Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 4, No. 2, April : 2024

DESIGN AND IMPLEMENTATION OF A GEOFENCING-BASED TEENAGER MONITORING MOBILE APPLICATION

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Abstract
This research focuses on developing and implementing a mobile app to enhance teen safety using geofence technology. Geofencing creates virtual boundaries that trigger notifications when teens enter certain areas. The app aims to address concerns like location tracking and improve communication between teens and parents. It integrates theoretical analysis, system architecture design, user interface development, and practical implementation. The goal is to offer a practical solution for parents while respecting teen privacy, contributing to the discourse on technology in parenting, and fostering a safer digital environment.

1. Introduction

The introduction of a Geofence (Gf)-based teen monitoring app marks the start of a crucial exploration into a pioneering solution for the challenges of the digital age, especially for parents. In today's highly connected world, teens face complex digital environments, raising concerns for safety and responsible behavior. Geofencing technology offers promising solutions by creating virtual boundaries triggering alerts when teens enter or exit specified areas. This project aims to design, execute, and evaluate a cutting-edge mobile app leveraging Geofence technology to monitor teens effectively while respecting their privacy. This introduction sets the stage for a comprehensive exploration of technical development, ethical considerations, and user needs. Ultimately, the goal is to contribute to the discourse on technology in parenting, striving for safer, healthier digital behaviors among teens in our constantly connected world.

1.1 Objectives

1.1.1 Design a mobile application for multi level user management access

Our aim is to develop a mobile app for multi-level user management, focusing on empowering parents to oversee and control their children's smartphone activities. Parents can restrict certain apps or functions on their kids' devices while maintaining their own access. They can create a family group within the app for monitoring, but children can't add parents to this group, ensuring parents retain control. By creating this app, we provide parents with a tool to enforce digital boundaries and promote responsible smartphone use among children.

1.1.2 Implement parental monitoring features for mobile usage

Our secondary goal is to incorporate a parental monitoring feature into our project, which is crucial for parents to gain insight into their children's smartphone activities, including browsing behavior. This feature helps identify and address risks like cyberbullying and exposure to harmful online content, promoting a safer digital environment for children and aligning with our project's objectives.

1.4.3 To enable location tracking feature of mobile device

The project's final objective is to implement a location tracking system for mobile devices, allowing parents to accurately locate their children's smartphones. This feature becomes crucial in unfortunate situations like missing children, where parents can access vital information about their last known location, increasing the chances of swift location and ensuring their safety. It provides peace of mind to parents and enhances overall safety measures for children in the digital age.

3. System Methodology/Approach

3.1 System Architecture Diagram

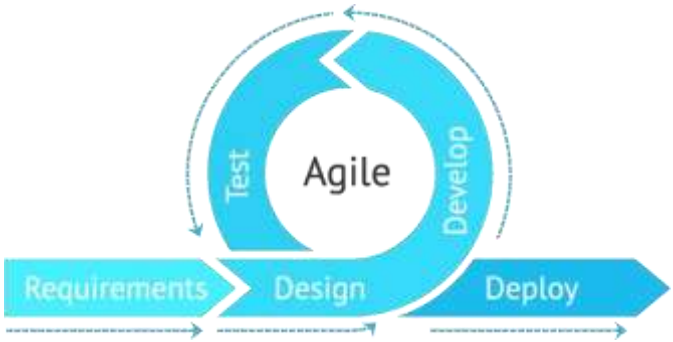

Figure 5 Agile development

I've chosen Agile Development Methodology for my project due to its widespread use among mobile app developers and its effectiveness in facilitating client-developer communication. Agile enables rapid iterations and continuous communication, ensuring responsiveness to evolving client needs. It aligns well with this project's relatively small scale and avoids extensive pre-development analysis of Waterfall Methodology. Agile's flexibility allows seamless incorporation of changes during implementation, ensuring the final product meets client requirements. The methodology consists of six key phases: requirements gathering, design, development, testing, deployment, and review, enabling systematic progress while maintaining adaptability for successful project outcomes.

Stage 1 : Requirements

Our project focuses on creating a Parental Monitoring Application using Android Studio as the IDE. We recommend a computer with a minimum of 8GB RAM, Windows 10-64bit OS, and an i5 processor or higher for optimal performance. The deliverables include problem statements, project objectives, and project scope.

Deliverable : Problem statements , project objectives and project scope

Stage 2 : Design

During this stage, we create the user interface (UI) for the application, covering seven main designs: homepage, call log, SMS detection, GPS tracking, geofencing, screen time management, and web filtering. Before coding, Adobe XD is used to sketch the UI design meticulously, ensuring visual appeal, ease of navigation, and alignment with project objectives and user requirements.

