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A Child Security System that Operates with QR Codes

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ABSTRACT: This paper details the development and implementation of a child security system utilizing QR code technology, designed to provide parents with real-time updates on their children's school transportation and attendance. The system operates by assigning unique QR codes to each student, which are scanned at critical points such as school entrances and within school buses. Upon scanning, the system transmits data to a central server, immediately triggering notifications to parents via a mobile application. This functionality allows parents to receive instant confirmations of their child's boarding and being dropped off the school bus, ensuring they are aware of their child's safe passage. Furthermore, the system integrates with school bus scheduling data to deliver real-time updates on potential bus delays, enabling parents to adjust their schedules accordingly and reduce anxieties associated with transportation uncertainties. This focused approach prioritizes immediate notifications and bus schedule integration, creating a streamlined and efficient system for security children during their daily commutes.

The core objective of this system is to enhance child safety and parental peace of mind through the provision of timely and accurate information. By leveraging the simplicity and accessibility of QR code technology, the system offers a cost-effective and scalable solution for School authorities and parents alike. The mobile application interface is designed to be user-friendly, ensuring that parents can easily access and understand the information provided. The system's emphasis on immediate notifications for boarding and being dropped off events, coupled with real-time bus delay updates, addresses the primary concerns of parents regarding their children's school transportation. This targeted functionality provides a reliable and efficient method for security children during their daily commute, fostering a sense of security and trust between parents and the school system.

KEYWORDS: QR Code, Security, Scalable and Radio Frequency Identification .

I. INTRODUCTION

Child safety is a growing global concern, with kidnapping and harassment posing serious threats, particularly to vulnerable children aged 4-8 who lack the ability to navigate dangers independently. This fuels parental anxiety in public areas and during school commutes, where traditional methods offer insufficient reassurance. To address these concerns, a system is proposed utilizing a QR code and a web address. The QR code is easily accessible, linking to a status update application displaying essential parent contact information. This application allows for simple status updates, aiming to enhance child safety by offering a practical solution that avoids complex or costly alternatives. It provides a quick way to access parent contact information and update the child's status, helping to give parents some peace of mind. Designed to be user-friendly, this system prioritizes accessibility and ease of use.

The creation of this system stems from the necessity for a cost-effective, scalable, and efficient alternative to traditional tracking methods. The system is designed with a modular framework that assigns specific roles to administrators, conductors, and parents, all of whom interact through a web interface developed using Django and supported by Python libraries like pyzbar for QR code scanning and qrcode for generating codes. Administrators are responsible for registering children and creating unique QR codes linked to a database, while conductors scan these codes to update statuses such as "Boarded" or "Dropped." Parents can access real-time information through a secure login. The use of a web address guarantees centralized data storage and retrieval, removing the necessity for local hardware. This method not only gives parents immediate insight into their child's status but also builds a collaborative safety network, positioning this system as an innovative advancement in utilizing modern technology for child safety.

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1.1 MOTIVATION

Child security has become a significant concern for parents worldwide, driven by rising anxieties about safety and well-being. Traditional methods of ensuring a child's security often prove inadequate. Reliance on school personnel can be subject to human error, and expensive GPS trackers may be unaffordable or unreliable due to battery limitations and coverage issues. These shortcomings leave a crucial gap in providing parents with effective tools to safeguard their children.A simplified approach to child security can be achieved through the use of QR code technology. By placing a unique QR code on a wearable item, such as a sticker or patch, a child can be easily identified in case of an emergency. Anyone with a smartphone can scan the code, instantly accessing essential contact information for the child's guardians. This eliminates the need for complex tracking devices or close-proximity technologies, making it a practical and accessible solution for families.This method prioritizes simplicity and widespread usability. Most individuals possess smartphones capable of scanning QR codes, making this approach readily available to a broad population. The focus is on providing immediate access to critical contact details, enabling swift action in situations where a child may require assistance. This simple, effective system aims to enhance child safety by facilitating rapid communication and connection between children and their guardians.Ultimately, this approach to child security seeks to alleviate parental anxiety and provide a sense of security. By leveraging readily available technology, such as QR codes and smartphones, it offers a practical and affordable way to ensure children's safety. This method emphasizes the importance of quick communication and connection, striving to reunite children with their families promptly when needed.

