones
Use the app to create Safe Zones like home, school, or playgrounds.
Whenever your child leaves or enters these zones, you'll receive instant notifications on your phone.

🔹 Step 5 — Use Smart Features
✅ AI Cry Detection:
Harisi's AI listens for your child's cry — you get an alert even if they can't reach the SOS button.
✅ Transport Mode Detection:
See if your child is walking, running, or traveling in a vehicle.
✅ Health Monitoring:
Check your child's basic health signals if your version supports it.
✅ Remote Camera & Mic:
Activate the camera or microphone remotely to see and hear your child's surroundings.
✅ Emergency SOS:
Teach your child how to press the SOS button if they feel unsafe — it sends you their exact location immediately.

Tips & Best Practices

✓ Test the device at home before sending your child out.
✓ Charge it daily to ensure continuous tracking.
✓ Keep the app updated for the latest features.
✓ Talk to your child so they know how to use the SOS button and feel safe!

Figure 57: User Guide & Best Practices

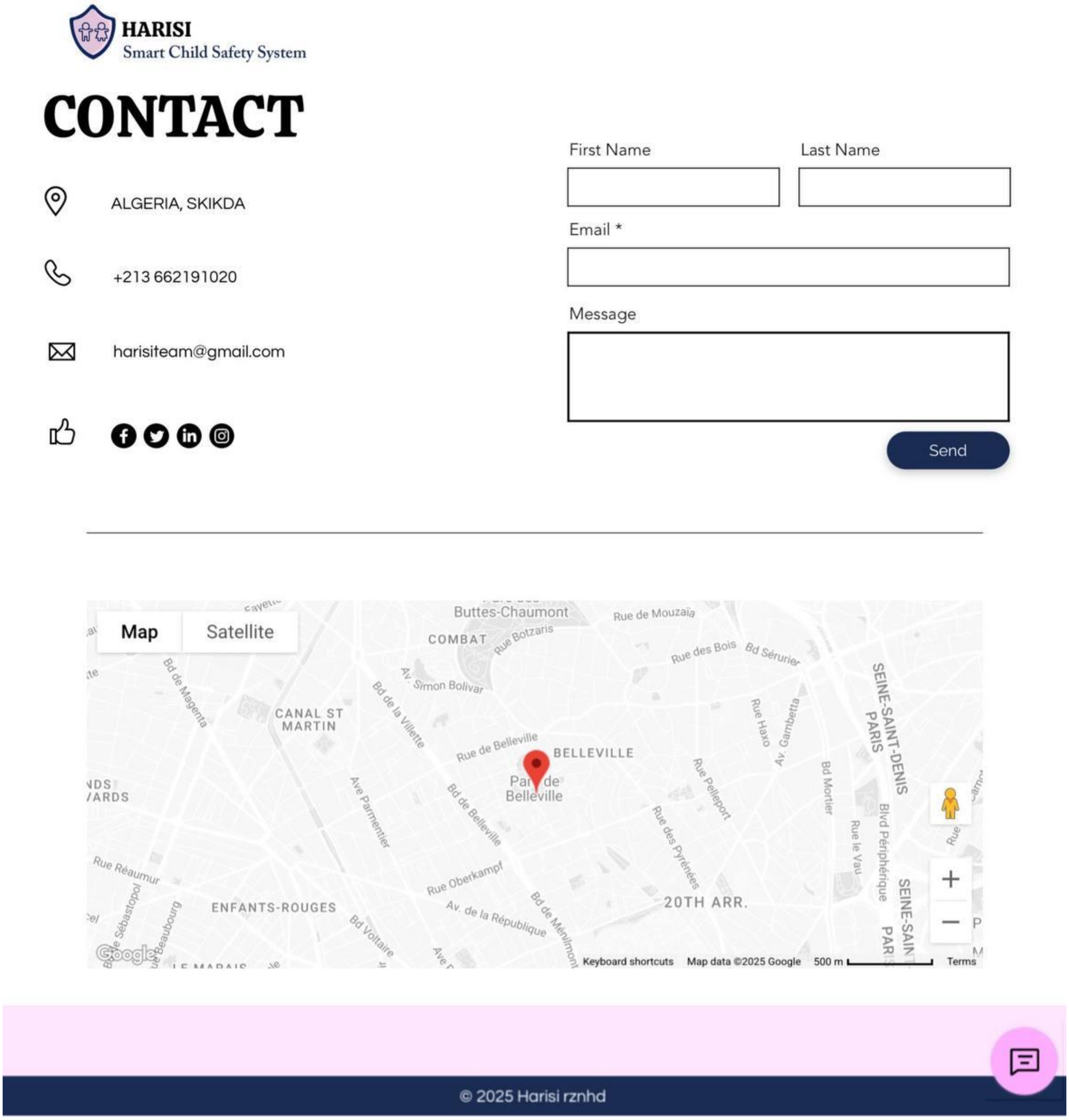


Figure 58: Contact & Location

We made this website to share everything about the *HARISI* system in a nice and easy way. We added a cart so in the future parents can buy the device directly from here. We also put a chat box so we can talk with parents and help them anytime.

7. Conclusion

In this chapter, we showed how we built the **HARISI** project. We explained the tools, programming languages and hardware we used. We also added screenshots of the mobile app, website and the real prototype. This shows how the software and hardware work together to protect children.

Chapter 5: Conclusion

Conclusion

The **HARISI** project provides a practical and innovative solution designed to ensure children's safety when they are away from their parents whether at home or in public places by incorporating a range of technologies including the use of artificial intelligence to detect children's crying and analyze transportation methods (TMD), combined with accurate GPS tracking, geolocation, remote camera and microphone access and even health monitoring.

A key part of our mission is to give families peace of mind as if they are always with their child. **HARISI** makes it possible for parents to find their child's location, be alerted to signs of distress, and see what is happening around their child whenever and wherever needed.

Families can choose from different versions of **HARISI** each offering a specific combination of features to suit various needs and budgets whether they require just location tracking, or advanced options like sound detection, camera, health monitoring, or all combined.

Protecting privacy is essential: camera and microphone features are designed to be controlled only by parents and automatically switch off in sensitive places like schools and all the data collected is secured and used strictly to support child safety.

Looking forward the adaptable nature of **HARISI** means it can serve various purposes beyond child safety It has great potential to support elderly individuals especially those with conditions like Alzheimer's or individuals who are prone to becoming disoriented or require continuous monitoring.

Ultimately, with more support, more work, and better technology we believe **HARISI** can make a real difference and we hope this project not only succeeds now but also evolves in the future to help save lives, protect children around the world and vulnerable groups.

Bibliography

[1] S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2010.

[2] J. Liu, *Machine Learning, Animated: Illustrated Guide & Examples for Beginners*. Independently published, 2021.

[3] R. Santhosh, "What is Machine Learning? Definition, Types, Applications," *Great Learning Blog*, Feb. 23, 2023. [Online]. Available: https://www.mygreatlearning.com/blog/what-is-machine-learning/. [Accessed: Jun. 24, 2025].

[4] P. Wulff, M. Kubsch, and C. Krist, "Basics of Machine Learning," in *Applying Machine Learning in Science Education Research: When, How, and Why?*, P. Wulff, M. Kubsch, and C. Krist, Eds. Cham, Switzerland: Springer, 2023.

[5] S. Rastegari and Y. Jasemi, "A survey on supervised learning for big data processing," *J. Big Data*, vol. 7, no. 1, p. 28, 2020. [Online]. Available: https://www.researchgate.net/publication/347804920. [Accessed: Jun. 24, 2025].

[6] A. Jung, *Machine Learning: The Basics*. Singapore: Springer, 2022.

[7] M. Hanif, "Machine Learning," *Medium*, Apr. 19, 2021. [Online]. Available: https://majidhanif230.medium.com/machine-learning-280aed692b8e. [Accessed: Jun. 24, 2025].

[8] IBM, "Reinforcement Learning," *IBM Think*. [Online]. Available: https://www.ibm.com/think/topics/reinforcement-learning. [Accessed: Jun. 24, 2025].

[9] I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016.

[10] V7 Labs, "What is Machine Learning? The Ultimate Beginner's Guide," *V7 Blog*, Jun. 1, 2021. [Online]. Available: https://www.v7labs.com/blog/machine-learning-guide. [Accessed: Jun. 25, 2025].

[11] K. Gurney, *An Introduction to Neural Networks*. London, U.K.: UCL Press, 1997.

[12] Nerd for Tech, "Neural Networks," *Medium*, Nov. 29, 2021. [Online]. Available: https://medium.com/nerd-for-tech/neural-networks-68531432fb5. [Accessed: Jun. 25, 2025].

[13] Y. Pan, “Different Types of Neural Networks and Applications: Evidence from Feedforward, Convolutional and Recurrent Neural Networks,” *Highlights in Science, Engineering and Technology*, vol. 85, pp. 247–255, Mar. 2024. [Online]. Available: https://doi.org/10.54097/6rn1wd81.

[14] Eastgate Software, “Understanding Feed Forward Neural Network.” [Online]. Available: https://eastgate-software.com/jp/understanding-feed-forward-neural-network/. [Accessed: Jun. 25, 2025].

[15] Zilliz, “Convolutional Neural Network,” *Zilliz Glossary*. [Online]. Available: https://zilliz.com/glossary/convolutional-neural-network. [Accessed: Jun. 25, 2025].

[16] BotPenguin, “Recurrent Neural Network,” *BotPenguin Glossary*. [Online]. Available: https://botpenguin.com/glossary/recurrent-neural-network. [Accessed: Jun. 25, 2025].

[17] H. Dalianis, “Evaluation Metrics and Evaluation,” in *Clinical Text Mining*. Cham, Switzerland: Springer, 2018, pp. 45–53. doi: 10.1007/978-3-319-78503-5_6.

[18] K. K. Patel and S. M. Patel, “Internet of Things–IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges,” *Int. J. Eng. Sci. Comput.*, vol. 6, no. 5, pp. –, 2016. doi: 10.4010/2016.1482.

[19] A. Ghosh, “Hybrid Cloud is the Door to Internet of Things (IoT),” *The Customize Windows*, Aug. 23, 2014. [Online]. Available: https://thecustomizewindows.com/2014/08/hybrid-cloud-door-internet-things-iot/. [Accessed: Jun. 27, 2025].

[20] S. Naveen, “Study of IoT: Understanding IoT Architecture, Applications, Issues and Challenges,” *Conference Paper*, Manipal Academy of Higher Education, 2016. [Online]. Available: https://www.researchgate.net/publication/330501274. [Accessed: Jun. 27, 2025].

[21] S. Haboussi, A. Abbas, M. Amad, and N. Oukas, “Internet of Things: Brief Overview, Protocols, Related Technologies, and Challenges,” *Conference Paper*, Bouira University, Algeria, 2024. [Online]. Available: https://www.researchgate.net/publication/377442627. [Accessed: Jun. 28, 2025].

[22] Blaisepascal.fr, “Présentation du logiciel Arduino.” [Online]. Available: https://arduino.blaisepascal.fr/presentation/logiciel/. [Accessed: May 28, 2025].

[23] Microsoft, “Visual Studio: IDE and Code Editor for Software Developers and Teams.” [Online]. Available: https://visualstudio.microsoft.com/#vscode-section. [Accessed: May 28, 2025].

[24] Coursera Staff, “What Is GitHub and Why Should You Use It?” *Coursera*, Mar. 8, 2025. [Online]. Available: https://www.coursera.org/articles/what-is-git. [Accessed: May 28, 2025].

[25] D. Stevenson, "What is Firebase? The complete story, abridged," *Medium*, Sep. 24, 2018. [Online]. Available: https://medium.com/firebase-developers/what-is-firebase-the-complete-story-abridged-bcc730c5f2c0. [Accessed: May 28, 2025].

[26] Kaggle User, "What is a kaggle?" *Kaggle*. [Online]. Available: https://www.kaggle.com/discussions/general/328265. [Accessed: May 28, 2025].

[27] Shopify Staff, "What Is Canva? Ways To Use Canva for Business," *Shopify*, Oct. 1, 2024. [Online]. Available: https://www.shopify.com/blog/what-is-canva. [Accessed: Jun. 30, 2025].

[28] Python Software Foundation, "Welcome to Python.org." [Online]. Available: https://www.python.org/. [Accessed: May 28, 2025].

[29] TechTarget, "C (programming language)," *SearchDataManagement Definitions*. [Online]. Available: https://www.techtarget.com/searchdatamanagement/definition/C. [Accessed: Jun. 13, 2025].

[30] Dart Language Team, "Overview [Dart documentation]." [Online]. Available: https://dart.dev/overview. [Accessed: Jun. 13, 2025].

[31] Django Software Foundation, "Django: The web framework for perfectionists with deadlines." [Online]. Available: https://www.djangoproject.com/. [Accessed: May 28, 2025].

[32] Google, "Flutter: Build apps for any screen." [Online]. Available: https://flutter.dev/. [Accessed: May 28, 2025].

[33] Databricks, "TensorFlow Guide." [Online]. Available: https://www.databricks.com/glossary/tensorflow-guide. [Accessed: May 28, 2025].

[34] NumPy documentation, *NumPy v2.3 Manual*. [Online]. Available: [Add link]. [Accessed: May 28, 2025].

[35] Wikipedia contributors, "OpenStreetMap," *Wikipedia*. [Online]. Available: https://en.wikipedia.org/wiki/OpenStreetMap. [Accessed: May 28, 2025].

People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

University of 20 août 1955 - SKIKDA

Faculty of Sciences

Department of Computer Sciences

Domain: Mathematics and Computer Science

Field: Computer Science

Specialty: Artificial Intelligence and network and distribute system

A project to obtain a Master's degree and a Start-up Certificate within the framework of Ministerial Decree 1275

HARISI: Smart Child Safety and Monitoring Device using artificial intelligence

By:

BELAMRI Nouhad

MOUMEN Abir

ZERIOUL Razane Lina Hind

Supervised By:

DR. LAHSASNA Adel

DR. BOULNEMOUR Imen

2024-2025

Acknowledgment

قال الله تعالى:﴿ وَلَقَدْ آتَيْنَا لُقْمَانَ الْحِكْمَةَ أَنِ اشْكُرْ لِلَّهِ ۚ وَمَنْ يَشْكُرْ فَإِنَّمَا يَشْكُرُ
لِنَفْسِهِ ۖ وَمَنْ كَفَرَ فَإِنَّ اللَّهَ غَنِيٌّ حَمِيدٌ ﴾(سورة لقمان، الآية 12)

First, we thank Allah for giving us patience, health, and courage to complete this humble work.

We are deeply grateful to our respected supervisors **''Dr. LAHSASNA Adel''** and **''Dr. BOULNEMOUR Imen''** for their valuable advice, kind support and trust during this project.

We sincerely thank our teachers for their knowledge and guidance.

We thank our friends and classmates who stood by our side and made this journey better.

We thank every teacher in the Media and Communication Department and everyone who helped us near or far with their effort, words or encouragement.

We also thank all the university staff and workers, the incubator staff and the team at the "20 August 1955 SKIKDA University Business Incubator" for their help and all the facilities they gave us. May God reward them all with good.

Dedication

We dedicate the fruit of our humble effort to our dear parents who always stood beside us and gave us strength.

May God protect them and keep them in good health.

To our brothers and sisters whose smiles gave us hope every day.

To our whole family and all our relatives for their endless love and support.

To every teacher who guided us on our learning journey from school until university.

To our friends and classmates who shared moments of hard work and success with us.

To everyone who supported us with their help, time, and kind words.

To all who gave us love, respect, and encouragement we thank you with all our hearts.

Table of Contents

List of Figures

List of Tables

General Introduction

The safety of children in public places and neighborhoods has become a growing concern around the world, whether it is fear of kidnapping, getting lost in traffic accidents, or even just the fear of not knowing where the child is.

In Algeria, the situation is no less worrying than in the rest of the world. From the free hotline 1111 and the mobile application Alo Tofoula, the National Authority for the Protection and Promotion of Children (ONPPE) has received more than 248,000 alerts regarding children in danger, whether it be attempted kidnapping, missing children, children found wandering in public places, or signs of abuse. These alerts indicate that there is no completely safe environment. There is no normal moment of potential danger, despite legal campaigns such as Law 15-12 and stricter penalties for crimes against minors. The hope is that the laws will then punish.

