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Parent–Child Safety & Monitoring App

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***Abstract*—Smartphones are widely used by children for education and entertainment, but unmonitored usage creates safety and well-being concerns such as excessive screen time, harmful content exposure, and lack of supervision. This paper presents a Parent–Child Safety and Monitoring system that combines Android's native monitoring features with IoT-enabled smartwatch support. The Android application provides app blocking, web filtering, live location tracking, daily screen-time control, and logbook reports of child activity. IoT integration is focused on health sensor monitoring (e.g., heart rate, steps) and an SOS emergency button for quick alerts. The proposed framework emphasizes usability, consent-first onboarding, and secure data handling while addressing challenges such as battery drain, connectivity loss, and privacy compliance.**

***Index Terms*—Parental control, Child safety, Android, IoT, UsageStatsManager, App blocking, Web filtering, GPS tracking, Screen-time control, SOS, DPDP**

I. Introduction

Children's smartphone usage has increased rapidly, offering educational benefits but also risks such as behavioral addiction, inappropriate content exposure, and unsafe movement. Parents need solutions that provide timely information while respecting children's privacy. Android's platform features support app-level supervision (usage tracking, app blocking, web filtering, location services, and screen-time limits). Complementary IoT devices such as smartwatches provide health monitoring and panic alert buttons, enhancing physical safety. This paper proposes a system that integrates Android-based parental control with IoT-based health and emergency support to provide a unified monitoring solution.

II. Problem Statement

Existing parental control solutions often cover only a subset of features (e.g., app blocking or location tracking) and lack integration with IoT safety tools. A comprehensive solution is required that:

- Monitors live child location and generates safe-zone alerts,
- Provides app usage permissions, blocking, and web filtering,
- Enforces daily screen-time limits and activity logbooks,
- Integrates smartwatch sensors for child health monitoring,
- Provides an SOS panic button for emergencies,
- Ensures privacy-first and consent-based design.

III. Background & Key Technologies

A. Android Usage Monitoring

The `UsageStatsManager` API enables access to app usage statistics (time spent, launch counts). This supports activity logbook generation and daily reports.

B. App & Web Blocking

Through Accessibility Services and Device Admin APIs, apps and websites can be selectively blocked, enabling content control for safer device usage.

C. Location Tracking

The FusedLocationProviderClient API supports efficient GPS-based tracking with geofencing and real-time updates to parents.

D. Screen-Time Limits

The app enforces configurable daily usage caps. Notifications alert children and parents when limits are reached.

E. IoT Smartwatch Integration

IoT devices add physical safety features:

- **Health Monitoring:** Heart rate, step count, and basic activity data synced from a child's smartwatch.
- **SOS Button:** A panic alert on the watch triggers immediate notifications with location details to the parent app.

F. Cloud Backend

Firebase (Authentication, Firestore, and Cloud Messaging) provides secure storage, account linking, and real-time alerts.

IV. Literature Survey

Several existing mobile applications and research works have focused on ensuring children's safety and responsible smartphone usage. Traditional parental control apps such as Google Family Link, Qustodio, and Norton Family allow parents to monitor app usage, block websites, and set screen-time limits. However, these apps often face limitations such as high battery consumption, limited customization, and lack of real-time emergency alert mechanisms, which restrict their effectiveness in practical scenarios [1].

Early studies on Android parental control systems demonstrated the feasibility of app blocking and monitoring features

by leveraging Android permissions and usage statistics. For instance, research by Reddy and Murthy (2013) showcased one of the first Android-based solutions for restricting children's smartphone access [2]. Similarly, subsequent works explored the misuse of smartphones by children, highlighting risks such as excessive screen time, exposure to harmful online content, and unsupervised usage [3].

With the rise of IoT, researchers have also proposed wearable-based child safety systems. IoT-enabled smartwatches and SOS devices allow for continuous health monitoring, location tracking, and one-tap emergency alerts. Studies show that combining smartphone apps with IoT wearables enhances safety by providing parents with both contextual digital usage data and real-world health or location information [4].

More recent works emphasize integrating multiple features—such as app usage analytics, website blocking, live GPS tracking, and emergency alerts—into a single unified system. However, most commercial solutions are either intrusive or lack strong privacy-preserving mechanisms. Research highlights the importance of adopting consent-first designs, minimal data retention, and compliance with data protection regulations such as the DPDP Act (2023) to maintain user trust while protecting children's rights [5].

Despite these developments, very few systems provide a modular, real-time, and privacy-aware solution that combines Android-based parental control with IoT-enabled emergency monitoring. Our project builds upon these existing systems by integrating features such as app blocking, web filtering, daily activity reports, GPS tracking, smartwatch-based health monitoring, and SOS alerting into a single framework. This approach ensures a more comprehensive, reliable, and user-friendly safety and monitoring experience compared to most existing solutions.

V. Proposed Design Framework

The proposed system consists of two modules: Android App (software control) and IoT Smartwatch (physical safety). These two modules work in coordination through a secure cloud backend for real-time data sharing. The Android app focuses on digital well-being by monitoring, restricting, and reporting smartphone activities. Meanwhile, the smartwatch enhances physical safety by offering health tracking and SOS alerts. Together, they form an integrated framework to ensure both online and offline protection of the child.