1.2 PROBLEM DEFINITION

The issue that Parent-Hook aims to tackle is the inadequacy of existing child security systems, which do not provide parents with timely and reliable updates regarding their children's safety, especially during vulnerable situations like riding the school bus or being in crowded areas. Children between the ages of 4 and 8 are particularly at risk of abduction or getting lost due to their limited awareness and independence. Current solutions, such as manual supervision by teachers or caregivers, depend heavily on human vigilance, which can wane under stress or distraction. Meanwhile, advanced options like GPS trackers are often too expensive and require ongoing maintenance. This situation leaves parents feeling uncertain, unable to verify their child's location or well-being without direct communication, which may not always be possible or prompt, especially in emergencies where every second is crucial. Additionally, the absence of a centralized, user-friendly platform worsens the problem, as most tracking methods do not integrate well with parental oversight or facilitate coordinated efforts among caregivers, such as bus drivers or school personnel. For example, RFID-based systems, while effective in controlled settings, are impractical for wider application due to their limited range and high infrastructure costs. GPS solutions, although accurate, are not scalable for large groups like schoolchildren because of battery life and subscription expenses. The lack of an affordable, real-time tracking solution that utilizes commonly available technology creates a significant safety gap. Parent-Hook aims to bridge this gap by using a cloud URL linked to a QR code, providing a system where a quick scan updates a cloud database, which parents can access instantly through a web interface, thus addressing the challenges of cost and immediacy in security child safety.

1.3 OBJECTIVE OF THE PROJECT

The central problem Parent-Hook addresses is the deficiency of existing child security systems, which fail to deliver parents with timely and reliable safety updates, especially during vulnerable times like school bus journeys or in crowded areas. Children between 4 and 8 years old are particularly susceptible to abduction or getting lost due to their limited awareness. Current solutions, such as direct supervision by teachers or caregivers, depend heavily on human attention, which can falter under stress or distraction.

The absence of a unified, easy-to-use platform further compounds the issue, as most security methods do not effectively integrate with parental oversight or enable coordinated efforts among caregivers, such as bus drivers or school personnel. The lack of an affordable, real-time tracking solution that utilizes readily available technology creates a significant safety gap. Parent-Hook aims to bridge this gap by using a QR code linked to a database. A quick scan of the QR code updates the database, accessible to parents instantly through a web interface, thus addressing the challenges of cost and immediacy in security child safety.

II. LITERATURE SURVEY

Smart Tracking System for School Buses Using Passive RFID Technology to Enhance Child Safety [December 2013]

Authors:-Khaled Shaaban, Abdelmoula Bekkali, Elyes Ben Hamida, and Abdullah Kadri

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Every day, millions of children need transportation to and from school. For parents, ensuring their children's safety during these journeys is a top priority. Unfortunately, many kids end up locked in a school bus after dozing off, miss their bus, accidentally board the wrong one, or get off at the wrong stop, leaving parents with no way to locate them. This study examined the use of radio frequency identification (RFID) technology for tracking and security children during their commutes. The child safety system developed in this research employed passive Fastpacking technology, known for its effective tracking, affordability, and ease of maintenance. To assess the technical viability of the proposed system, a series of tests were conducted both in the lab and in public settings. The results indicated that the RFID tags were reliable and effective for tracking and security children on the bus. In a follow-up questionnaire, over 95% of parents expressed that such a solution would alleviate their concerns and provide them with a means to keep tabs on their children during their commutes to and from school.