The hotlines can only respond when the child is actually in trouble. What is missing is a system that will act before it is too late. There are also quiet moments of uncertainty that never make it to the news, but every parent knows and remembers by heart the panic of a child who does not return home at the usual time, and even if they have a phone they do not answer.

This is where **HARISI** comes in. This project isn't just a GPS tracking device. It's an attempt to redefine child protection in the age of artificial intelligence(AI) and the Internet of Things (IOT) by combining geolocation, transportation detection, cry detection, a health sensor, an SOS button, a camera, a microphone, and real-time alerts.

Thus, the **HARISI** project was born. **HARISI** is a smart wearable device designed to do more than just track a child's location. It uses artificial intelligence to detect crying sounds, recognize movement patterns, and alert parents immediately. It also records what surrounds the child at critical moments and sends notifications to the parents' application on their phones.

HARISI is not just a technology, but rather a link between the child and his parents, providing protection and rapid response in times of danger. With **HARISI**, parents are no longer oblivious to what's happening. They gain the ability to act quickly and support their children even in their absence. And for children, it provides them with safety and protection in the moments that matter most.

Chapter 1: Project Idea

1. Genesis of the Idea

Many children go to school or play outside without supervision. Some of them disappear without anyone noticing early on. Parents are worried and want to know where their children are, what is happening around them, and whether they are safe or not. They are looking for something that will give them peace of mind, not just a point on a map.

The idea for **HARISI** came not from a single event, but from many recurring stories: a lost child, a frightened family, an unanswered question... This project does not aim to create something new, but to provide a real tool for families something small that watches, listens, and speaks on behalf of the child when the child cannot.

2. Problem Statement

Children continue to be exposed to accidents around the world and within Algeria that threaten their safety. Parents and guardians lack a solution to mitigate this problem, such as a wearable device that simultaneously tracks the child's location, detects any sudden movements, such as leaving the safe zone, and provides a visual view of the child's surroundings. Current devices, such as standalone GPS tracking systems or simple emergency buttons, do not integrate immediate situational awareness, which creates gaps in child protection and delays immediate emergency response.

3. Project Objectives and Scope

The **HARISI** Child Security Device is designed to provide comprehensive protection and peace of mind for parents and guardians. Its primary objectives are:

1. Crying Detection Alert: Automatically detect the child’s cry and send an instant notification to the caregiver’s mobile app.
2. Geofence Monitoring: Define a safe zone; upon exit, trigger an immediate alert to guardians.

3. Transport Detection: Identify when the child boards a vehicle (e.g., car or school bus) or is walking, and notify parents.
4. Remote Camera & Microphone Control: Allow guardians to activate the child's device camera and microphone remotely for live monitoring.
5. SOS Button: Provide a one-touch emergency button on the device; pressing it sends an SOS notification and records a short video clip of the child's surroundings.
6. Health Monitoring: Continuously measure the child's heart rate and body temperature and notify parents in case of abnormal values.
7. Wireless Data Transmission: Ensure real-time data and media delivery via Wi-Fi or mobile network.

Scope:

Hardware: Includes audio sensor (microphone) for cry detection, GPS module, motion sensors, camera, microphone, SOS button, health sensor (heart rate and temperature), and wireless communication modules.

Firmware: Implements AI-based cry detection using audio input, transport mode classification, health data monitoring, alert logic, and device control.

Mobile App: Real-time alerts, map interface, media viewer, health status display, and emergency response dashboard.

Pilot Testing: Prototype deployment with 20 children to validate detection accuracy and user experience.

4. Proposed Solution

• Solution Overview

HARISI is an AI-powered wearable device paired with a mobile application, offering comprehensive child protection features designed to address safety concerns proactively and in real time.

• Key Features

Real-time Geolocation Alerts: Notifies guardians when the child exits predefined safe zones (e.g., home, school route).

Crying Detection (AI-based): Detects when a child is crying using a general AI model. This feature helps alert guardians to signs of distress.

Automatic Transport Mode Detection: Distinguishes between walking and vehicular movement to provide context-aware alerts.

Remote Live Video/Audio Control: Allows guardians to activate the child's camera and microphone remotely for live environmental monitoring.

Health Monitoring: Tracks real-time heart rate and body temperature to detect abnormal physical conditions early.

Multi-Child Support: Enables the management of multiple child profiles within a single parent application.

Privacy-Respecting Mechanisms: Automatically disables camera and microphone functions in privacy-sensitive areas (e.g., inside schools).

• Technical Components

AI Modules: Crying detection and transport mode classification models.

Sensors: MEMS microphone, MPU6500 accelerometer, GPS module, health sensor MAX30100.

Connectivity: Wi-Fi or SIM-modules (e.g, SIM808) for real time data transmission.

User Interface & Hardware: Custom PCB, emergency SOS button, power management system.

5. Project Team

We are three Master 2 students in Computer Science at University of August 20, 1955 - SKIKDA:

- **Student 01:** ZERIOUL Razane Lina Hind (Networks & Distributed Systems)
- **Student 02:** BELAMRI Nouhad (Artificial Intelligence Specialization)
- **Student 03:** MOUMEN Abir (Networks & Distributed Systems)

We worked side by side on this project helping each other at every step sharing ideas, solving problems together and supporting each other through every challenge.

We also took on the following tasks:

🔍 A.I – Cry Detection & TMD

- Collecting the necessary data for crying detection and transport mode detection (TMD).
- Preparing and cleaning the datasets to ensure quality results.
- Training, testing and evaluating different models and choosing the right one based on the best accuracy and performance for both crying detection and TMD.
- Converting the AI model to TFLite and integrating it into the mobile application and the device efficiently.

📲 Mobile Application (Flutter)

- Designing and developing the mobile application (Flutter) for the parental user interface.
- Programming a system to add children, view their profiles, and control each child individually.
- Connecting the application to the Firebase database (Realtime Database + Authentication).
- Integrating Firebase Storage to save images and videos from the ESP32-CAM.
- Implementing remote control commands for the camera and microphone via Firebase.
- Creating a notification system using Firebase Cloud Messaging (FCM).

🌍 Geolocation System

- Designing a geolocation system using GPS.
- Implementing the geolocation system, tracking routes, and sending alerts when exiting the safe zone.

🔌 Prototype Development

- Developing the physical prototype of the device using ESP32-CAM, MAX9814.
- microphone, MAX30100 health sensor, ESP32 WROOM 32E, and power modules.

- Planning all connections and preparing the electronic circuit diagrams for the prototype.
- Managing the assembly and testing of the hardware components.

🗄 **Backend Server (Django)**

- Designing and developing a Django backend server to handle advanced data management.
- Creating APIs to manage user data, device commands, and secure communication.
- Preparing the backend for future extensions such as dashboards, logs, or AI processing.

💵 **Financial & Business Planning**

- Preparing a complete financial study for all versions of the **HARISI** device (Geo, Smart, Bio, etc.).
- Calculating wholesale production prices, determining the proposed selling price, and calculating the profit margin.
- Developing a four-year financial plan highlighting expected profits and expenses.
- Preparing a detailed Business Model Canvas (BMC) for the **HARISI** project.

📚 **Documentation & Presentation**

- Writing the thesis covering all technical, economic, and marketing aspects of the project.
- Preparing clear visuals, tables and presentations to explain the project during the defense.

Supervision:

- Dr. LAHSASNA Adel, PhD in Computer Science
- Dr. BOULNEMOUR Imen, PhD in Computer Science

6. Project Timeline

Phase Number	Phase Description	Duration (Weeks)
1	Idea Definition & Planning	1–2
2	AI Model Development	3–6
3	Application Development	7–10
4	Software Integration & Testing	11–14
5	Prototype Assembly	15–18
6	Prototype Validation	19–20
7	Thesis Writing & Documentation	21–24

Table 1: Comprehensive Project Timeline

Chapter 2: Innovative Value and Project Advantages

1. Innovative Aspects of the Project

The **HARISI** device demonstrates several novel and distinctive features that position it ahead of conventional child safety solutions:

- **Multi-modal Artificial Intelligence Detection**
  Combines embedded AI algorithms to detect both **crying sounds** and **transportation modes** (walking vs. vehicle), offering a dual-layered protection system in one wearable unit.

- **Unified Smart Platform**
  Integrates **real-time geolocation**, **audio/video remote monitoring**, and an **SOS emergency trigger** within a single compact device removing the need for fragmented tools or multiple devices.

- **Smart Geofencing and Transport Awareness**
  Automatically adapts the safe zone boundaries and intelligently classifies motion to distinguish between **walking**, or **being inside a vehicle** improving alert relevance.

- **Live Remote Activation (Camera & Microphone)**
  Parents can remotely activate the child's camera and microphone in real time without physical intervention, offering full **situational awareness** during emergencies.

- **Embedded Health Tracking:** Continuous monitoring of heart rate and body temperature integrated within the wearable device.

- **Privacy-Compliant Logic**
  Recording functions are automatically **disabled in sensitive areas** (like classrooms), ensuring **privacy respect**, legal compliance, and parent/school trust.

2. Project Advantages

The **HARISI** system delivers measurable value for families and institutions alike:

- **Improved Child Protection**
  By providing instant alerts for abnormal behavior or risk conditions, response time during **critical incidents is significantly reduced**.
- **Affordability**
  Instead of requiring several separate tools, **HARISI** consolidates features into **one cost effective device**, reducing hardware and maintenance expenses.
- **Child-Friendly and Wearable**
  The device is **comfortable, lightweight**, and designed with child usage in mind ensuring children **accept and wear it consistently**.
- **Remote Update Capability**
  All AI models (cry detection, transport classification(TMD)) are **software based** and can be remotely improved through over the-air updates, ensuring long term adaptability and innovation.
- Health Awareness Enables early detection of unusual physiological states such as fever or irregular heartbeat.
- **Simple Setup and Use**
  Thanks to plug-and-play hardware and an intuitive mobile app, the system offers **easy onboarding** for both parents and institutions (schools, daycares)

Chapter 3: Market Analysis and Marketing Strategy

1. Market Overview

The wearable technology market in the Middle East and Africa (MEA) is experiencing rapid growth. In 2024, its value was estimated at approximately **603.95 billion DZD**, with a projected compound annual growth rate (CAGR) of **18.4%** from 2024 to 2031.

🔗 [Source – Grand View Research]

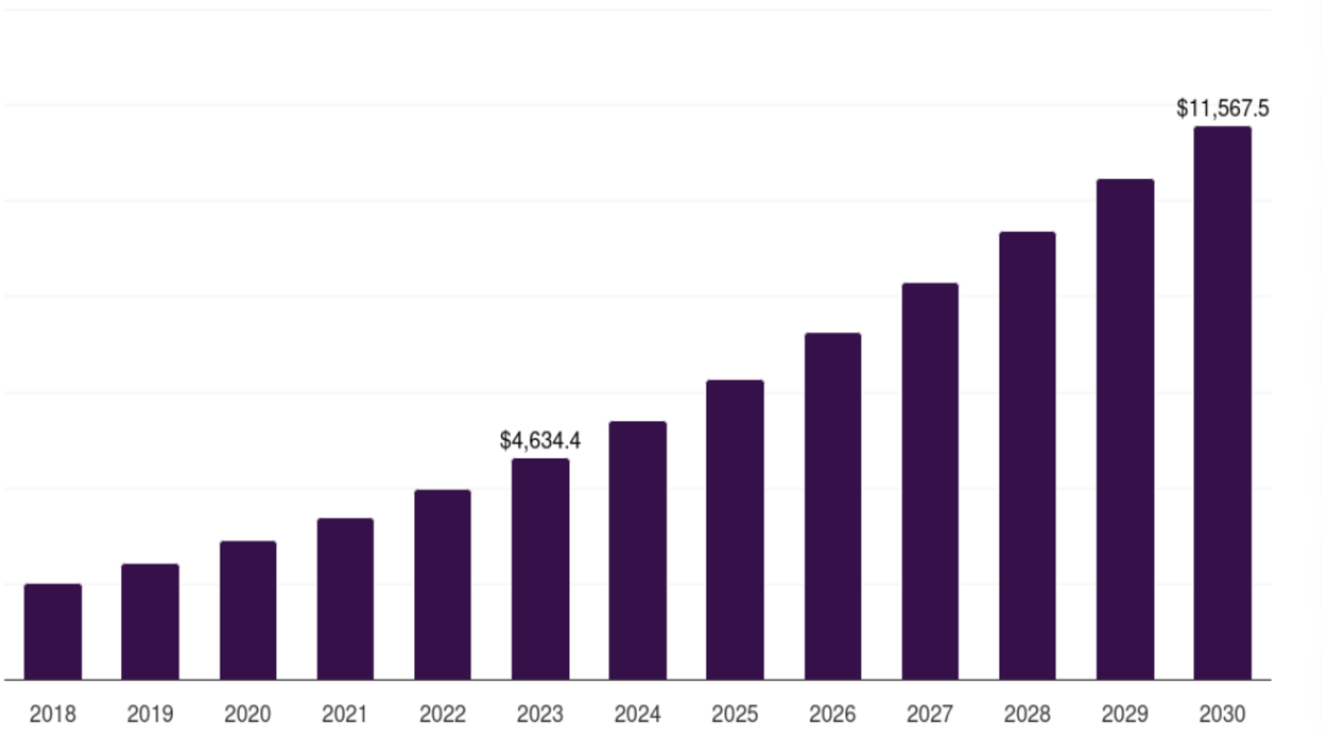


Figure 1: Middle East & Africa wearable technology market, 2018-2030

Within this broader segment, **child safety wearables** are gaining significant attention. This includes devices such as **GPS trackers, smart bands, and specialized watches**. As families and institutions continue to prioritize **real-time monitoring and security**, the demand for **practical, affordable, and efficient solutions** is rising sharply. Globally, the children's smartwatch market reached approximately **504.72 billion DZD** in 2024 and is expected to grow to about **588.53 billion DZD** by 2025, at a CAGR of **16.9%**.🔗 [Source – The Business Research Company]

These figures reflect a **global shift toward integrating technology into child protection and daily monitoring**.

Key distribution channels in this space include:

- Online e-commerce platforms
- Direct partnerships with schools and daycare centers
- Health institutions and local distributors

2. Competitive Landscape

The market for child safety wearable devices includes a variety of products and competitors offering different levels of functionality.

Main Competitors

- **Basic GPS trackers** like *LifeDots* and *AngelSense* offer only location tracking and limited alert capabilities.
- **Smartwatches** such as *Xiaomi Mi Bunny* provide simple GPS and voice call features, but lack advanced safety functionalities.

Porter's Five Forces Analysis

1) **Competitive Rivalry High**
   Numerous brands are present in the market, competing on design, features, and price. Innovation cycles are short, and new products are released frequently.
2) **Threat of Substitution Moderate**
   Substitutes like GPS keychains or mobile apps exist but are limited—they typically don't support real-time communication or advanced safety functions such as health monitoring or intelligent alerting.
3) **Supplier Power Moderate**
   Core components such as microcontrollers, GPS, and health sensors are globally available but may be affected by international supply issues or bulk pricing constraints.
4) **Barriers to Entry Low**
   It's easy for new players to enter with simple devices. However, developing a

complete solution with smart monitoring, secure communication, and accurate sensor fusion requires technical expertise.

5) **Buyer Power High**

   Parents and institutions are very price-conscious. They compare features, seek value for money, and are increasingly aware of data privacy and real-time protection needs.

HARISI's Competitive Edge

HARISI differentiates itself in several key areas:

- **Integration of smart technologies**:
  - **HARISI** combines GPS tracking, microphone, camera, health sensors, and AI-powered behavior detection in a compact device.
- **AI-Powered Features**:
  - **Crying detection** detect if a child is crying.
  - Intelligent **transport mode detection** that identifies if the child is walking, or riding in a vehicle.
- **Wide range of product options**:
  - From basic models like ***Harisi Geo*** to full-featured versions like ***Harisi SmartBio*** and ***HomeCam***, **HARISI** adapts to family needs and budgets.
- **Real-time alerts**:
  - Parents receive immediate notifications for SOS events, safe zone breaches, abnormal crying, or health issues.
- **Localized pricing**:
  - **HARISI** devices are priced affordably for Algerian families, ranging from **3,650 DZD** to **5,950 DZD**, with no subscription fees.
- **Privacy and trust first**:
  - Only parents can control the microphone and camera, ensuring the child's privacy is always respected.

