International Research Journal of Education and Technology

Peer Reviewed Journal

ISSN 2581-7795

MOBILE ADDICTION PREDICTION USING MACHINE LEARNING

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Abstract - *The **Mobile Addiction Prediction System** is a **machine learning-based** web application that analyzes **user behavior patterns** to predict **smartphone addiction levels**. With increasing **mobile dependency** affecting **mental health**, **productivity**, and **social interactions**, this system offers an **automated, data-driven solution** to promote **digital well-being**. Users can upload **smartphone usage data**, including **screen time**, **app usage**, and **unlock frequency**, via **CSV files** or **real-time tracking**. The system processes this data using **AI models** to classify **addiction levels** and provides **personalized recommendations** for healthier **digital habits**. Built with **React.js** for the **frontend**, **Firebase** for **authentication and storage**, and **Flask** for **backend processing**, the platform ensures **secure, scalable, and efficient data management**. The **interactive web dashboard** presents **historical trends**, **graphical reports**, and **actionable insights**, empowering users to **monitor and reduce excessive mobile usage**. By leveraging **cloud-based machine learning models** and **privacy-focused infrastructure**, the system ensures **accurate predictions** while **safeguarding user data**. This project serves as a valuable tool for **individuals, parents, educators, and mental health professionals** seeking to understand and manage **smartphone dependency**. Through **real-time analytics** and **intuitive visualizations**, the system enhances **self-awareness** and encourages **responsible smartphone consumption**.*

Key Words: **Mobile Addiction Prediction, Machine Learning, Smartphone Usage Analysis, Digital Well-being, Predictive Analytics, Screen Time Monitoring, Behavioral Data Analysis, AI-Powered Insights**.

1.INTRODUCTION

In today's **digital era**, **excessive smartphone usage** has become a major concern, leading to potential **addiction** and **negative behavioral impacts**. The increasing **dependency on mobile devices** affects **productivity, mental well-being,** and **social interactions**, especially among **students and professionals**. **Unregulated screen time, frequent device unlocks,** and excessive engagement with **social media** or **gaming applications** contribute to **mobile addiction**, making it essential to develop an **intelligent system** for **monitoring and predicting addiction levels**. However, most individuals **lack awareness** of their **smartphone usage patterns**, making it difficult to take **preventive measures**.

To address these concerns, the **Mobile Addiction Prediction System** offers a **machine learning-based, cloud-integrated,** and **user-friendly solution** for analyzing **smartphone usage behavior**. Users can upload their **mobile usage data**, which is then **processed and analyzed** to determine their **addiction level**. Utilizing technologies like **React.js** for the **frontend**, **Firebase Firestore** for **authentication and storage**, and **Flask** for **backend processing**, the system provides **real-time predictions, interactive visual reports,** and **personalized recommendations** to help users **manage their screen time effectively**. Additionally, **predictions and historical data** are **securely stored in Firebase**, enabling users to **track their addiction trends over time** and take **proactive steps** toward **healthier digital habits**.

This project stands out by offering an **automated, data-driven approach** to **mobile addiction monitoring**, unlike existing **applications** that lack **predictive capabilities** and **personalized insights**. It also serves as a **valuable tool** for **researchers, psychologists,** and **digital well-being advocates** by providing **structured insights** into **mobile usage patterns**. The integration of **predictive analytics** and **dynamic visualizations** helps users **identify behavioral trends** and take **corrective actions** before **addiction worsens**. With **cloud-based accessibility** and **secure data encryption**, the system ensures **privacy, data protection,** and **availability across devices**, making it a **reliable and practical solution** for managing **digital addiction**.

2. LITERATURE SURVEY

Existing research on **mobile addiction prediction systems** has explored various techniques for **data collection, behavioral analysis,** and **addiction classification** within the context of **digital well-being** and **mobile usage analysis**. Several studies have emphasized the growing concerns related to **excessive smartphone usage, screen time management,** and **digital**

dependency, highlighting the need for **automated tools** to assess and mitigate **mobile addiction**. Traditional methods relied on **manual surveys** and **self-reported data**, which often suffered from **bias** and lacked **real-time accuracy**. However, recent advancements in **machine learning** and **mobile activity tracking** have paved the way for **data-driven approaches** to predicting **mobile addiction levels**, ensuring higher accuracy and reliability in addiction assessment.

Early **digital well-being systems** primarily focused on **basic screen time tracking** and **app usage statistics**, without offering **personalized insights** or **predictive analytics**. These systems lacked **real-time processing capabilities** and did not incorporate **addiction severity classification**, making it difficult for users to evaluate their **digital habits** effectively. Additionally, many existing solutions did not integrate **cloud-based data storage**, limiting their ability to provide **long-term behavioral insights** and **historical tracking**. As a result, users were unable to **visualize their mobile usage patterns** over time, reducing the effectiveness of **intervention strategies**. Recent studies, such as those by **Wang et al. (2020)**, have demonstrated that **machine learning-based addiction detection models** significantly improve the accuracy of **addiction classification** and the effectiveness of **personalized recommendations** by analyzing **usage behavior metrics** such as **screen time, app engagement, night usage,** and **unlock frequency**.