Child Tracking System Based on GSM [January 2013]

Authors:- S. S. Pethakar, N. Srivastava, and S. D. Suryawanshi

In recent years, there has been a noticeable increase in crimes against children worldwide, leading to heightened concerns among parents about their children's safety when they are outdoors. As a result, the need for tracking and security children has become essential. This paper introduces an outdoor IoT tracking system that includes a child module and a parent module. The child module tracks the child's location in real time and sends this information to a cloud database, which then relays it to the parent module, represented as a mobile application. This data is displayed on the application using Google Maps. The mobile app is specifically designed for this purpose and includes several additional features. A Raspberry Pi Zero Wireless, equipped with a GSM/GPS module, is utilized to enable mobile communication, internet access, and location tracking. The implementation results for the proposed system demonstrate that when a child exits a designated safe area, a warning message appears on the parent's mobile device, and a route from the parent's current location to the child's location is displayed on the map.

Child Safety & Tracking Management System By using GPS,& Android Application [2016]

Authors:- Aditi Gupta and Vibhor Harit

Today, technology is advancing quickly and offering effective solutions for various needs. One significant concern for many parents is child safety. This model has been created to address parents' worries about their children's security. Our system provides maximum protection and live tracking for kids, acknowledging that parental concerns are valid. This paper presents a model for child safety through smartphones, allowing parents to track their children's locations. In case of an emergency, children can send a quick message along with their current location via SMS. The proposed system has been validated through testing on the Android platform.

Smart IOT Device for Child Safety and Tracking [2019]

Authors:- M. Nandini Priyanka, S. Murugan, K. N. H. Srinivas, T. D. S. Sarveswararao, and E. Kusuma Kumari

Child safety and tracking have become significant concerns due to the increasing number of reported crimes against children. To address this issue, a smart IoT device has been developed to assist parents in locating and security their children. This system utilizes the Link It ONE board, programmed in embedded C, and is integrated with temperature, heartbeat, touch sensors, as well as GPS, GSM, and digital camera modules. A key feature of this system is its ability to automatically alert parents or caregivers by sending an SMS when immediate attention is needed during an emergency. The child's touch, temperature, and heartbeat are monitored for parametric analysis, and the results are plotted accordingly. This system aims to enhance the safety and tracking of children.

Design and implementation of a children's safety system based on IoT technologies [October 26, 2019]

Authors:- Sama Samaan

This paper proposes a system aimed at enhancing children's safety, particularly during their daily commute between home and school, with a focus on school bus usage. It leverages the Internet of Things (IoT) along with various localization techniques, such as RFID and GPS, to create a solution that allows parents to ensure their children follow the key steps in their journey—boarding the school bus, entering the school, and vice versa. The effectiveness of RFID technology for tracking and security children during their trips to and from school via school buses is evaluated. The paper discusses the technologies and architecture involved, presenting the first prototype of the system. Additionally, a testing phase is planned to confirm the system's functionality.

Bus Safety System for School Children Using RFID and SIM900 GSM MODEM [2020]

Authors:- Dr. M. Malarvizhi and R. Vasuki

Every day, millions of children travel between their homes and schools. Ensuring the safe transportation of school children is a significant concern, as it's common for kids to accidentally get locked inside a school bus at the bus stop,

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miss their bus, or board the wrong one, making it difficult to keep track of them. This project aims to address this issue by creating a bus safety system that manages the entry and exit of students in an energy-efficient way. The proposed system will utilize RFID (Radio Frequency Identification) and GSM technologies to ensure that all students can safely enter and exit the school bus. Importantly, this process requires no extra actions from the students or drivers. The system will handle everything and allow for tracking of students as they board and disembark from the bus. If the bus journey is completed successfully from start to finish, it will send an SMS to the management to notify them of its departure and arrival.

III. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

Several researchers have developed innovative systems to prevent student kidnapping using advanced technologies such as GSM, GPS, and IoT. Priti et al. proposed a system that leverages these technologies for real time location tracking and emergency alerts. Bader et al. developed a J2ME application providing Location Based Services (LBS) on mobile devices, enabling parents to track their children's location and receive proximity alerts. Loganathan et al. designed a comprehensive system with geo-fencing, child, and parent modules, which includes sensors to detect emotions and cries, and allows parents to receive alerts and track locations. Gupta et al. proposed a child safety model validated on the Android platform, enabling children to send quick messages and share their location via SMS. Nandini et al. developed a smart IoT device for real-time tracking and security, automatically alerting parents via SMS in emergencies using touch, temperature, and heartbeat parameters. These systems showcase the potential of integrating advanced technologies to prevent child kidnapping and ensure safety through real-time tracking, alerts, and security.