3. Marketing Strategy

HARISI will adopt a focused and efficient marketing strategy using the **4P Model**: **Product, Price, Place, Promotion**.

1) Product

HARISI offers a range of wearable child safety devices that provide **smart protection and real-time control**. The main features include:

- **GPS tracking** with geofencing and real-time alerts
- **AI-powered crying detection**, (cry, no cry)
- **AI-based transport mode detection** (walk, car, bus...)
- **Motion tracking and SOS button** for emergencies
- **Health monitoring** (body temperature and heart rate – Harisi SmartBio only)
- **Remote audio and video control**, triggered by the parent via app
- **Lightweight design** with child-friendly and tamper-proof casing
- **Multiple device options**, from basic to advanced (Geo to SmartBio & HomeCam)

2) Price

HARISI is designed to be **affordable and accessible** for all Algerian families:

- **For individual families (B2C):**
  Prices range from **3,650 DZD to 5,950 DZD**, depending on the device model.

- **For institutions and bulk orders (B2B):**
  Discounted prices between **2,700 DZD and 4,300 DZD** per unit.

- **No monthly subscription** is required – it's a **one-time payment only.**

3) Place

HARISI will be distributed through a variety of **direct and digital channels**:

- **Direct sales to schools**, nurseries, health centers, and child protection organizations
- **Online sales** through local e-commerce platforms (e.g., **Jumia Algeria**, official Harisi website)
- **On-site promotion** at school fairs, parent meetings, and educational events
- Potential **partnerships with government child safety programs**

4) Promotion

The promotional strategy focuses on **trust, education, and visibility**:

- **Targeted campaigns on social media** (Facebook, Instagram, TikTok) showing real family stories
- **Live demonstrations** at expos and safety workshops
- **Referral and reward programs** through pediatric clinics and teacher networks
- **Awareness content** in schools, parenting forums, and community centers
- Potential **endorsements** from local influencers, educators, and pediatricians

Chapter 4: Production and Organizational Plan

1. Production Process

The production of **HARISI** devices follows a structured and quality-focused process designed for **scalability, consistency, and low cost per unit**. This process ensures that **all six device models** (Geo, GeoVoice, GeoVoiceCam, Smart, SmartBio, and HomeCam) are produced efficiently and tested reliably.

🛠 Step-by-Step Manufacturing Workflow:

1.1. PCB Design & Preparation

- Electronic circuits for each device are designed using CAD software.
- **Gerber files** are generated for PCB fabrication.
- Boards are customized per model (Geo vs. SmartBio, etc.) and sent to a professional PCB manufacturing service.

1.2. SMT (Surface Mount Technology) Assembly

- High-speed automated machines place and solder **core components**: ESP32-C3, SIM808, sensors, etc.
- This ensures **high precision**, especially for microcomponents.

1.3. Manual Assembly

- Remaining components like the **battery**, **connectors**, **camera**, **microphone**, **SOS button**, and **ABS-PC plastic casing** are installed manually.
- Devices are matched with the correct sensor modules based on the model (e.g., MAX30102 for SmartBio, OV2640 for GeoVoiceCam).

1.4. Firmware Installation & AI Calibration

- Custom firmware is uploaded to the **ESP32-C3 microcontroller** using secure flashing tools.
- Each device is calibrated:
  - **GPS calibration** (using SIM808)
  - **Motion sensors** (MPU6500)
  - **Crying detection AI model** (only on models with mic)

- **Health sensor tuning** (SmartBio only)

1.5. **Functional Testing & Final Inspection**

- Every unit undergoes **multi-point testing** for camera, mic, AI, GPS, and battery performance.
- Devices are powered up, connected to Firebase, and a full **feature checklist** is validated.
- Once approved, units are packaged and serialized for tracking.

2. Supply Chain Management

To ensure stable production, avoid component shortages, and maintain low per-unit costs, **HARISI** follows a **robust and strategic supply chain plan** adapted to the Algerian context and startup production scale.

🔧 Component Sourcing

- **Electronic Modules:**
  Core components such as the **ESP32-C3**, **SIM808 (GSM + GPS)**, **MAX9814** (microphone), **OV2640** (camera), **MAX30102** (health sensor), and **MPU6500** (motion sensor) are imported in bulk from **verified international suppliers** like DigiKey and Mouser Electronics.
- **Casing, Batteries & Packaging:**
  Durable **ABS-PC enclosures**, **500mAh Li-Po batteries**, and all packaging materials are **manufactured locally** in Algeria to reduce lead times, avoid customs delays, and support the national economy.
- **PCB Fabrication & Assembly:**
  Custom-designed PCBs are produced and SMT-assembled by **JLCPCB** (or equivalent global provider).
  For higher volumes, a **turnkey PCB + SMT assembly** service is used to ensure fast and error-free board production.

📦 Inventory & Procurement Strategy

- **Just-in-Time Inventory:**
  HARISI follows a **lean inventory model**, keeping minimal storage while planning monthly restocking based on sales and school-year cycles.
- **Bulk Ordering & Pricing:**
  Electronic modules and SMT services are ordered in **batches of 100–500 units**, allowing for **volume discounts** and better supplier negotiations.
- **Trusted Sensor Supply Chain:**
  Specific biometric components like **MAX30102** are pre-tested and ordered in bulk from official distributors to ensure **accuracy and authenticity**, avoiding low-quality clones.
- **Local Partnerships:**
  For casing, packaging, and simple manual labor, **HARISI** builds **partnerships with local SMEs** (plastic molding, printing, etc.), reducing costs and supporting local employment.

3. Workforce Structure

HARISI relies on a **lean and skilled production team** to ensure every unit is assembled, tested, and delivered according to strict quality and functionality standards. The structure is optimized for initial production batches (100–500 units) with potential to scale.

Assembly Technicians (2 Full-Time)

- Responsible for the **manual integration** of components such as the SIM808 module, sensors, batteries, and casing.
- Handle small-scale SMT soldering or final attachment of modules after PCB assembly.
- Perform basic **functionality checks** before devices proceed to final testing.

Firmware & Test Engineer (1 Full Time)

- Uploads the **firmware** onto each ESP32-C3 board.
- Calibrates modules (GPS, motion, microphone, health sensor).
- Develops and runs **automated testing scripts** to verify that each unit meets functional and communication standards.
- Fixes technical errors and ensures sensor data flows correctly to Firebase.

Quality Inspector (1 Part Time)

- Verifies the quality of all **incoming components** and **finished products**.
- Conducts **visual inspection**, stress tests, and packaging validation.
- Ensures each unit complies with **HARISI**'s safety and reliability standards before shipment.

Production Supervisor (1 Full-Time)

- Oversees the entire **production workflow**, from inventory arrival to packaging.
- Coordinates with external suppliers and local partners.
- Tracks productivity, resolves workflow issues, and ensures delivery deadlines are met.
- Reports progress and optimizations to the management or startup lead team.

Chapter 5: Financial Plan

1. Calculating Production Cost per Model

Below are the Bill of Materials (BOM) tables for each **HARISI** model, showing how the total cost is built up:

📟 Harisi Geo

Component	Qty	Unit Cost (DZD)
SIM808 (GSM + GPS)	1	675
ESP32-C3-WROOM	1	300
TP4056 + DW01 (Charger & IC)	1	45
500 mAh Li-Po battery	1	225
PCB + SMT assembly	1	450
ABS-PC enclosure	1	300
Accessories (antenna, cable)	1	75
Total BOM Cost		**2 070**

Table 2: Components and Production Cost Breakdown for Harisi Geo

📟 Harisi GeoVoice

Component	Qty	Unit Cost (DZD)
All Harisi Geo components	–	2 070
MAX9814 microphone	1	180
Total BOM Cost		**2 250**

Table 3: Components and Production Cost Breakdown for Harisi GeoVoice (with microphone)

📟 Harisi GeoVoiceCam

Component	Qty	Unit Cost (DZD)
All Harisi GeoVoice components	–	2 250
OV2640 camera module	1	450
Total BOM Cost		**2 700**

Table 4: Components and Production Cost Breakdown for Harisi GeoVoiceCam (with microphone and camera)

📟 Harisi Smart

Component	Qty	Unit Cost (DZD)
All Harisi GeoVoiceCam components	–	2 700
MPU-6500 3-axis accelerometer	1	225
Total BOM Cost		**2 925**

Table 5: Components and Production Cost Breakdown for Harisi Smart (full-feature version)

📟 Harisi SmartBio

Component	Qty	Unit Cost (DZD)
All Harisi Smart components	–	2 925
MAX3102 heart-rate + temperature sensor	1	375
Total BOM Cost		**3 300**

Table 6: Components and Production Cost Breakdown for Harisi SmartBio (with biometric sensors)

📟 Harisi Home (with camera)

Component	Qty	Unit Cost (DZD)
ESP32-C3-WROOM	1	300
TP4056 + DW01 (Charger & IC)	1	45
500 mAh Li-Po battery	1	225
PCB + SMT assembly	1	450
ABS-PC enclosure	1	300
MAX9814 microphone	1	180
OV2640 camera module	1	450
Accessories (antenna, cable)	1	75
Total BOM Cost		**2 025**

Table 7: Components and Production Cost Breakdown for Harisi Home

2. Aggregate Production Costs

Model	Total BOM Cost (DZD)
Harisi Geo	2 070
Harisi GeoVoice	2 250
Harisi GeoVoiceCam	2 700
Harisi Smart	2 925
Harisi SmartBio	3 300
Harisi Home (with camera)	2 025
Total per "Batch" (one of each)	**15 270**

Table 8: Total Production Costs per Model in the Harisi Device Line

3. Selling Price & Revenue Tiers (B2B vs B2C)

Using :

- a **1.3× markup** for wholesale (B2B)
- a **1.8× markup** for retail (B2C)

Model	B2B Price (DZD)	B2C Price (DZD)
Harisi Geo	2 700	3 750
Harisi GeoVoice	2 950	4 050
Harisi GeoVoiceCam	3 500	4 850
Harisi Smart	3 800	5 250
Harisi SmartBio	4 300	5 950
Harisi Home (with camera)	2 650	3 650

Table 9: Wholesale and Retail Selling Prices per Model (B2B vs. B2C)

4. Net Profit per Unit

Calculated at B2C price:

Model	B2C Price (DZD)	Cost (DZD)	Net Profit (DZD)	Margin (%)
Harisi Geo	3 750	2 070	1 680	44.8%
Harisi GeoVoice	4 050	2 250	1 800	44.4%
Harisi GeoVoiceCam	4 850	2 700	2 150	44.3%
Harisi Smart	5 250	2 925	2 325	44.3%
Harisi SmartBio	5 950	3 300	2 650	44.5%
Harisi Home (with camera)	3 650	2 025	1 625	44.5%

Table 10: Net Profit per Unit for Each Model Based on B2C Selling Price

5. Four-Year Financial Forecast (B2C Sales Only)

The following section presents a detailed four-year financial forecast for the **HARISI** project. This forecast includes a comprehensive analysis of the projected costs, revenues, and net profits for each product model, providing a clear vision of the anticipated growth and expansion.

📈 Year 1: Launch Phase (100 Units)

Model	Units	Total Cost (DZD)	Total Revenue (DZD)	Net Profit (DZD)
Harisi Geo	10	27,000	37,500	10,500
Harisi GeoVoice	15	44,250	60,750	16,500
Harisi GeoVoiceCam	20	70,000	97,000	27,000
Harisi Smart	20	76,000	105,000	29,000
Harisi SmartBio	20	86,000	119,000	33,000
Harisi Home (with camera)	15	39,750	54,750	15,000
Total	**100**	**343,000**	**474,000**	**131,000**

Table 11: Year 1 Financial Forecast – Launch Phase (100 Units)

📈 Year 2: Expansion Phase (200 Units)

Model	Units	Total Cost (DZD)	Total Revenue (DZD)	Net Profit (DZD)
Harisi Geo	20	54,000	75,000	21,000
Harisi GeoVoice	30	88,500	121,500	33,000
Harisi GeoVoiceCam	40	140,000	194,000	54,000
Harisi Smart	40	152,000	210,000	58,000
Harisi SmartBio	40	172,000	238,000	66,000
Harisi Home (with camera)	30	79,500	109,500	30,000
Total	**200**	**686,000**	**948,000**	**262,000**

Table 12: Year 2 Financial Forecast – Expansion Phase (200 Units)

📈 Year 3: Growth Phase (500 Units)

Model	Units	Total Cost (DZD)	Total Revenue (DZD)	Net Profit (DZD)
Harisi Geo	50	135,000	187,500	52,500
Harisi GeoVoice	75	221,250	303,750	82,500
Harisi GeoVoiceCam	100	350,000	485,000	135,000
Harisi Smart	100	380,000	525,000	145,000
Harisi SmartBio	100	430,000	595,000	165,000
Harisi Home (with camera)	75	198,750	273,750	75,000
Total	**500**	**1,715,000**	**2,370,000**	**655,000**

Table 13: Year 3 Financial Forecast – Growth Phase (500 Units)

📈 Year 4: Scaling Phase (1,000 Units)

Model	Units	Total Cost (DZD)	Total Revenue (DZD)	Net Profit (DZD)
Harisi Geo	100	270,000	375,000	105,000
Harisi GeoVoice	150	442,500	607,500	165,000
Harisi GeoVoiceCam	200	700,000	970,000	270,000
Harisi Smart	200	760,000	1,050,000	290,000
Harisi SmartBio	200	860,000	1,190,000	330,000
Harisi Home (with camera)	150	397,500	547,500	150,000
Total	**1000**	**3,430,000**	**4,740,000**	**1,310,000**

Table 14: Year 4 Financial Forecast – Scaling Phase (1,000 Units)

Overall Financial Summary (4 Years)

Metric	Value (DZD)
Total Units Sold	1,800
Total Cost	6,174,000
Total Revenue	8,532,000
Net Profit	**2,358,000**

Table 15: Overall Financial Summary over 4 Years

Chapter 6:
Experimental Prototype and Business Model Canvas

1. Prototype Description

The prototype of the **HARISI** device is a compact, wearable IoT system created to ensure the safety of children during school commutes and outdoor activities. Our design philosophy was to unify essential protection features real-time tracking, cry detection, health monitoring, and emergency alerts into a single, child-friendly device.