Deliverable : User Interface Design

Stage 3 : Development

This stage signifies the implementation and coding phase of the project, requiring proficiency in Java coding language to implement functions like web filtering and screen time management. Following Agile methodology, this phase allows for iterative testing and feedback collection. Users can engage with the application midway through implementation, providing insights for continuous improvement. This iterative approach ensures dynamic evolution of the application, meeting user expectations and enhancing usability.

Deliverable : Prototype coding of application

Stage 4 : Testing

In this testing stage post-development, black box testing is adopted, where testers lack prior knowledge of the project's design or implementation details. This method gathers genuine user feedback to ensure the application meets expectations and functions correctly. Functionality tests are also conducted to validate features and ensure smooth operation.

Deliverable : Functionality testing

Stage 5 : Deployment

After testing, the application is deployed on the internet or Google Play. Subsequent enhancements are included in new versions, which are then updated on the platform. This iterative process keeps the app up-to-date and continuously improves it to meet user needs and emerging requirements.

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Deliverable : Deploy to the internet of platform.

Stage 6 : Review

This stage verifies the application's post-deployment performance and gathers user feedback. Based on feedback, new functionalities or improvements are incorporated to enhance usability and ensure user satisfaction. This iterative process ensures the application evolves according to user preferences and requirements.

Deliverable : Improve the application and receive feedback

3.2 Use Case Diagram and Description

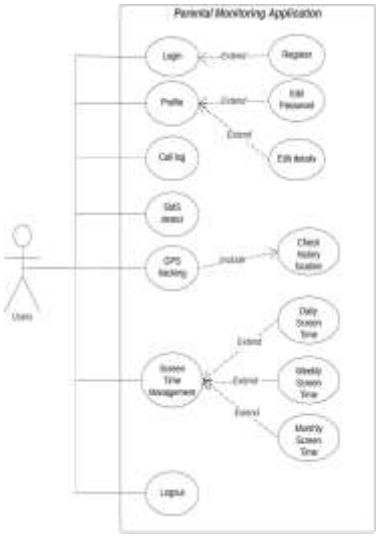

Figure 6 Use case diagram

The diagram illustrates the use case of the Parental Monitoring Application. Users log in or register, accessing their profile to view/edit personal information. The profile page menu offers functionalities like call log, SMS detection, GPS tracking, geofencing, screen time management, and web filtering. Call log/SMS detection monitor communication, GPS tracks location, geofencing sets usage limits in specific areas, and screen time management tracks device usage. Web filtering blocks harmful sites. Users can log out after the session.

3.3 Activity Diagam

Figure 7 Activity Diagram

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4. System Design

4.1 System Block Diagram

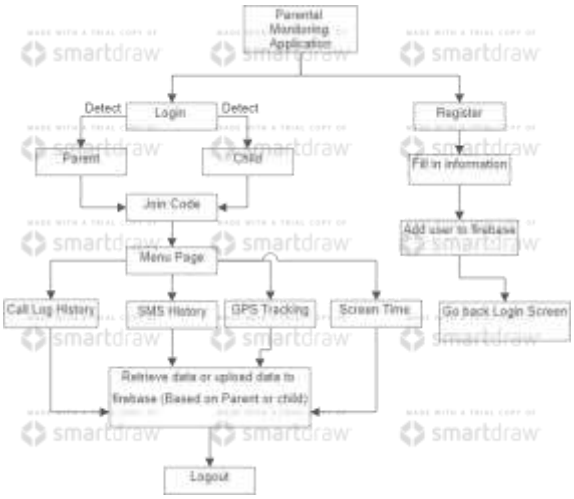

Figure 8 Block Diagram

The block diagram in Figure 8 outlines the operational flow of the application system. Users can login or register upon launching the app. Registration prompts new users to input necessary information, securely stored in Firebase. After login, users access the join code screen to collaborate in circles or skip this step. The main menu offers functions like "call log history," "SMS history," "GPS tracking," and "Screen Time," each leading to relevant screens. All data management with Firebase is seamless. Users can log out to end their session. This streamlined flow ensures efficient navigation and utilization of the app's functionalities.

4.2 System Components Specification

4.2.1 Login screen (Parent & Child)

This is the login screen (parent & child) for the login , forget password and register purpose.

4.2.2 Register Screen

The register screen (parent & child) is used to create a new user account and store into Firebase.

Figure 9 Login screen

Figure 10 Register Screen

4.2.3 Join circle (Parent & Child)

The join circle screen is for the parent join circle with children and the children cannot join the circle with parent.

4.2.4 Family Group (Parent only)

This is the family group screen which will only occur in parents . Each of the children will lead the parent to different children’s data displaying.

4.2.5 Home screen (Parent & Child)

The home screen offers parents and children access to four key functions: call detection, SMS detection, GPS tracking, and screen time monitoring. Through this centralized hub, parents can effectively monitor their children's activities and whereabouts, ensuring their safety and well-being.
This is the display of the call log history of children's smartphones which is displayed on parent smartphones only .