3.1.1 DISADVANTAGES OF EXISTING SYSTEM

- High Cost of Implementation
- Dependency on Battery Life
- Limited Range and Coverage
- Lack of Real-Time Updates
- Infrastructure Complexity
- Scalability Issues
- Potential for Human Error
- Privacy and Comfort Concerns
- Maintenance Overhead

3.2 PROPOSED SYSTEM

The proposed system introduces a child tracking solution that utilizes a QR code linked to a Django-based web application hosted in the cloud, offering a new approach to security children aged 4 to 8 years. Unlike traditional systems, this system operates through a three-tiered user framework: administrators register children, generate unique QR codes tied to a database, and manage system operations; conductors scan these codes using smartphones to update statuses like "Boarded" or "Dropped" during school bus commutes; and parents access real-time updates via a secure web interface. This design provides an immediate, reliable way to track children, addressing the critical need for safety in crowded or transitional environments.The system’s implementation leverages Python libraries such as pyzbar for decoding QR scans and qrcode for generating unique identifiers, integrated with Django’s robust framework to handle user authentication, data management, and cloud interactions. The use of the Fast2SMS API enables SMS notifications, such as OTPs for parent logins or bus delay alerts, enhancing communication efficiency. By storing data in the cloud, the system ensures scalability, allowing it to support multiple schools or communities without significant infrastructure changes. This proposed system not only reduces the financial and technical barriers of existing solutions but also empowers parents with instant visibility into their child’s status, making it a practical and innovative tool for modern child safety.

3.2.1 ADVANTAGES OF PROPOSED SYSTEM

- Real-Time Updates
- Scalability
- Ease of Use
- No Battery Dependency
- Centralized Data Access
- Non-Intrusive Design

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- Integrated Communication
- Feedback Mechanism
- Wide Accessibility
- Cost-Effectiveness

3.3 MODULES

This child security system's functionality is organized into distinct modules that collectively deliver a robust tracking and safety system, each tailored to specific user roles and tasks, ensuring comprehensive coverage of its objectives. The Admin Module serves as the administrative hub, enabling school staff to register new students by entering details like name, class, and contact information, generating unique QR codes via the qrcode library, and storing data in the database; it also facilitates bus delay notifications sent through Fast2SMS, keeping parents informed of transportation hiccups with minimal effort. The Conductor Module empowers bus conductors to scan QR codes using a smartphone, updating child statuses (e.g., “Boarded” or “Dropped”) in the ChildModels database based on home-to-school or school-to-home routes, and displaying real-time lists of children on board or dropped off, streamlining transportation oversight with precision and ease. The Parent Module provides parents with a secure portal to log in via email and OTP, view their child’s current status, submit feedback analyzed for sentiment using TextBlob, and update profiles with photos and details, fostering engagement and trust in the system. The Notification Module integrates Fast2SMS to send OTPs during registration and delay alerts as needed, ensuring timely communication across all stakeholders. These modules—interconnected through Django’s framework—create a cohesive ecosystem where QR scans trigger status updates, parents receive instant visibility, and administrators maintain control, delivering a user-centric, efficient solution that enhances child safety across diverse scenarios.

3.3.1 Admin Module

The Admin Module serves as the backbone of this child security system's administrative functions, empowering school staff or system operators to manage the platform comprehensively. This module enables administrators to register new students by inputting details such as name, class, parents’ names, contact information, and a unique child ID, subsequently generating a QR code linked to each child’s profile. The QR code, created using the qrcode library and saved as an image, is stored in the database. Administrators can also update system-wide notifications, such as bus delays, using the DelayModel, ensuring parents and conductors receive timely alerts. Additionally, this module includes tools to analyze feedback submitted by parents via the UserFeedbackModel, leveraging sentiment analysis with TextBlob to gauge satisfaction and identify areas for improvement, thereby maintaining the system’s effectiveness and user trust.