The framework supports live GPS tracking with geofencing alerts to notify parents of unusual movements. Daily usage summaries and activity logs are generated for parental review, improving transparency. The smartwatch records vital signs like heart rate and steps, which are transmitted securely to the parent dashboard. In case of emergencies, the SOS button provides immediate location and alert notifications to parents. This design ensures reliability, data privacy, and user-friendly control for both children and parents.

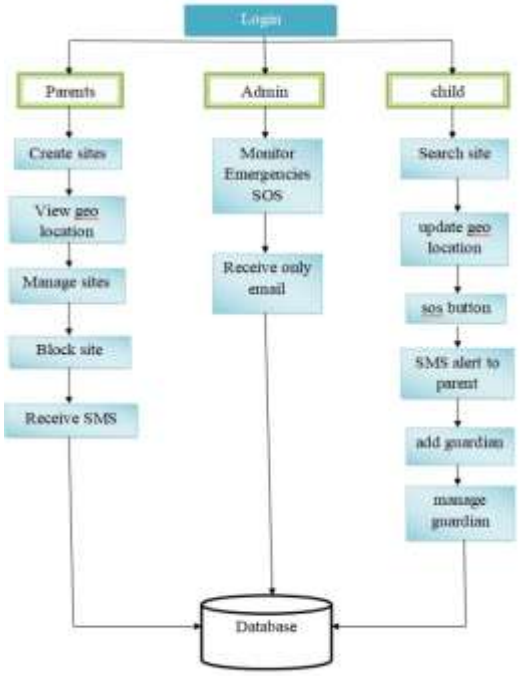

Fig. 1: Architecture: Android app manages digital safety (app usage, blocking, reports, GPS); IoT smartwatch provides health data and SOS alerts.

A. Child Device (Android)

- App usage tracking and blocking,
- Web filtering for harmful sites,
- Live GPS location updates and geofencing,
- Screen-time limit enforcement,
- Daily logbook report of activity.

B. IoT Smartwatch

- Heart rate and step tracking for child well-being,
- SOS button integration for emergency alerts.

C. Parent Dashboard

Provides:

- Real-time map and health status,
- Screen-time and usage analytics,
- Alert notifications from SOS or web/app violations.

VI. Security Algorithm

To protect sensitive data (location, health metrics, activity logs) the system uses device-backed symmetric authenticated encryption. Design goals are confidentiality, integrity and low computational overhead.

A. Summary

- **Algorithm:** AES-256 in Galois/Counter Mode (AES-256-GCM) for authenticated encryption.
- **Key storage:** Keys generated and stored in Android Keystore (non-exportable).

- **Transport:** All network traffic over TLS (HTTPS). Encrypted payloads (IV + ciphertext) uploaded to Firestore.
- **Integrity:** GCM authentication tag detects tampering; decryption fails on modification.

Notes: Use Base64 to store IV and ciphertext in Firestore. Rotate/rotate keys on device reprovisioning and keep server-side secrets in a secure vault.

VII. Privacy & Data Governance

- Consent-first onboarding for parents and children,
- Minimal data retention with deletion options,
- Encrypted storage of sensitive health and location data,
- Compliance with DPDP and global data protection principles.

VIII. Evaluation Metrics

- GPS accuracy and update latency,
- Battery impact on Android device and smartwatch,
- Effectiveness of app/web blocking,
- Reliability of SOS alert transmission,
- Usability from parent/child feedback.

TABLE I: Comparison of Existing and Proposed System Features

Existing Systems	Proposed System (Parent–Child Safety & Monitoring App)
Limited to app blocking or screen-time control	Integrates app blocking, web filtering, GPS tracking, and SOS alerting
No IoT integration for physical safety	Smartwatch integration for health monitoring (heart rate, steps) and emergency alerts
Manual or delayed location updates	Real-time GPS tracking with geofencing and instant notifications
High battery consumption	Optimized sampling and adaptive GPS usage to minimize battery drain
Basic parental control dashboard	Interactive parent dashboard with live data and analytics
Limited privacy measures	Encrypted data handling, consent-first onboarding, and DPDP compliance

IX. Challenges & Mitigations

- **Battery drain:** Adaptive GPS and health data sampling,
- **Connectivity loss:** Local caching with Firebase offline sync,
- **Over-blocking:** Granular settings to avoid excessive restrictions,
- **Ethical concerns:** Transparency and parental–child trust.

X. Future Directions

- Expanded smartwatch integration (SpO_2, temperature),
- Multi-device support for families,
- Multilingual parental dashboards,
- Enhanced analytics for long-term health and usage trends.

XI. Conclusion

The proposed Parent–Child Safety and Monitoring system combines Android-based app usage and safety features with IoT smartwatch health monitoring and SOS functionality. By integrating digital and physical safety tools, the system offers parents comprehensive visibility while respecting privacy and usability. This framework provides a practical roadmap for future prototype development.

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