- **Hardware Components**

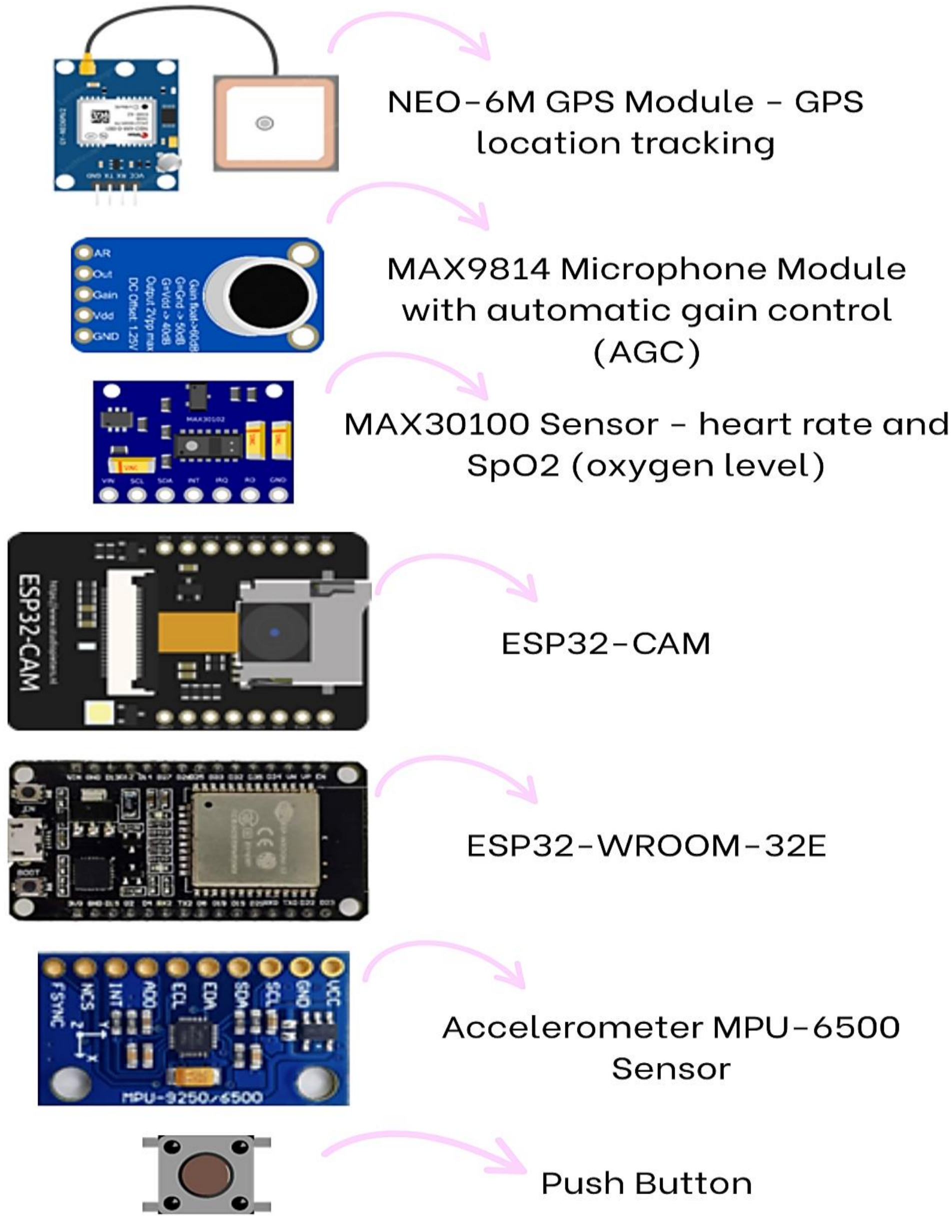


Figure 2: Hardware Components

- **The Circuit Diagram**

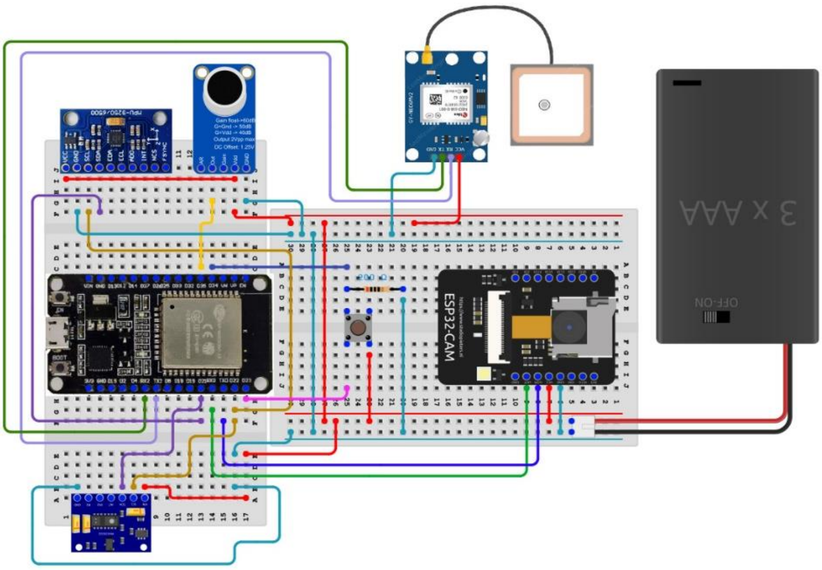


Figure 3: Electronic Circuit Diagram of the Harisi Prototype

- **The Prototype**

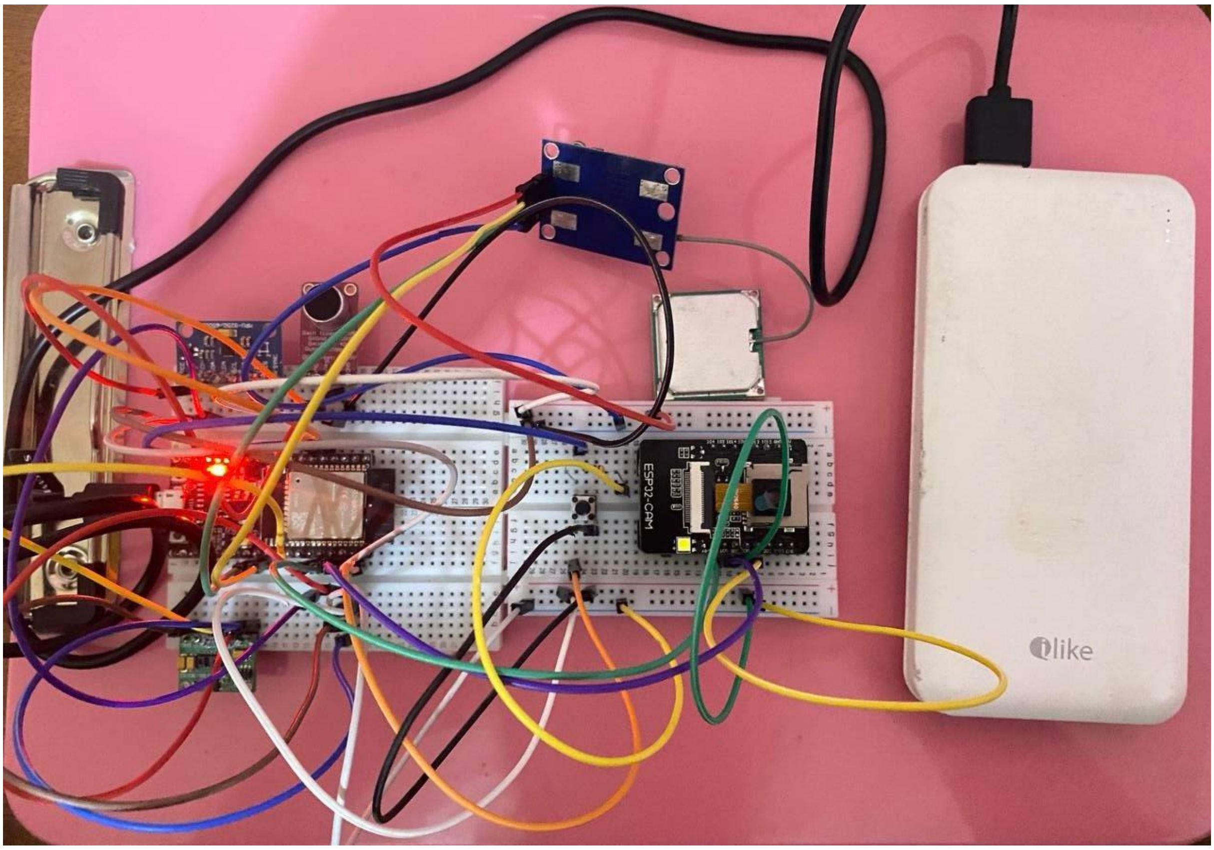


Figure 4: Breadboard Implementation of the Prototype

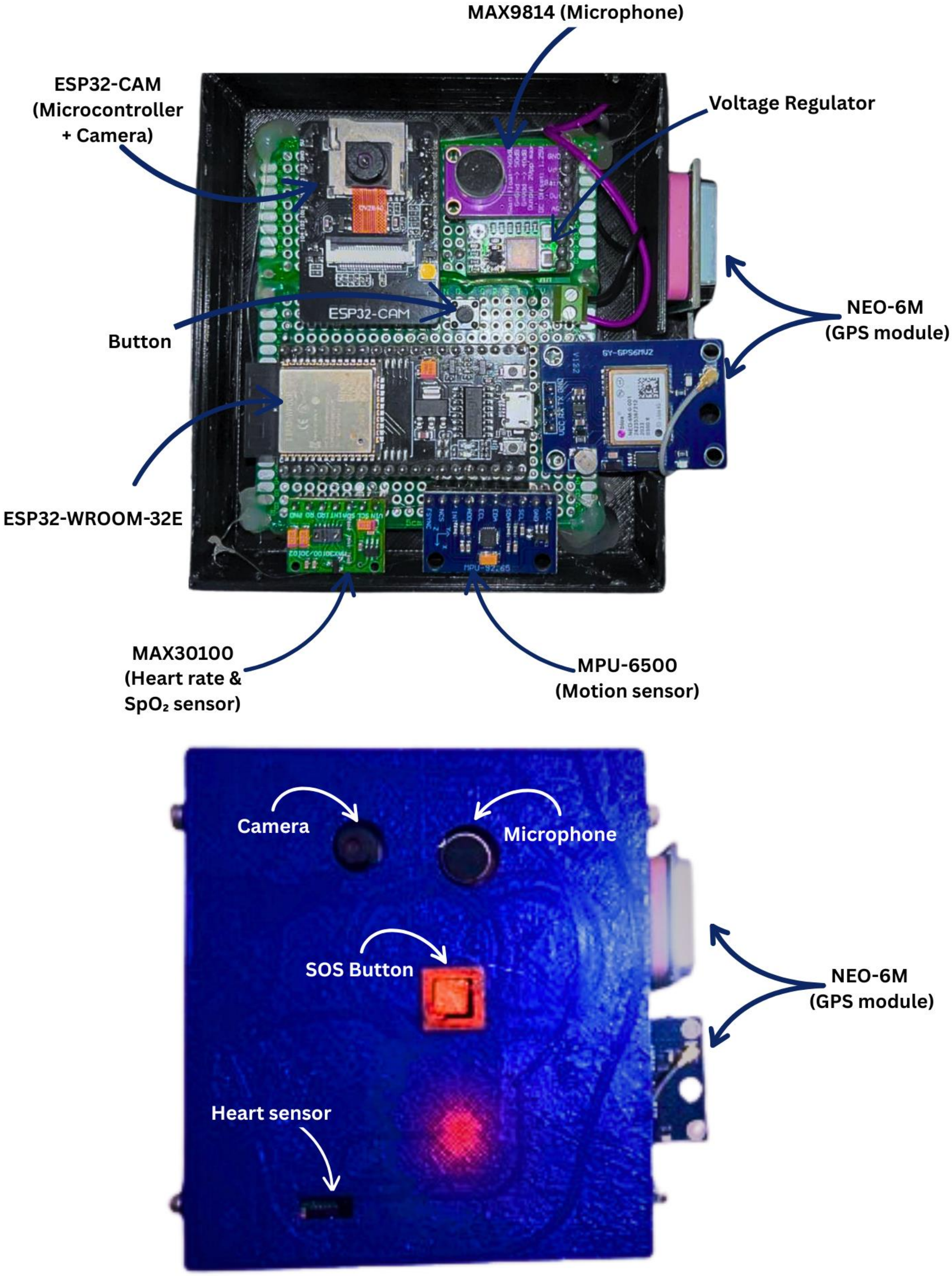


Figure 5: Final Enclosed Prototype

2. Mobile Application Development

The **HARISI mobile application** acts as the parental control center, built using a hybrid stack of **Flutter** (frontend) and **Firebase + Django** (backend).

- **Frontend: Flutter**
  - Developed using Flutter for a modern, responsive interface
  - Features a real-time map for tracking child location
  - Alert system for geofence exit, SOS press, or abnormal detection
  - Media gallery showing live images and audio received from the device
  - Multi-child management functionality
  - Setup wizard for easy onboarding

- **Backend: Django + Firebase**
  - **Django** handles:
    - Custom APIs
    - Authentication
    - Secure data storage for child profiles and logs
    - Administrative dashboard for evaluation
  - **Firebase** enables:
    - Real-time alert and media transfer
    - Remote command trigger (camera, microphone)
    - Lightweight synchronization using Firebase Realtime Database

➢ **Mobile application screenshots**

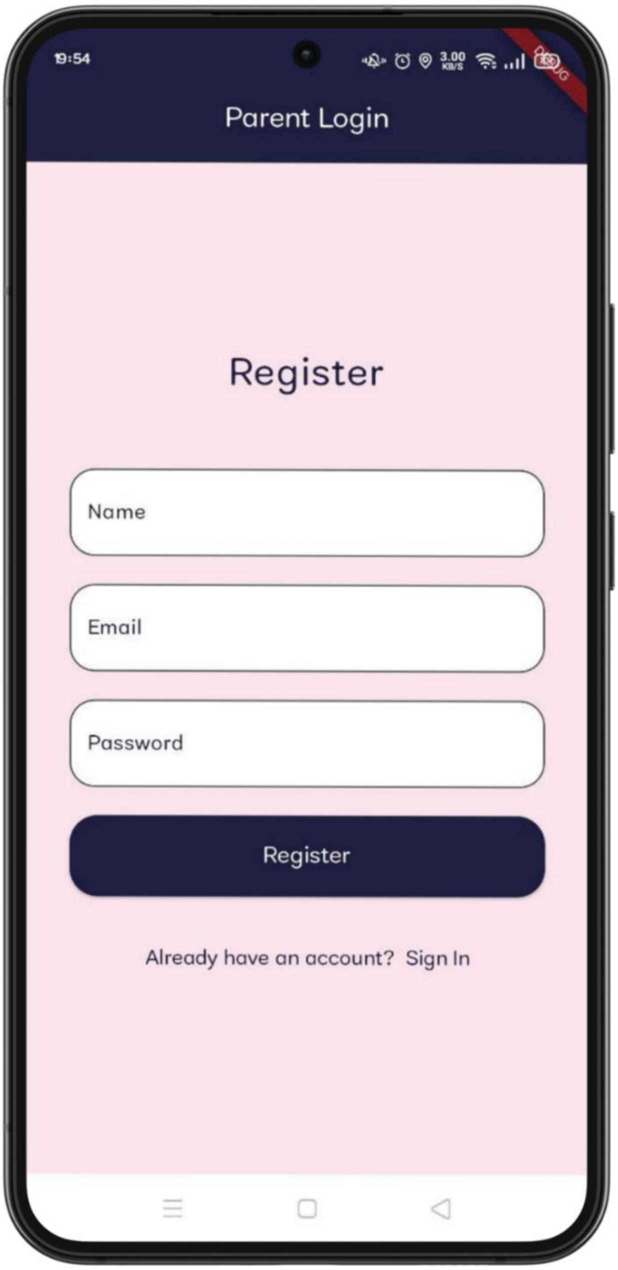


Figure 6: Register Screen

A clean registration screen for parents to create an account by providing their name, email, and password, with an option to switch to the sign-in page if they already have an account.

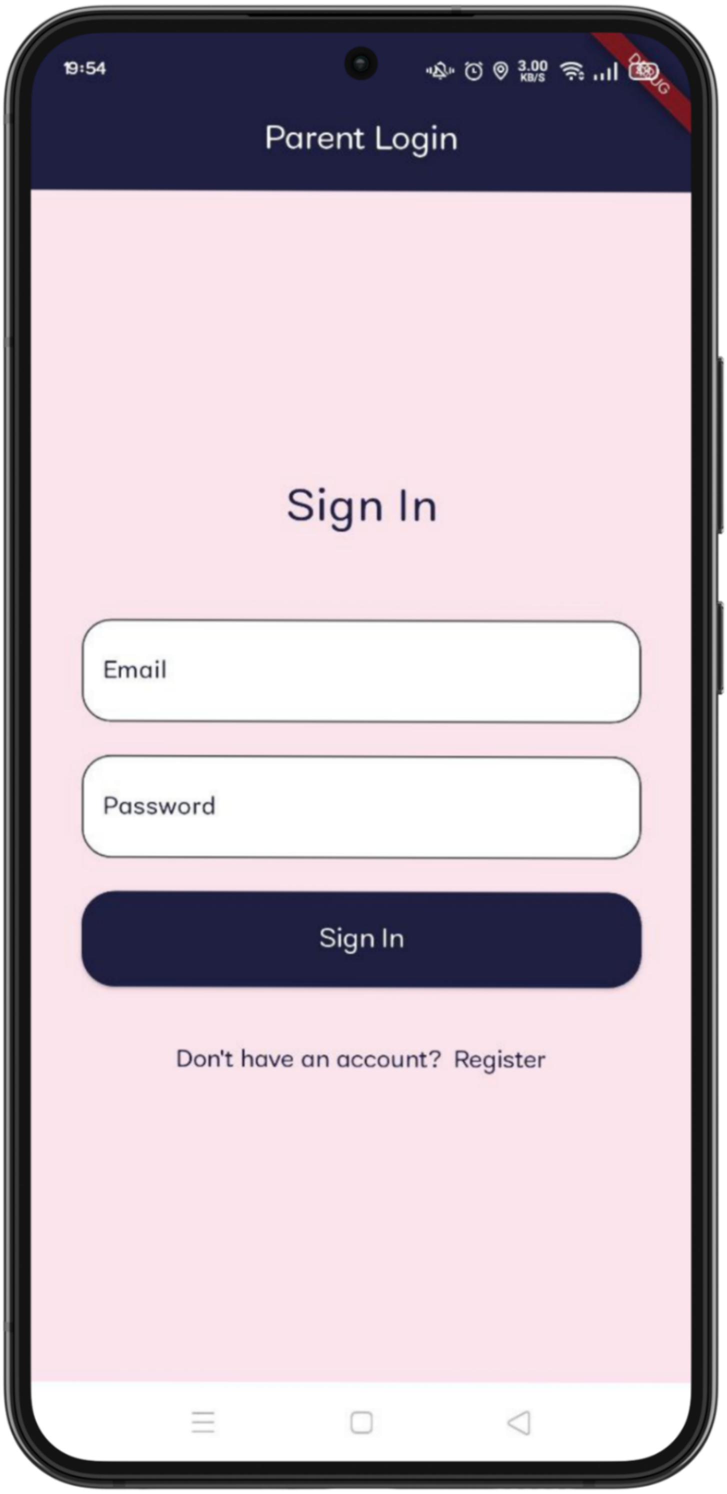


Figure 7: Sign In Screen

A simple login screen for parents to sign in using their email and password, with a link to switch to the registration page for new users.