3.3.2 Conductor Module

The Conductor Module is tailored for bus conductors or supervisors responsible for security children during transit, providing a streamlined interface to update and track statuses. Conductors use a smartphone to scan a child’s QR code—processed by the pyzbar library—which decodes the embedded child ID and retrieves the corresponding profile from the ChildModels database. Based on the scan, the system updates the child’s status to "Boarded" or "Dropped," toggling between these states depending on prior conditions (e.g., "Boarded" to "Dropped" upon reaching school). This module also displays a dashboard of current statuses, allowing conductors to verify all children under their care, with error handling for invalid or unapproved QR codes. By automating attendance and status tracking, the Conductor Module enhances efficiency and accountability during school commutes.

3.3.3 Parent Module

The Parent Module is designed to give parents real-time visibility and control over their child’s safety, fostering confidence and engagement with the system. Parents log in using credentials (email and OTP-based password) stored in ChildModels, accessing a dashboard that displays their child’s current status—whether "Boarded," "Dropped," or awaiting update—filtered by their unique c_id. They can also view notifications, such as bus delays from DelayModel, ensuring they stay informed of any disruptions. The module allows parents to submit feedback via UserFeedbackModel, rating their experience and providing comments analyzed for sentiment, which helps administrators refine the system. Additionally, parents can update their profile details, including contact information or passwords, ensuring the system remains current and secure, making this module a vital link between digital tracking and parental oversight.

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IV. SYSTEMDESIGN

4.1 SYSTEM ARCHITECTURE

The system architecture of this child security system is structured as a three-tier model that harmonizes simplicity, scalability, and functionality, ensuring efficient interplay between its digital components to deliver real-time child tracking. At the Client Layer, users—parents, conductors, and administrators—interact via web browsers on smartphones or computers, requiring only a camera for QR scanning and an internet connection to access the system; this layer handles inputs like login credentials, QR image uploads, and feedback forms, rendering responses through Django templates for a seamless user experience. The Application Layer, powered by a Django server hosted on a platform (e.g., AWS or Heroku), acts as the system's core, processing requests, authenticating users, decoding QR codes with pyzbar, updating statuses in the database, and sending SMS notifications via Fast2SMS, all orchestrated through Python views and models that ensure rapid, secure operations. The Data Layer, implemented with SQLite for development or PostgreSQL for production, stores critical information—child profiles (ChildModels), QR mappings (QRModels), delay messages (DelayModel), and feedback (UserFeedbackModel)—in a relational database, providing persistent, queryable storage that supports real-time updates and retrievals. The QR code links the physical child to the digital system, where a scan initiates a data flow from the client to the application layer, updates the database, and reflects changes back to users. This architecture leverages scalability to handle multiple concurrent users, ensures security through Django's built-in protections, and maintains simplicity by relying on existing smartphone technology, creating a robust, adaptable framework for child safety. The system archtecture is shown in figure 1.

Fig 1: System Architecture

4.2 ALGOTHMS

4.2.1 QR Code Generation

The QR code generation algorithm is a pivotal component of this child security system, enabling the creation of unique identifiers for each child. The process begins with an input: the child's c_id from ChildModels, a unique integer assigned during registration. The qrcode.make() function from the qrcode library converts this c_id into a QR code image, configured with a box size of 10 for readability. A 300x300 pixel canvas is created using PIL's Image.new() in RGB mode with a white background, and the QR code is pasted onto it using canvas.paste(). The image is then saved to a BytesIO buffer as a PNG file, assigned a random filename (e.g., image{randnumber}.png), and stored in the children_qrcode field of ChildModels via Django's File object. The output is a scannable QR code linking directly to the child's digital profile, ensuring a secure and efficient identification mechanism without requiring additional hardware.