4.2.6 Call log history (Child)

This is for updating the data to Firebase .

4.2.7 SMS history (Parent)

This is the screen for parents to watch the SMS history of their children's smartphone.

4.2.8 SMS history (Child)

This is for updating the data to Firebase .

4.2.9 Call log history (Parent)

4.2.10 GPS tracking (Parent & Child)

The GPS tracking feature displays the real-time location of children's smartphones. Parents can view their children's smartphone location from their side, while children can also see their own smartphone location from their perspective. This ensures that both parents and children are aware of the smartphone's whereabouts at all times.

4.2.11 Screen Time (Parent & Child)

The screen time feature provides a comprehensive record of smartphone usage over a 24-hour period for both parents and children. On the parent's side, they can access and view the children's screen time usage for the past 24 hours. Similarly, children can also access and view their own screen time usage record for the same duration. This ensures transparency and accountability regarding smartphone usage for both parents and children.

4.3 Circuit and Components Design

4.3.1 Register blank warning

At the register screen if one of the Text input fields is blank it will prompt the warning and remain the same and will not go to the next screen.

4.3.2 Register check email format

The system will check whether the email format is correct or not . If not it will prompt a warning to the user.

4.3.3 Double checking of the password

The system will do the checking the second time the password input is the same as the previous password . If not it will prompt the warning.

4.3.4 Register success toast message

After clicking the register button will prompt the "Successfully Register!" message mentions the account is created successfully and jumps back to the login screen.

4.3.5 Account checking

The system will check if the email and password match with the account stored inside our database or not. If not it will prompt the toast message "The password is invalid or the user does not have a password."

4.3.6 Detect child and not allow join circle

The system will detect the account that you have logged in as parent or child . If a child , it is not allowed to join the circle and prompt the toast message "You are child cannot join the circle .

4.3.7 Invalid join code

The system will check if the join code exists in our database or not . If not it will prompt "Circle code is invalid" and require user fill in again.

4.3.8 Join circle successfully

The system will prompt the message to mention the join circle successfully.

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ISSN: 0970-2555
Volume : 53, Issue 4, No. 2, April : 2024

4.3.9 Database data checking (four function (parent))

The system will detect if the database is empty data or not when every time entry . If empty it will go back to the main page and prompt the toast message “Database does not have data”.This feature is applied on all of the functions in the application.

4.4 System Components Interaction Operations

4.4.1 Step 1

Figure 29 Register new account

The first step is to create a new account and in the register screen we must fill in all of the input fields and make sure you have chosen the parent or children.

4.4.2 Step 2 <u>Parent</u>

Figure 30 Family - Home

For the parent , after the login successfully it will lead the parent join code screen and allow the parent to add the child by the join code .After join circle successfully it will jump to the family screen and can click one of the children to use the function of our application in the home screen .

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ISSN: 0970-2555
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Children

Figure 31 Home screen

For children , after login successfully it will directly go to the home screen and each of the functions can be clicked.

4.4.3 Step 3

Parent (Call log history)

Figure 32 Call log history (Parent)

From the home screen click the first function called “Call Detect” will jump to the call log history screen which will show the phone number , contact name , call type , call date , call time and the call duration.

Industrial Engineering Journal
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Children (Call log history)

Figure 33 Call log history (children)

From the home screen , the child can click the first function called “Call detect” and it will lead to the update call log screen to update the call log history to Firebase.

4.4.4 Step 4

Parent (SMS history)

Figure 34 SMS history (Parent)

From the home screen click the second function called “SMS Detect” will jump to the SMS history screen which will show the phone number , message type , message date , message time and the message body.

Child (SMS history)

Figure 35 SMS history (child)

From the home screen , the child can click the second function called “SMS detect” and it will lead to the update SMS screen to update the SMS history to Firebase.

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4.4.5 Step 5
Parent & Child

Figure 36 GPS tracking (Parent & Child)

4.4.5.1 Child location by GPS tracking.

The third function called "GPS tracking" will jump to the google map and show the location of children . For parents , it will show the child's location and for the child it will show the child's location also .