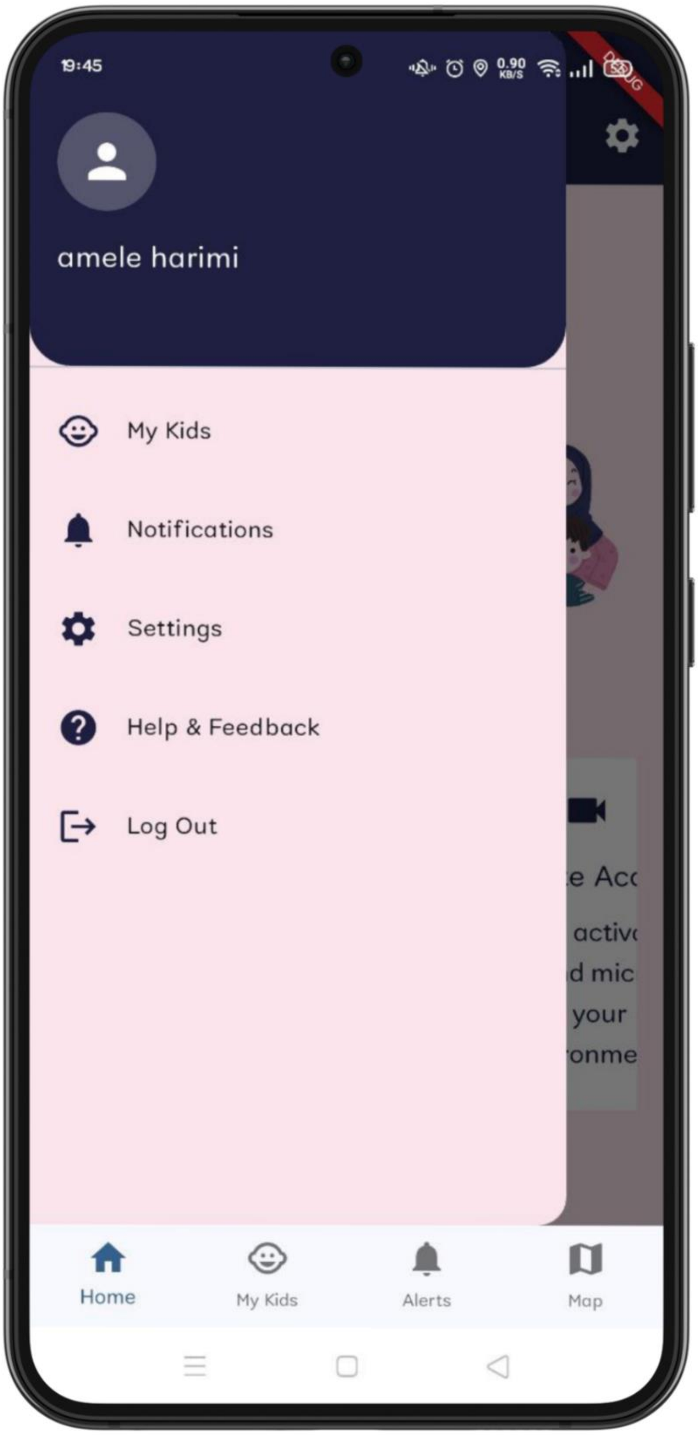


Figure 8: Sidebar Menu

The main navigation drawer for the parent app, showing the logged-in user's name and options to manage kids, view notifications, change settings, access help and log out.

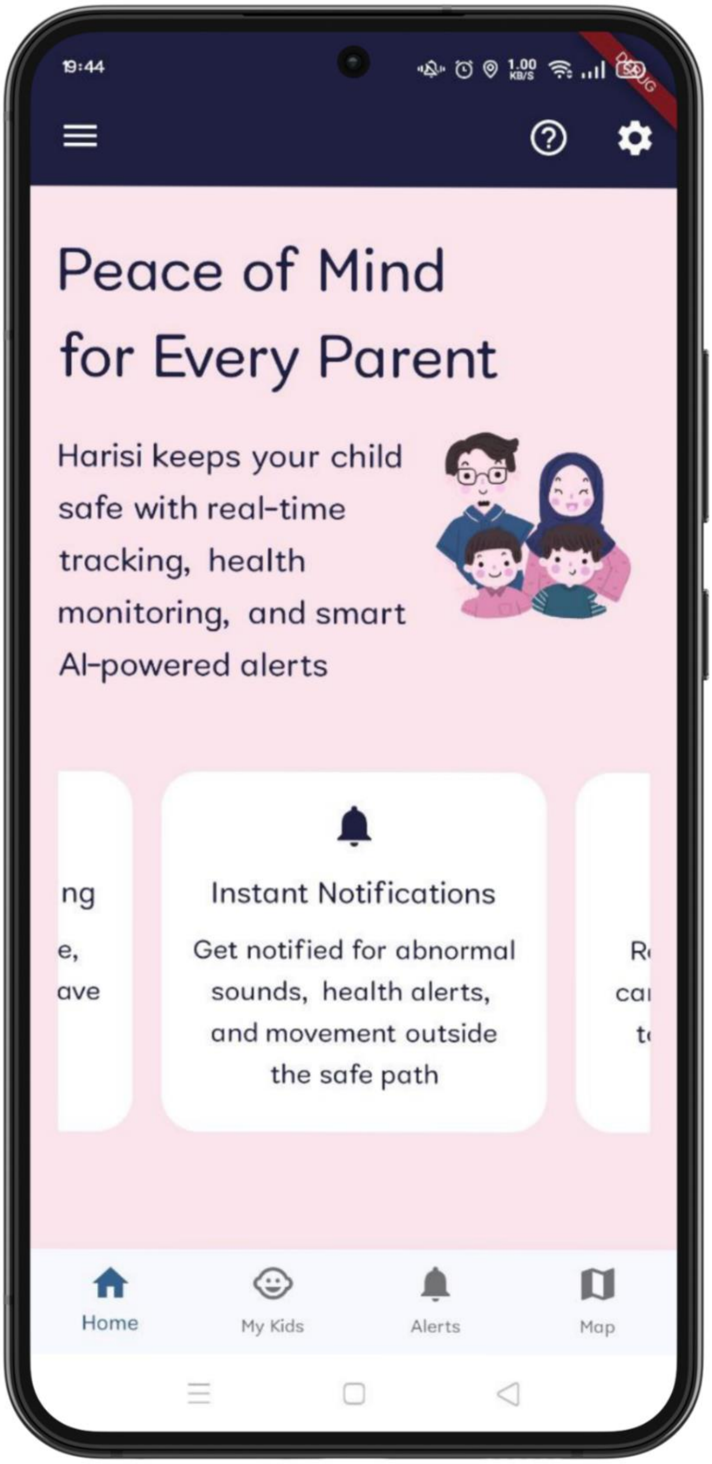


Figure 9: Home Screen

The home dashboard displaying the app's mission to give peace of mind to parents with live tracking, health monitoring and AI-powered alerts.

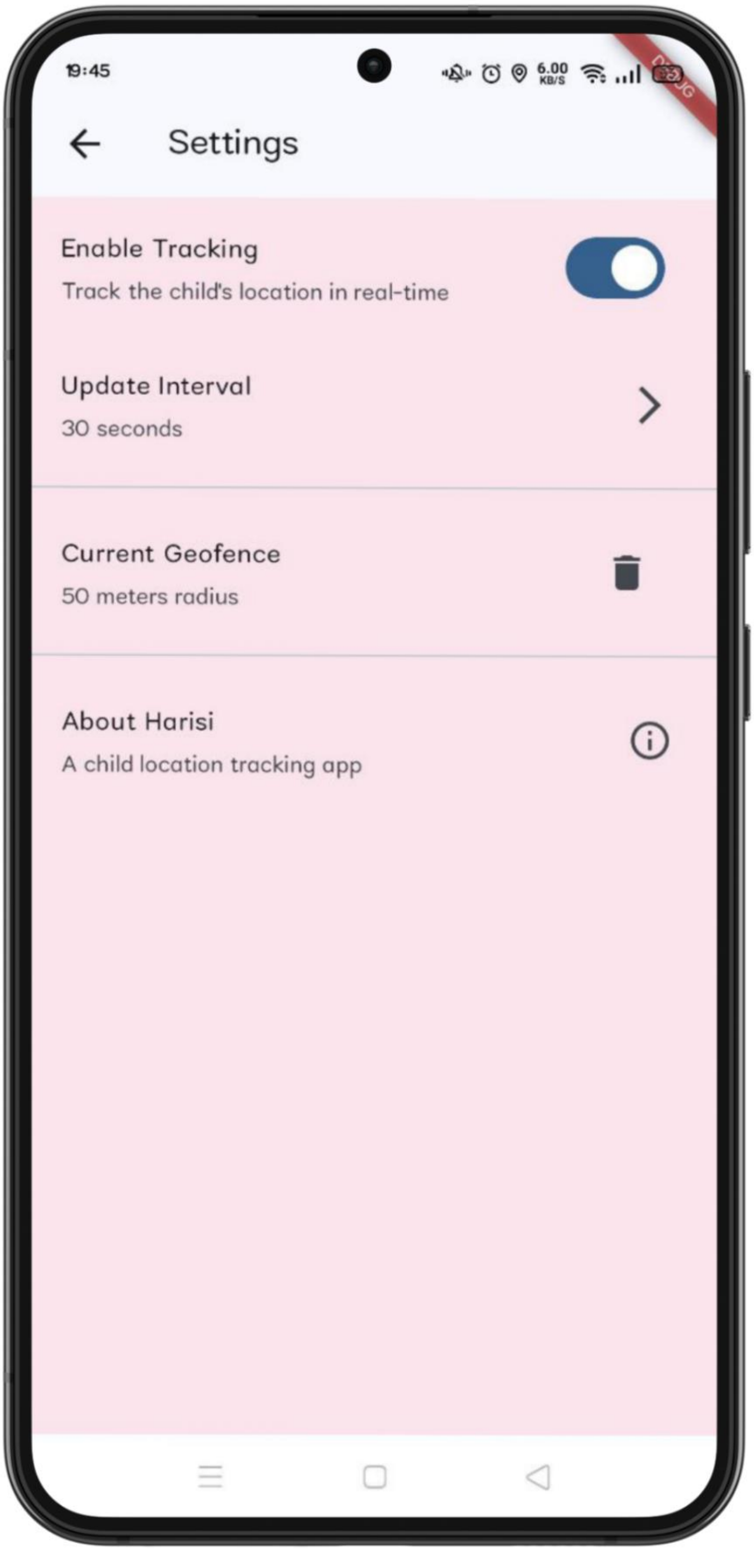


Figure 10: Settings Screen

A settings page where parents can enable or disable real-time tracking, set update intervals, manage geofencing and view app information.

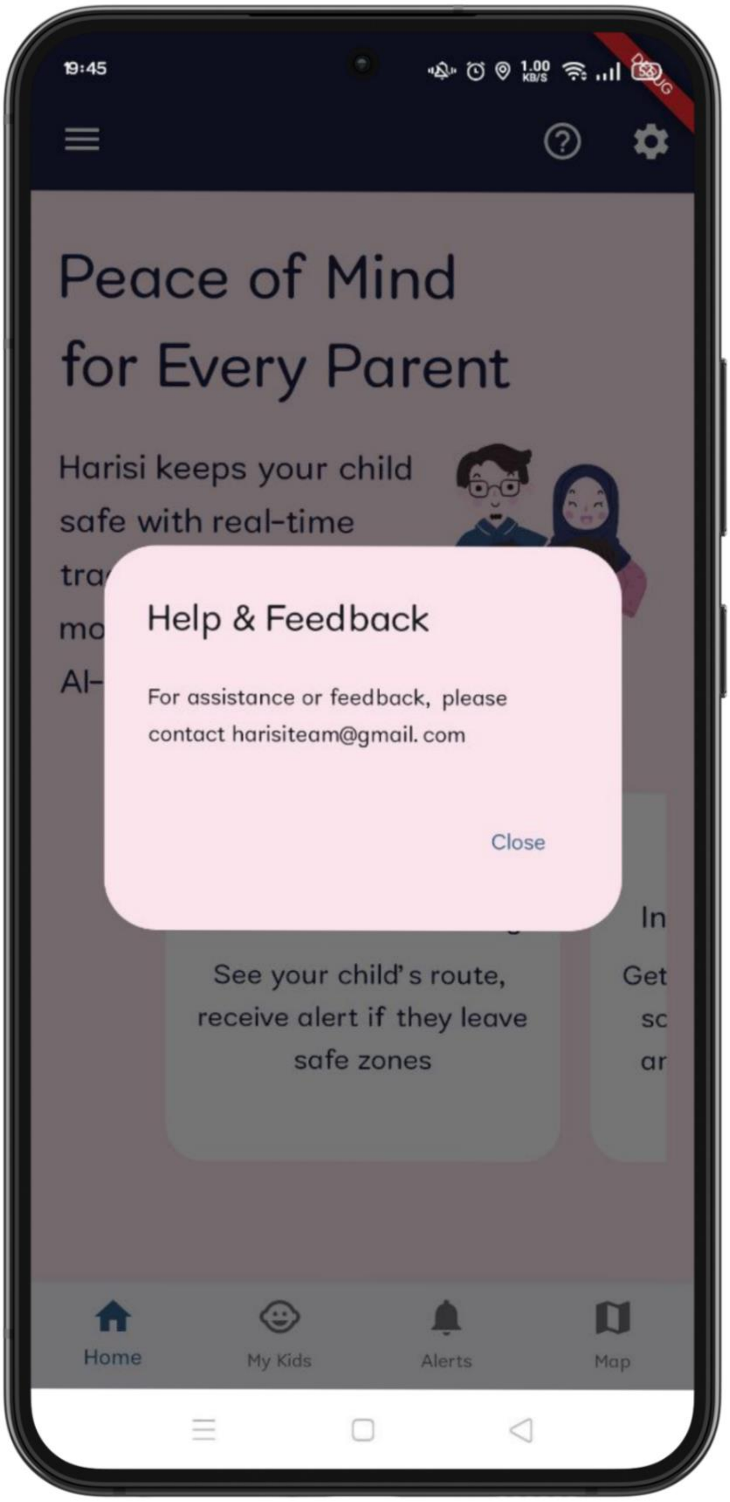


Figure 11: Help & Feedback

A simple modal providing contact information for users to get assistance or share feedback with the support team.