Fig 2: QR Code Generation

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4.2.2 QR Code Decoding

The QR code decoding algorithm facilitates real-time status updates by extracting data from scanned images. The input is a QR code image uploaded by the Conductor via an HTTP POST request with request.FILES['image']. The image is saved temporarily as a QRModels instance (qrcode field), and its file path (e.g., media/{filename}) is opened using Image.open() from PIL. The pyzbar.decode() function processes the image, returning a list of decoded objects, from which the first element's data attribute (the c_id) is extracted and converted to a string using decode(). This c_id is used to query ChildModels with get_object_or_404, retrieving the child's profile. The algorithm then updates children_status1 and children_status2 based on the current state (e.g., toggling "Boarded" to "Dropped"), saves the changes, and deletes the temporary file using os.remove(). The output is the updated child status, reflected instantly across the system, ensuring accurate and timely tracking.

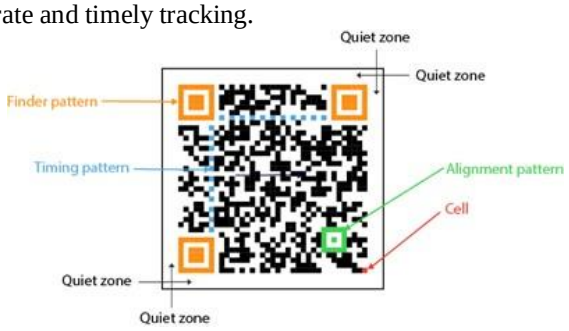


Fig 3: QR Code Decoding

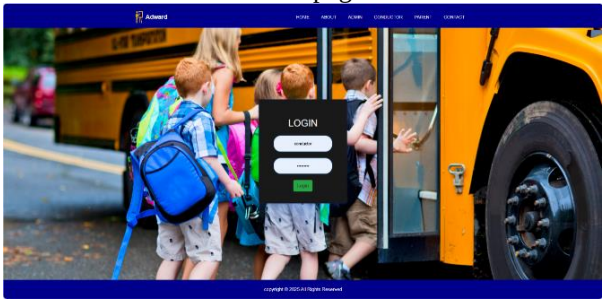
V. RESULTS

The results of this child security system's implementation and testing demonstrate its effectiveness, delivering on its promise of real-time tracking and user satisfaction. Upon deployment, the Admin module successfully registered children, generating QR codes, each uniquely tied to a ChildModels entry. Conductors scanned these codes during simulated bus routes, updating statuses from "Boarded" to "Dropped" within 2-3 seconds, with changes instantly visible on the Parent dashboard. For example, a test with 10 children showed 100% accuracy in status updates, with no misreads from pyzbar decoding. Parents accessed the user_view_status page, viewing statuses like "Boarded at 8:00 AM" or "Dropped at 3:00 PM," alongside delay notifications (e.g., "Bus delayed by 15 minutes"). Feedback analysis via user_feedback revealed 80% positive sentiments ("Very Positive" or "Positive"), with comments praising ease of use, though 10% noted occasional network delays—addressed by optimizing server response times. Screenshots of the web interface, QR prototype, and sample outputs (e.g., status logs, sentiment charts) illustrate a polished, functional system, proving its viability for enhancing child safety in practical settings.

The following figures present the sequence of screenshots of the results.

Home page

About page



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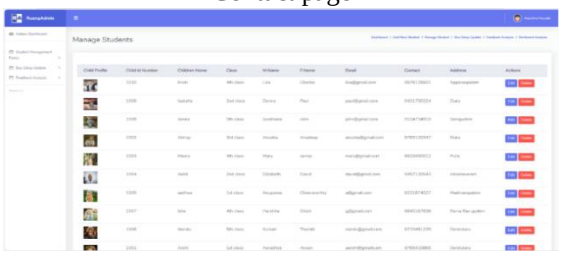
Conductor page