4.4.5.2 Child location by Geo-fencing.

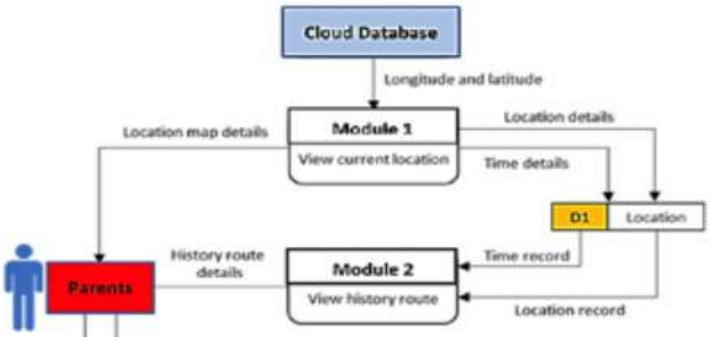

Figure 37 Data flow of the Geofence Alerts Application with GPS Tracking for Children Monitoring

4.4.5.3 Setting up geofence location:-

The Geofence feature allows parents to customize specific areas with personalized names and coordinates. They can also set time schedules for these zones. During testing, the Child Tracking app sends warning notifications if the child leaves the designated area within the scheduled time. Parents can manage alerts, cancel, reset, or delete geofence areas as needed, providing ease of oversight for their child's safety.

Industrial Engineering Journal
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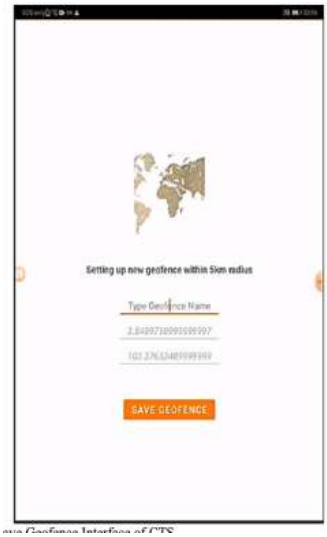

Figure 38 Save Geofence Interface

4.4.5.4 Displaying child's current location on the Application :-

The application offers a live view of the child's exact location on an interactive map interface, marked by a prominent red marker. Geofence areas set by parents are visually highlighted with orange circles. When the child crosses these boundaries, notifications are sent immediately to the parent's smartphone, ensuring timely updates on their child's movements and safety.

Figure 39 Children's current location and geofence areas on the application

4.4.6 Step 6 Parent & Child

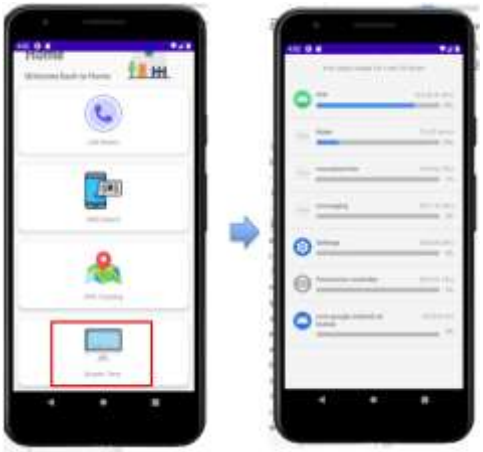

Figure 40 Screen time (Parent & Child)

From the home screen, selecting the fourth function, "Screen Time," will navigate users to the usage record screen, displaying a comprehensive list of applications utilized within the past 24 hours. This

screen provides details such as the name of the application, duration of usage, and the corresponding percentage. Parents can access their child's usage record, while children can view their own usage data, ensuring transparency and accountability for smartphone usage.

5.1 System Operations

5.1.1 Login screen

Figure 43 Login screen

Login button : Clicking the login button triggers a validation process to determine if the entered email and password match any existing accounts stored in Firebase. If a match is found, the user is directed to the Join Code screen.

Forget your password button : This button is designed for users who have forgotten their password and wish to reset it using their email address.

Register button : This button is for the new user who wants to create an account and it will jump to the register screen after clicking .

5.1.2 Register screen

Figure 44 Register screen

Parent & Children button : The button is one feature of our application , it can let the user choose the role of the user for example parent is used for monitoring children's phone.

Register button : The button clicked will check whether all the input fields are filled or not . If not it will prompt a warning to the user and if yes it will prompt a message to mention register successfully

and jump back to the login screen .
Login button : The button clicked will go back to the login screen.
Your code : Each user account generates a unique and distinct join code for display, ensuring individuality and exclusivity for each user.
Submit button : Upon clicking the button, the application will ascertain the user's role, distinguishing between parent and child. If identified as a child, a toast message will be prompted, indicating that the child is restricted from adding the parent. Conversely, if recognized as a parent, the application will verify the availability of the join code in Firebase

5.1.3 Family Group (Parent)

The family group only will be shown in the parent role .
Child list : The child list will show all of the children that parents have added by the join code.

5.1.4 Home screen

Figure 47 Home screen
Plus button : This button at the top right corner will lead the user to join the circle screen.
Menu button : This button will open the drawer menu .
Function list : This is the list of all the functions inside the application .

5.1.5 Drawer Menu

Figure 48 Drawer menu
Profile name : The profile name will change based on the user account data inside the Firebase.
Menu list : The menu list shows somewhere to navigate .

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