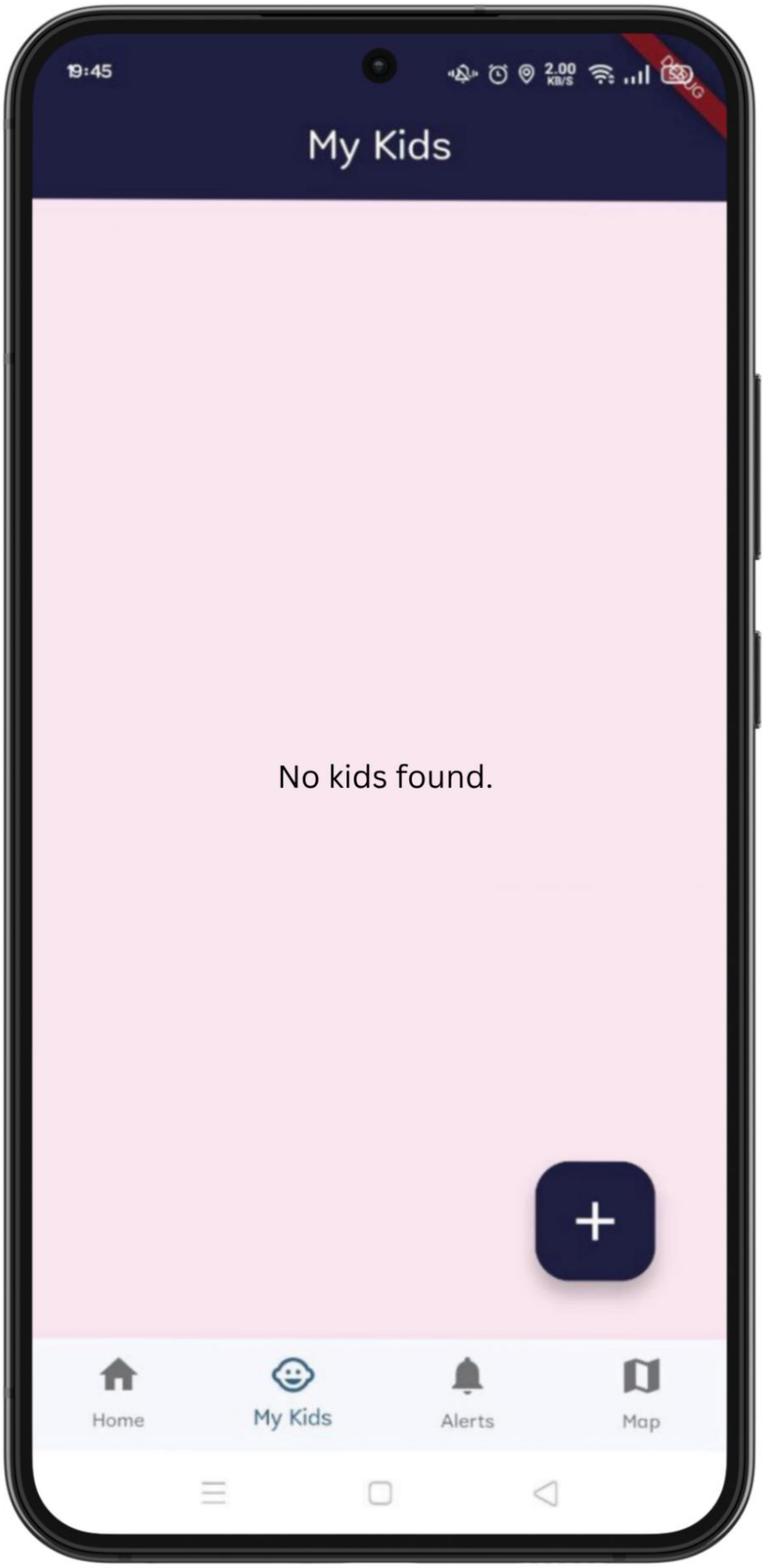


Figure 12: My Kids Screen

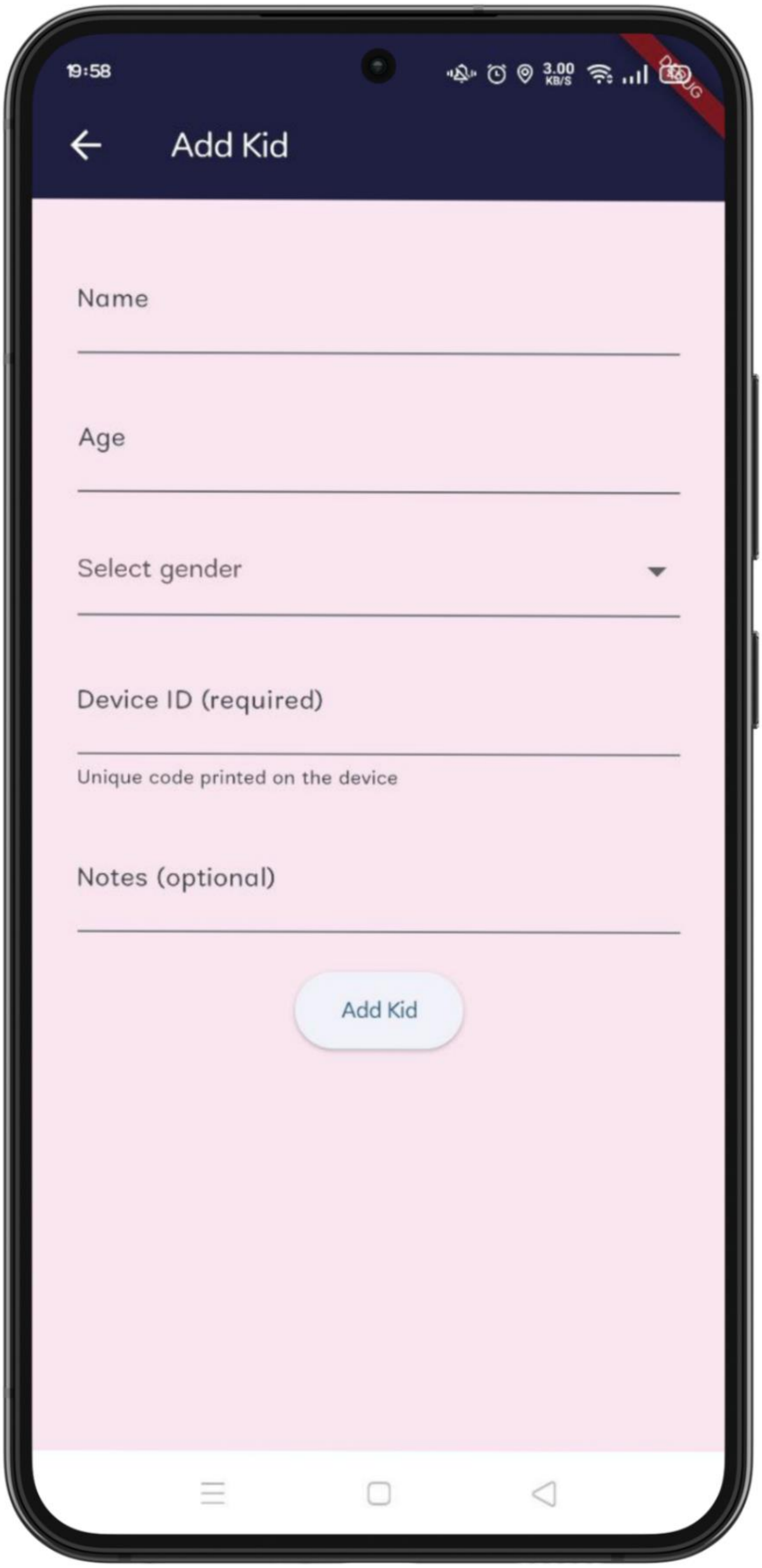


Figure 13: Add Kid Screen

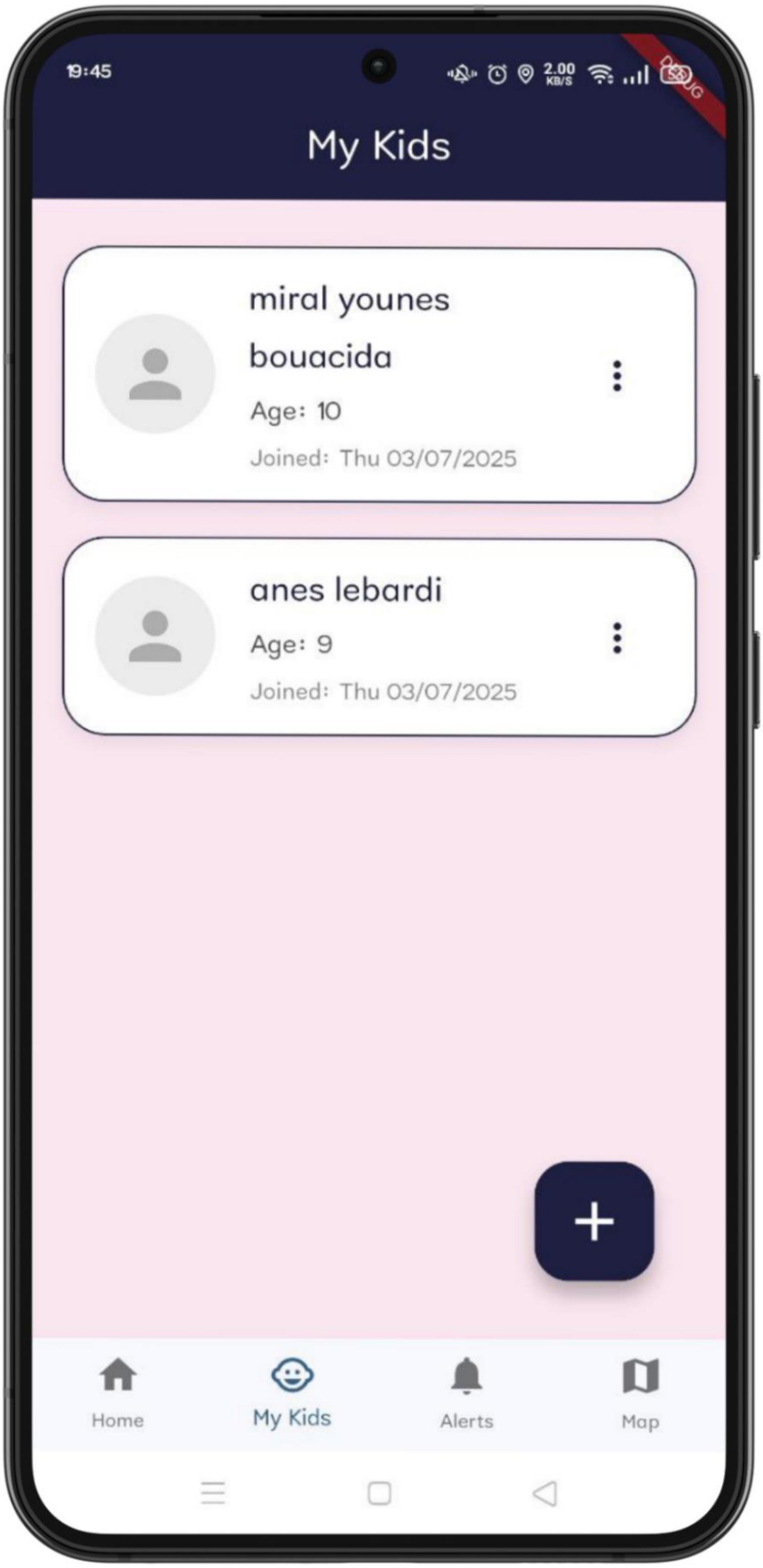


Figure 14: My Kids Screen (with list of kids)

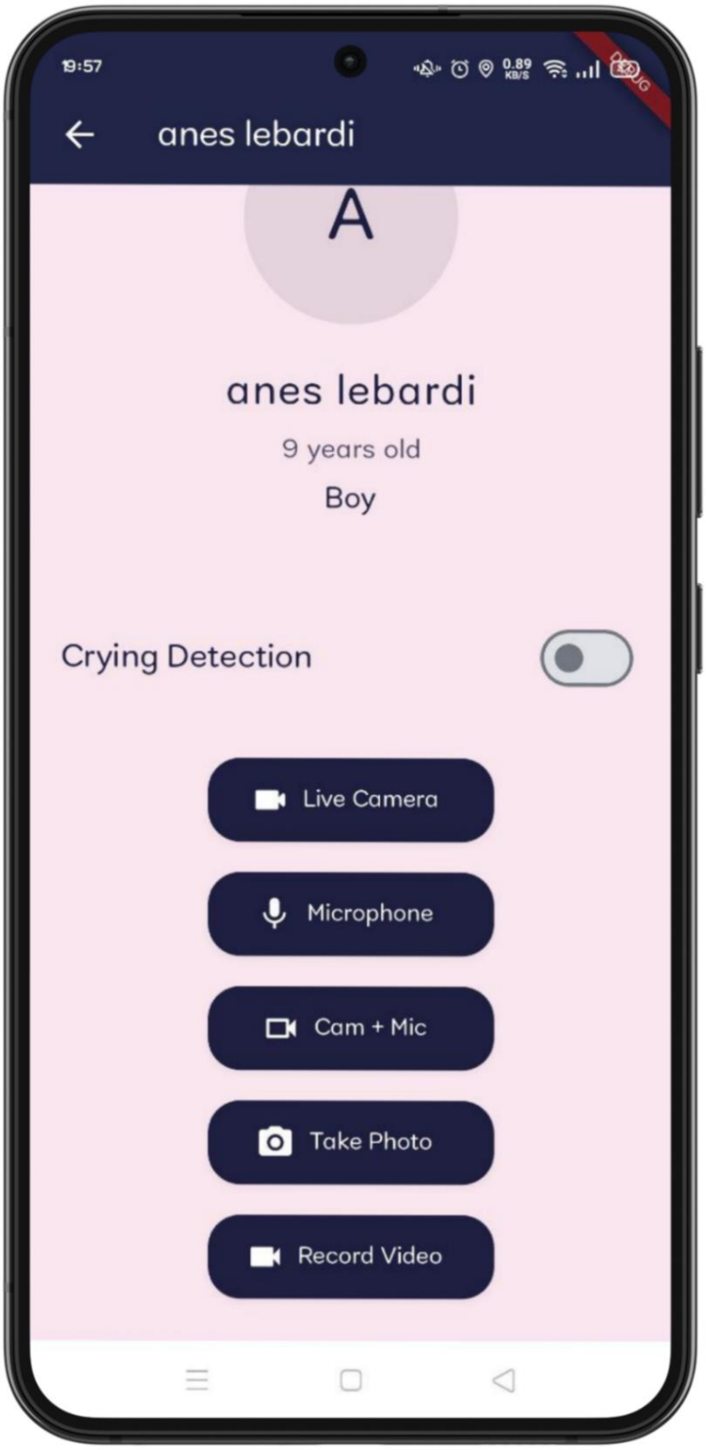


Figure 15: Kid Profile Screen

At first **(Figure 17)**, the parent has no kids on the *My Kids* page. They tap the **"+"** button to add a kid **(Figure 18)** by writing the name, age, gender, and device ID. After that, they see a list of kids **(Figure 19)**. The parent can open each kid's profile **(Figure 20)** to see details and turn on the camera or microphone. They can also edit or delete a kid anytime.