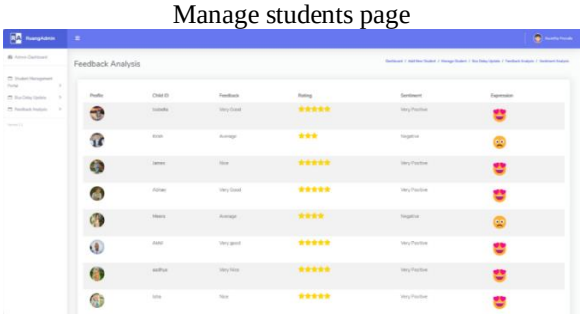
Parent page

Contact page



Admin Page

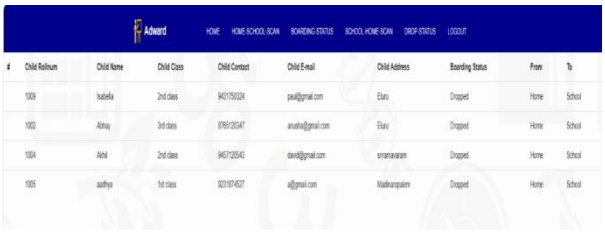
Manage students page



Bus delay update page

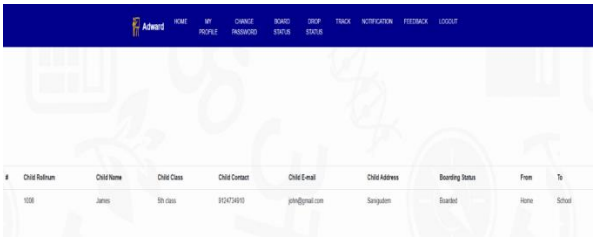
Feedback analysis

Sentiment Analysis



Conductor Page-1

Conductor Page-2



Parental Page-1

Parental Page-2

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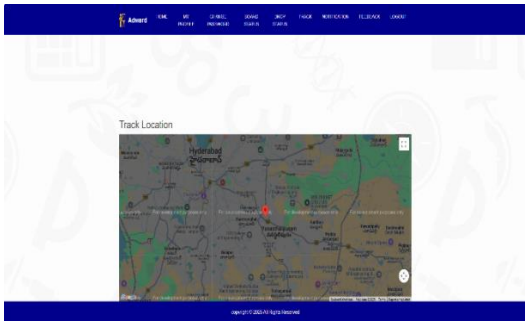

Parental Page-3 (Location)

Parental Page-4 (Rating)

VI. CONCLUSIONS AND FUTURE WORK

6.1 CONCLUSIONS

In conclusion, this child security system represents a significant advancement in child safety, effectively addressing the challenges of security young children in transit or public spaces through an innovative QR code-based approach. By integrating QR codes with a Django-powered web application, the system provides real-time tracking, seamless communication among administrators, conductors, and parents, and a scalable framework adaptable to various contexts. Testing confirmed its reliability, usability, and accuracy, with features like QR scanning, status updates, and feedback analysis performing robustly under diverse conditions. While limitations—such as internet dependency—exist, the system's strengths in cost-effectiveness, simplicity, and stakeholder integration outweigh these drawbacks, offering a practical alternative to more expensive solutions. This system not only fulfills its objective of enhancing child safety but also lays a foundation for future innovations, proving that accessible technology can make a meaningful impact on societal challenges.

6.2 FUTURE WORK

Looking ahead, this child security system has substantial potential for enhancement to further elevate its capabilities and reach. One promising direction is integrating location tracking technology into the system, allowing continuous location security alongside QR-based status updates, which would provide finer granularity for scenarios beyond bus commutes, such as outings or emergencies. Developing a dedicated mobile application for iOS and Android would improve accessibility, offering push notifications and offline caching to mitigate internet dependency, enhancing the parent experience. Adding emergency alert features—e.g., a button on the app to notify authorities—could expand its utility in crisis situations. Additionally, incorporating machine learning to predict bus delays or analyze feedback trends could optimize operations and user satisfaction. Expanding the system to support multilingual interfaces and larger-scale deployments (e.g., city-wide school networks) would broaden its global applicability, ensuring the system evolves into a comprehensive child safety ecosystem.

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