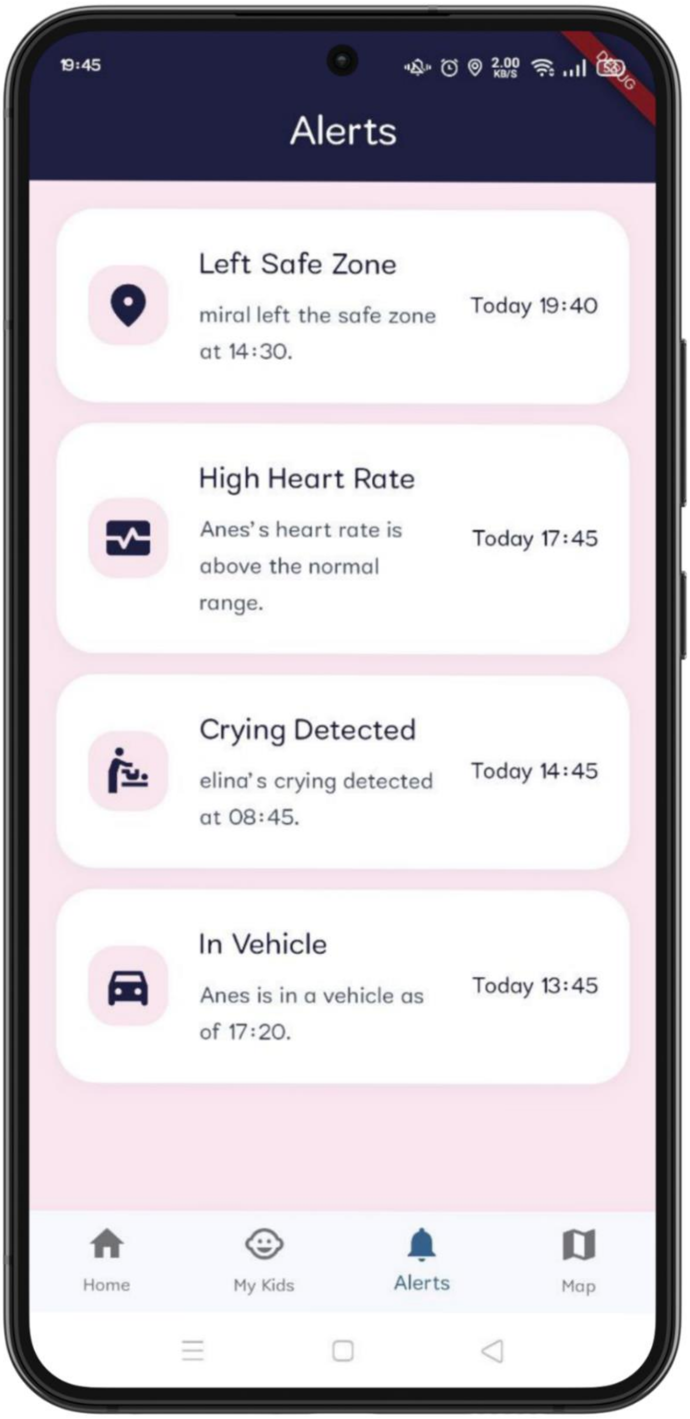


Figure 16: Alerts Screen

This screen shows all alerts. It tells parents if a child leaves a safe zone, has a high heart rate, is crying, or is in a vehicle, with the date and time.

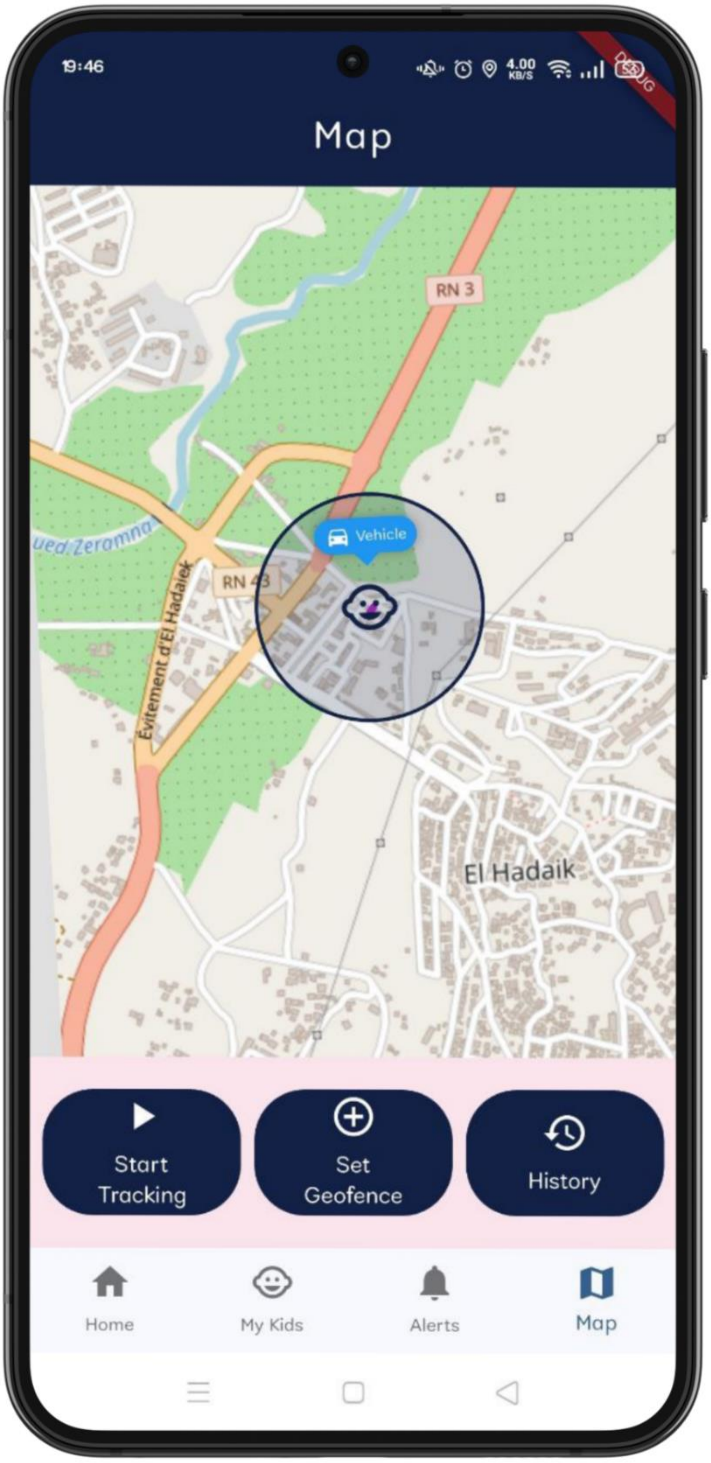


Figure 17: Map Screen

This screen shows the live location of the child on a map. Parents can see if the child is walking or in a vehicle. They can also start tracking, set a geofence or check the location history.

This hybrid approach allowed the team to **gain real-world experience**, combining scalable cloud infrastructure (Firebase) with full backend flexibility and logic (Django). It's an ideal setup for startups looking to merge reliability, control and fast prototyping.

3. Website Screenshots

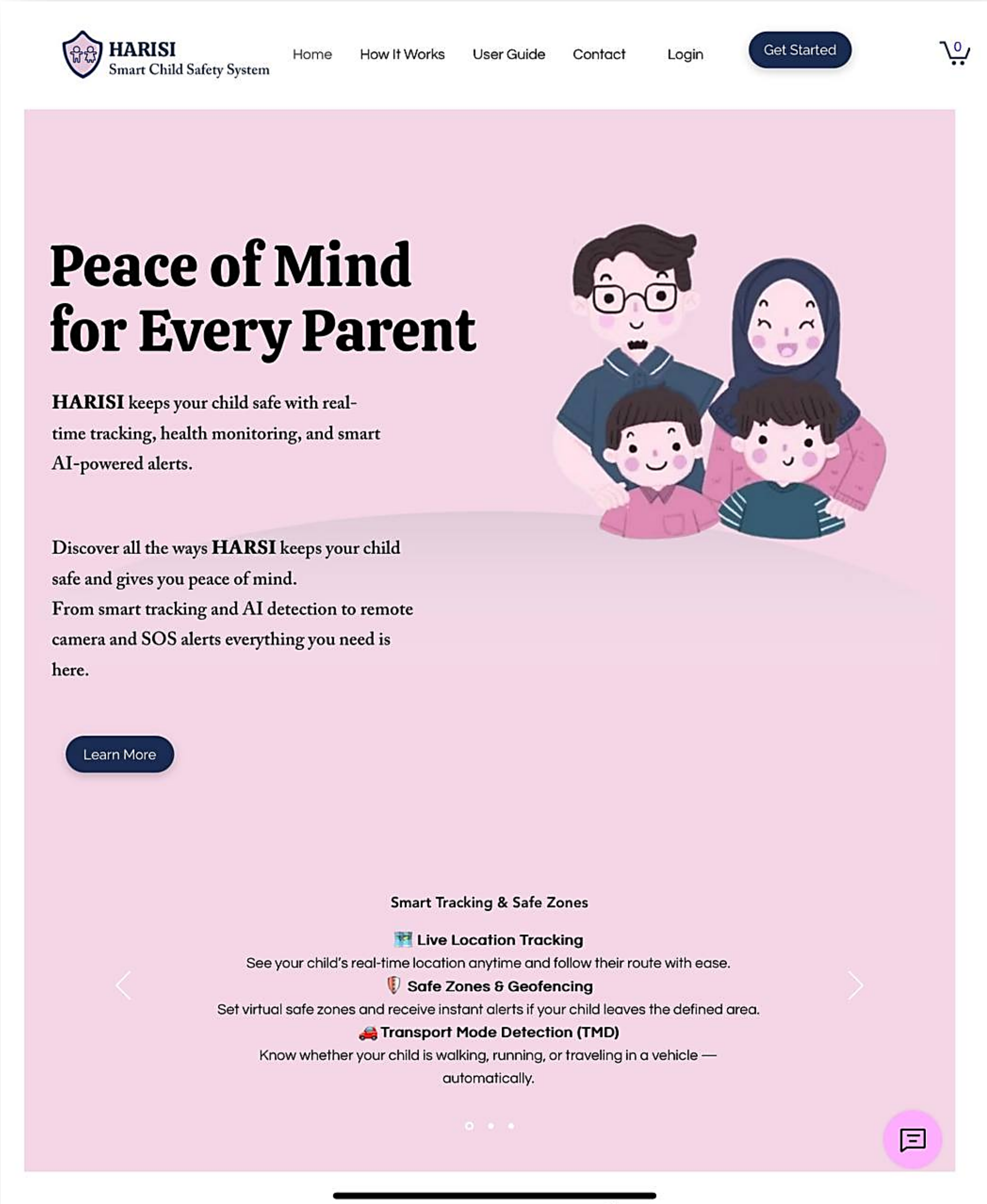


Figure 18: HARISI Home

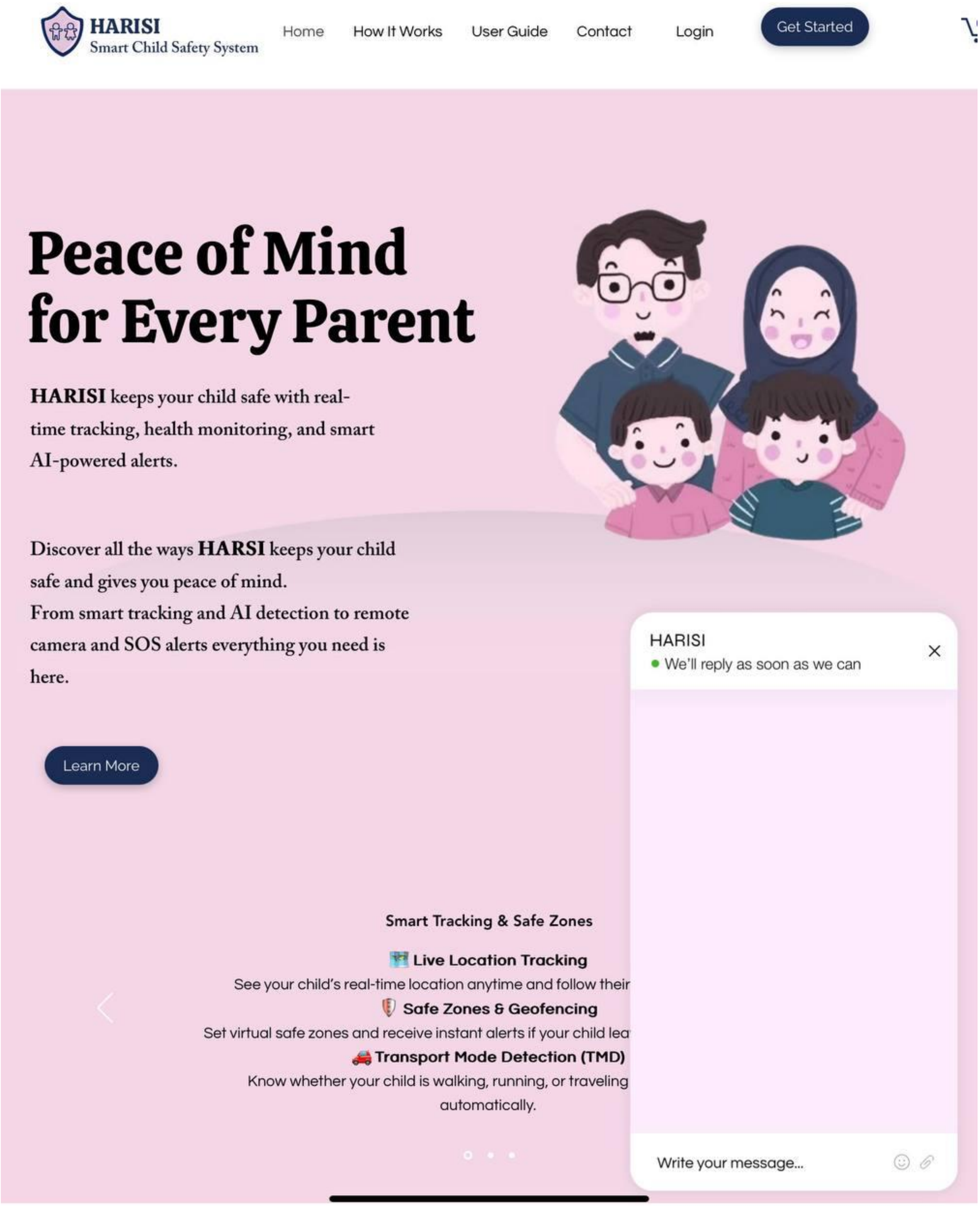


Figure 19: Home Page with Live Chat

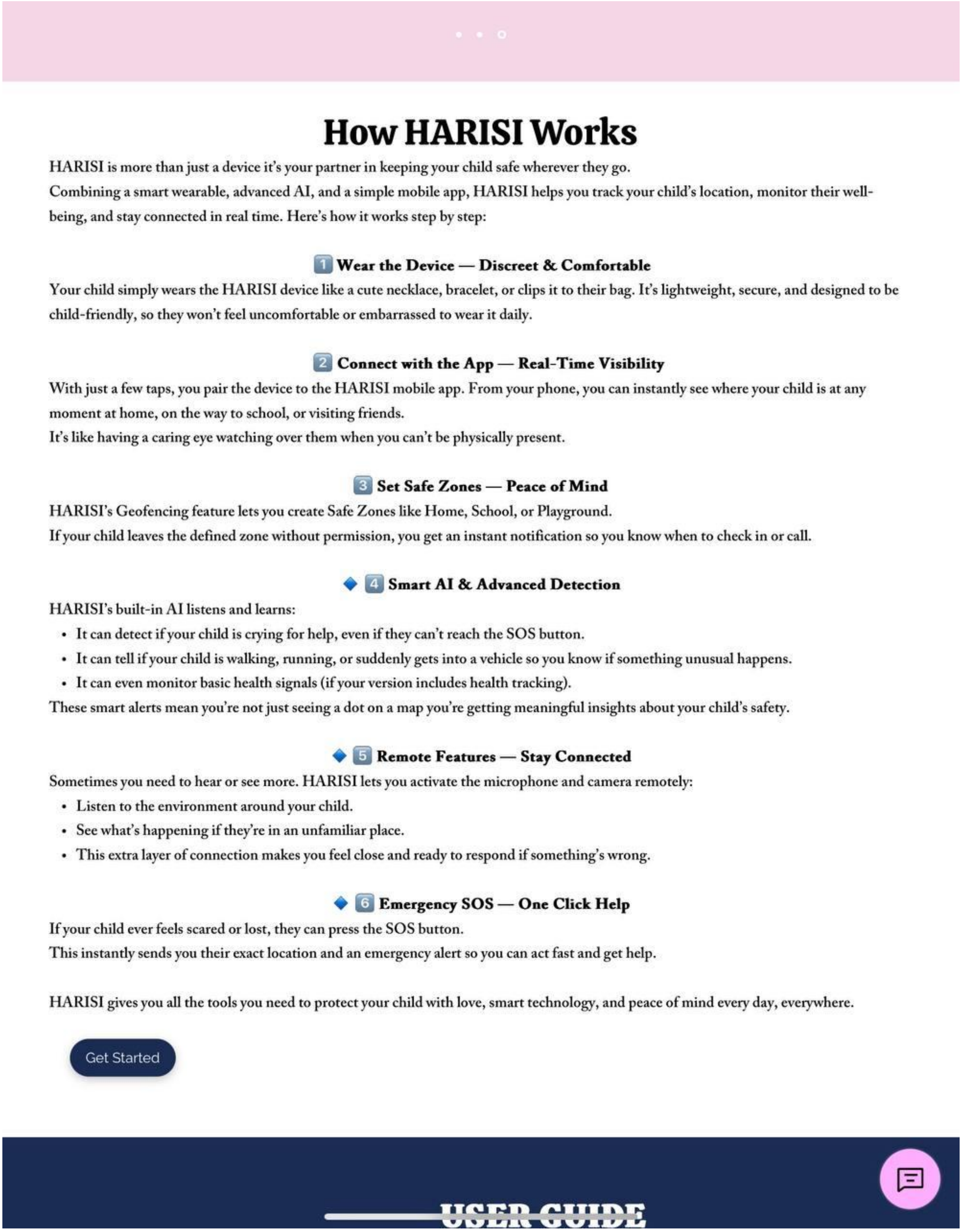
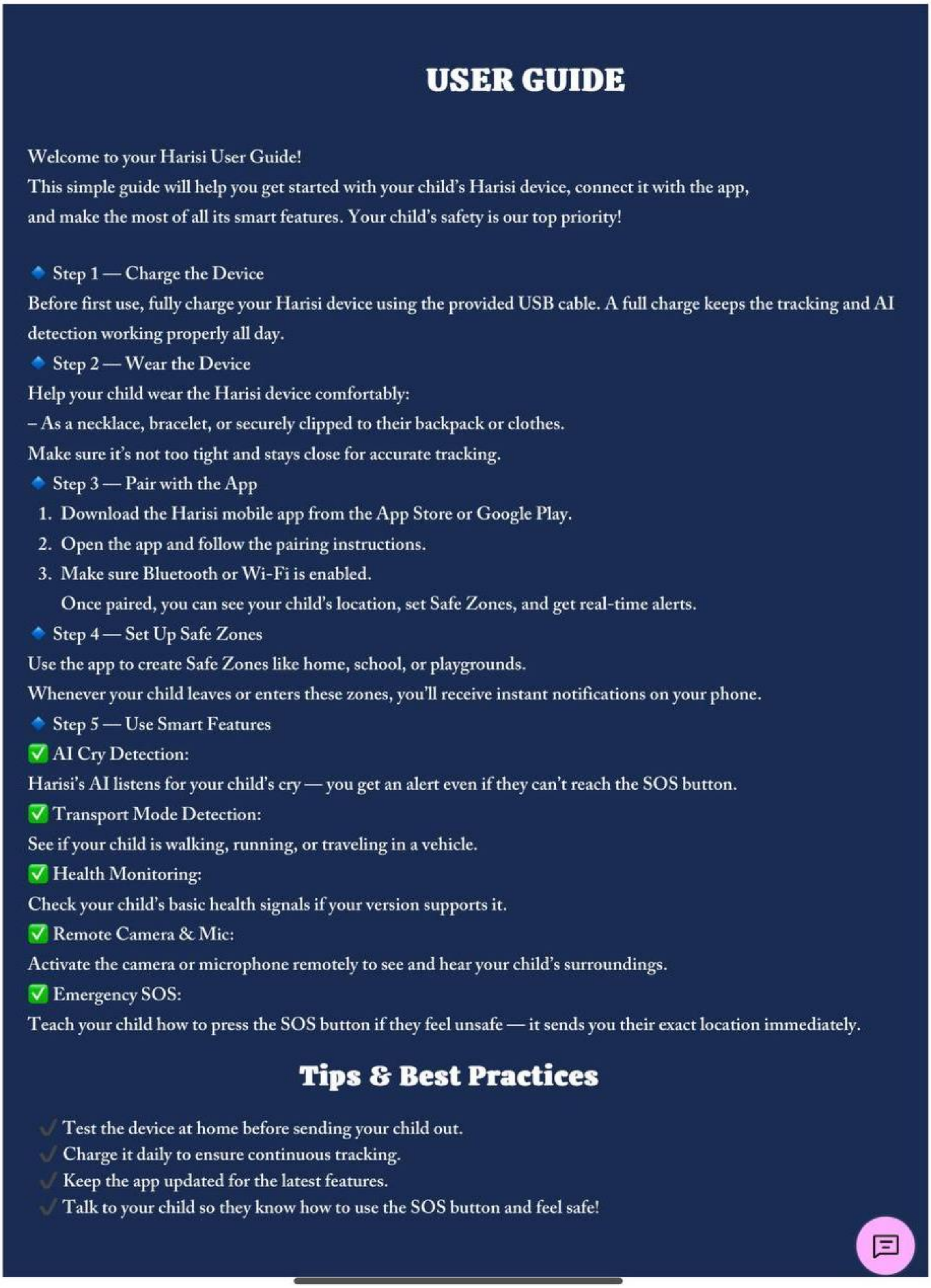


Figure 20: How It Works Page



USER GUIDE

Welcome to your Harisi User Guide!
This simple guide will help you get started with your child's Harisi device, connect it with the app, and make the most of all its smart features. Your child's safety is our top priority!

🔹 Step 1 — Charge the Device
Before first use, fully charge your Harisi device using the provided USB cable. A full charge keeps the tracking and AI detection working properly all day.

🔹 Step 2 — Wear the Device
Help your child wear the Harisi device comfortably:
– As a necklace, bracelet, or securely clipped to their backpack or clothes.
Make sure it's not too tight and stays close for accurate tracking.

🔹 Step 3 — Pair with the App

1. Download the Harisi mobile app from the App Store or Google Play.
2. Open the app and follow the pairing instructions.
3. Make sure Bluetooth or Wi-Fi is enabled.
   Once paired, you can see your child's location, set Safe Zones, and get real-time alerts.

🔹 Step 4 — Set Up Safe Zones
Use the app to create Safe Zones like home, school, or playgrounds.
Whenever your child leaves or enters these zones, you'll receive instant notifications on your phone.

🔹 Step 5 — Use Smart Features
✅ AI Cry Detection:
Harisi's AI listens for your child's cry — you get an alert even if they can't reach the SOS button.
✅ Transport Mode Detection:
See if your child is walking, running, or traveling in a vehicle.
✅ Health Monitoring:
Check your child's basic health signals if your version supports it.
✅ Remote Camera & Mic:
Activate the camera or microphone remotely to see and hear your child's surroundings.
✅ Emergency SOS:
Teach your child how to press the SOS button if they feel unsafe — it sends you their exact location immediately.

Tips & Best Practices

✔ Test the device at home before sending your child out.
✔ Charge it daily to ensure continuous tracking.
✔ Keep the app updated for the latest features.
✔ Talk to your child so they know how to use the SOS button and feel safe!

Figure 21: User Guide & Best Practices

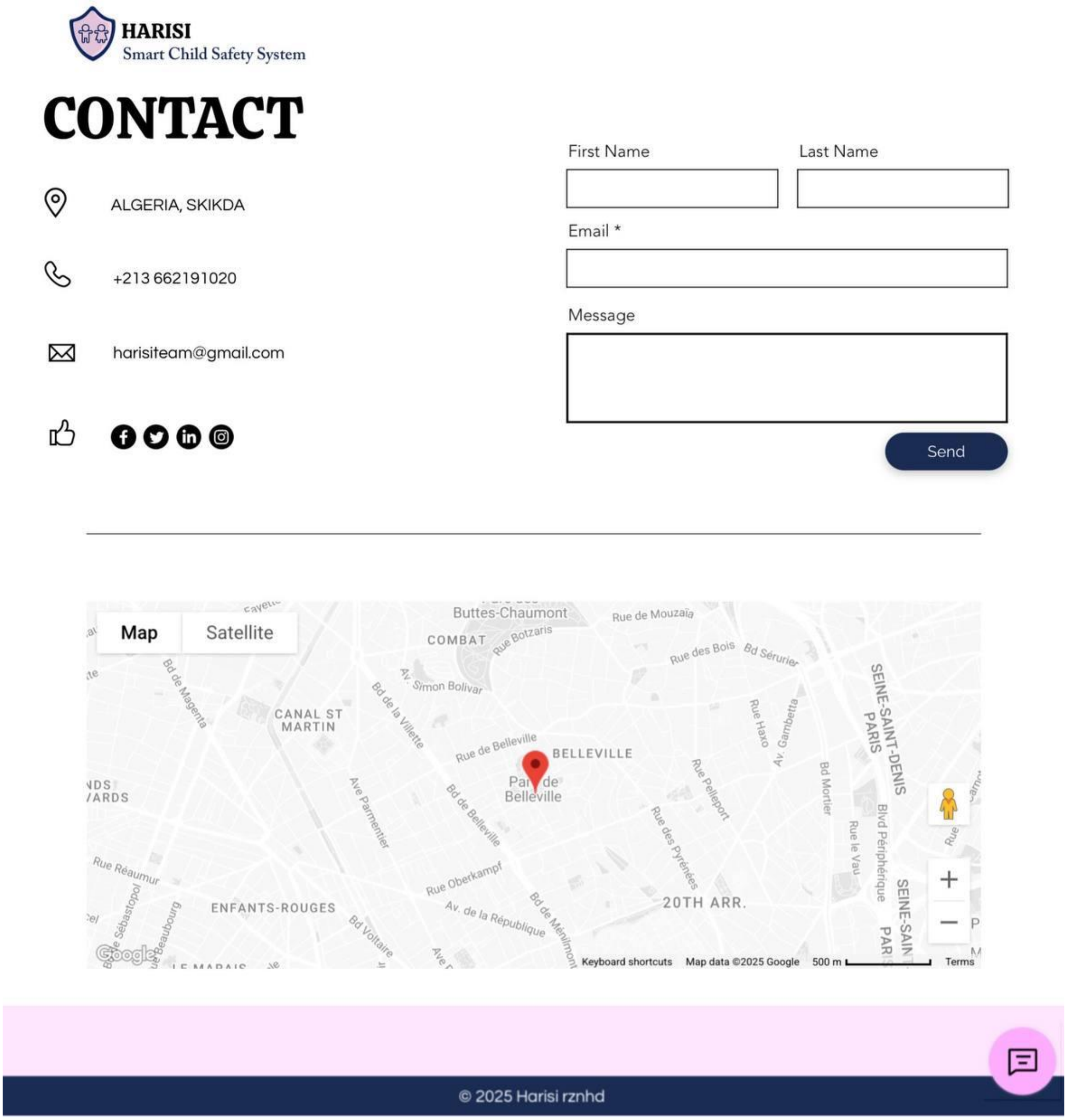


Figure 22: Contact & Location

- We made this website to share everything about the **HARISI** system in a nice and easy way. We added a cart so in the future parents can buy the device directly from here. We also put a chat box so we can talk with parents and help them anytime.

4. System Capabilities and Impact

- **Live Monitoring:** Instant access to child location and surroundings.
- **Health Awareness:** Real-time heart rate and oxygen monitoring.
- **Emergency Response:** SOS button triggers instant notifications and records the situation.
- **Automatic Cry Detection:** AI-powered sound recognition trained per child.
- **Transport Mode Detection:** Differentiates walking from riding in vehicles for context-based alerts.
- **Privacy Controls:** Smart deactivation of camera/microphone in sensitive areas like schools.

Together, the prototype and mobile application make **HARISI** a powerful, intelligent, and compassionate safety companion for families.

5. Business Model Canvas

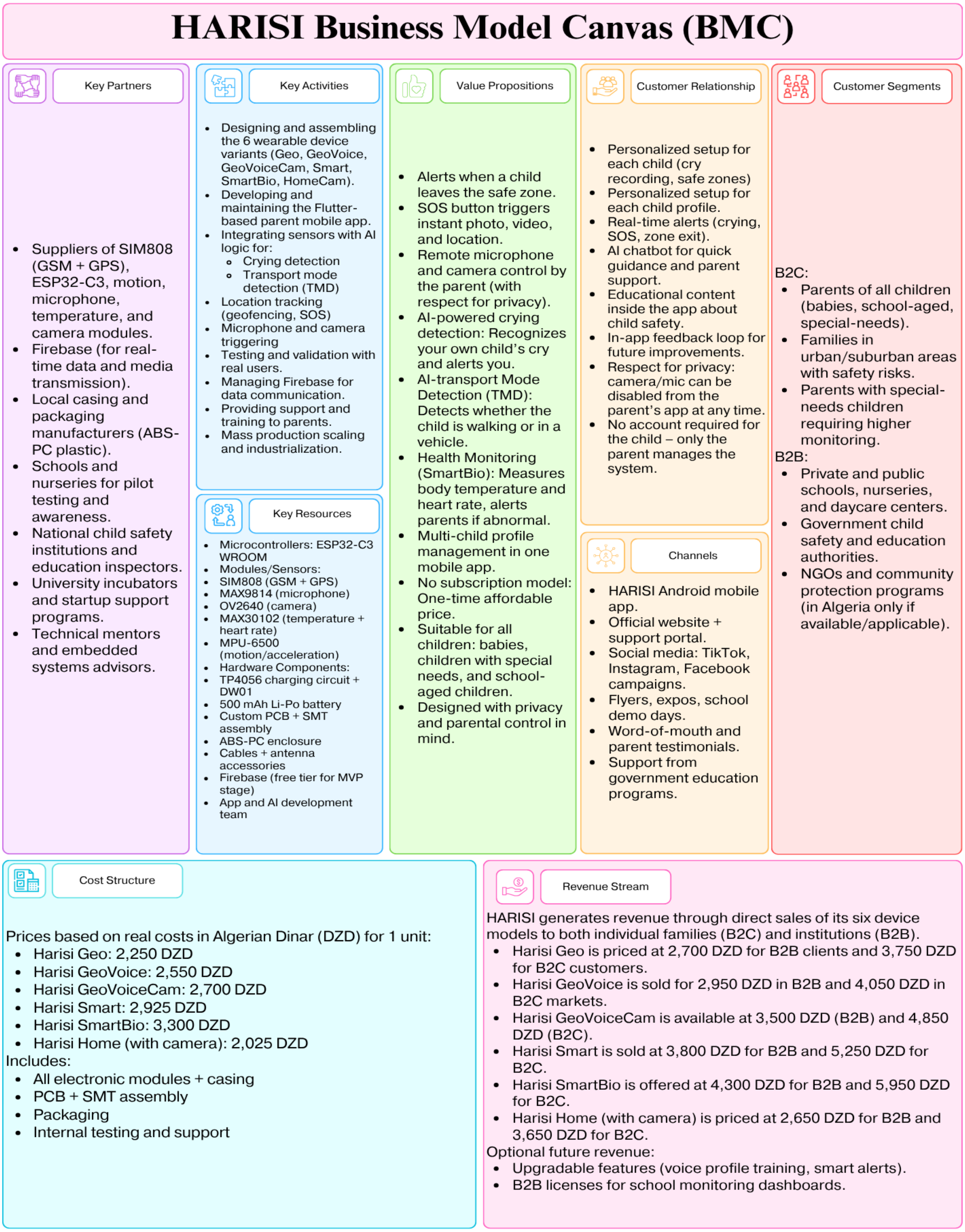


Figure 23: Business Model Canvas (BMC)

General Conclusion

The **HARISI** project provides a practical and innovative solution designed to ensure children's safety when they are away from their parents whether at home or in public places by incorporating a range of technologies including the use of artificial intelligence to detect children's crying and analyze transportation methods (TMD), combined with accurate GPS tracking, geolocation, remote camera and microphone access and even health monitoring.

A key part of our mission is to give families peace of mind as if they are always with their child. **HARISI** makes it possible for parents to find their child's location, be alerted to signs of distress, and see what is happening around their child whenever and wherever needed.

Families can choose from different versions of **HARISI** each offering a specific combination of features to suit various needs and budgets whether they require just location tracking, or advanced options like sound detection, camera, health monitoring, or all combined.

Protecting privacy is essential: camera and microphone features are designed to be controlled only by parents and automatically switch off in sensitive places like schools and all the data collected is secured and used strictly to support child safety.

Looking forward the adaptable nature of **HARISI** means it can serve various purposes beyond child safety It has great potential to support elderly individuals especially those with conditions like Alzheimer's or individuals who are prone to becoming disoriented or require continuous monitoring.

Ultimately, with more support, more work, and better technology we believe **HARISI** can make a real difference and we hope this project not only succeeds now but also evolves in the future to help save lives, protect children around the world and vulnerable groups.