Moreover, modern **cloud-based communication protocols**, such as **Firebase Firestore** and **Flask-based machine learning APIs**, enable **seamless data exchange** between **frontend applications** and **backend processing systems**. These **scalable cloud solutions** allow for **secure, real-time behavioral predictions**, ensuring **fast response times** and **encrypted data storage**. Studies have also emphasized the importance of **user-friendly web interfaces** with **interactive dashboards** and **personalized feedback** to keep users engaged and motivated to **reduce screen time**. However, many **mobile addiction analysis systems** still face challenges related to **data security, privacy,** and **scalability**. Some applications lack **secure authentication mechanisms**, raising concerns about **unauthorized access** to **sensitive mobile usage data**. Others struggle with handling **large datasets** and **historical trend analysis** effectively. This project aims to overcome these limitations by developing a **cloud-based, secure, and scalable mobile addiction prediction system** that integrates **machine learning-based addiction classification, real-time tracking, historical data visualization,** and **automated recommendation generation**. By leveraging **React.js, Firebase, Flask-based ML models,** and **advanced encryption techniques**, this system ensures **efficiency, transparency,** and **accuracy** in predicting and mitigating **mobile addiction**.

3. METHODOLOGY

The **Mobile Addiction Prediction System** follows a structured approach, starting with **technology selection, data collection, preprocessing, machine learning-based prediction, secure data storage,** and **visualization**. Built using **React.js** for the frontend, **Firebase Firestore** for real-time **database management**, and **Flask (Python)** for **backend processing**, the system leverages **cloud-based architecture** for **scalability, security,** and **accessibility**. Users can upload **mobile usage data**, receive **real-time addiction predictions**, and track **historical trends** through **visual reports**.

The **backend workflow** involves a **Flask server** handling **API requests, CSV file processing, feature extraction,** and **machine learning-based addiction prediction**. Once classified into **Low, Moderate,** or **High addiction levels**, the system provides **personalized recommendations**. Predictions are securely stored in **Firebase Firestore**, enabling users to track their **past records**. **Automated notifications** can alert users about concerning **mobile usage trends**.

For **data security**, mobile usage data is **AES-256 encrypted**, preventing **unauthorized access**. **JWT-based authentication** ensures only **authorized users** can access their reports, while **HTTPS protocols** secure data transmission. The **React.js** and **TailwindCSS**-based frontend provides an **interactive dashboard** for users to upload data and analyze **addiction trends**. The system's **scalability** and **efficiency** make it a **reliable tool** for individuals, businesses, and industries to make **data-driven decisions** for **digital well-being**.

3.1 System Architecture

The **Mobile Addiction Prediction System** is designed using a **multi-layered architecture**, ensuring **real-time data processing, machine learning-based analysis, secure user authentication,** and **cloud-based storage**. The architecture consists of five key layers: **User Authentication Layer, Data Communication Layer, Machine Learning Processing Layer, Cloud Storage Layer,** and **Application Layer**. This structured approach ensures **efficient prediction, secure data handling,** and an **interactive user experience**.

3.1.1 User Authentication Layer

This layer ensures secure login and access control, preventing unauthorized users from submitting mobile usage data or viewing predictions. The system uses Firebase Authentication, allowing users to register and log in securely via email/password or OAuth-based sign-in methods. JWT-based authentication protects API endpoints and secures user sessions. Users can access their historical predictions, reports, and analytics securely, ensuring data privacy and protection.

3.1.2. Data Communication Layer

The communication layer facilitates secure data exchange between the user, frontend, and backend services. Users upload mobile usage data (CSV files), which is validated before being transmitted via HTTPS to the backend for preprocessing. Secure CORS policy settings ensure seamless communication between the React.js frontend and Flask-based backend. Data is processed and stored in Firebase Firestore, providing real-time updates to ensure dynamic report visualization.

3.1.3 Machine Learning Processing Layer

This layer forms the analytical core of the system. When users upload their mobile usage data, the backend preprocesses it by ensuring correct formatting, handling missing values, and extracting relevant features. The extracted features include screen time, unlock frequency, social media usage, night-time phone usage, and gaming duration. A trained machine learning model then classifies users into three addiction categories: Low, Moderate, or High. This classification process is executed in real-time, ensuring quick and accurate predictions. The results are securely stored in Firebase Firestore for historical tracking.

3.1.4. Cloud Storage Layer

This layer provides secure and scalable data storage. Firebase Firestore serves as the primary database for user data, predictions, and analytics. Firebase Storage is used for securely storing uploaded CSV files when needed for long-term processing. Security measures such as Firestore Security Rules and role-based access control (RBAC) restrict access to authorized users only.

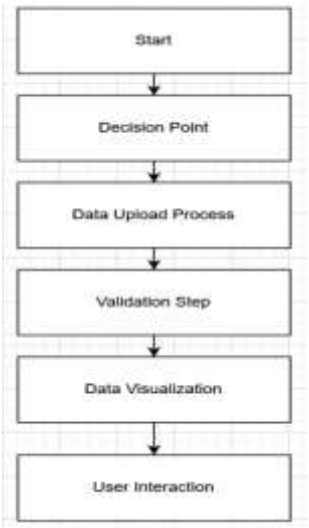
3.1.5. Application Layer

The application layer ensures interactive user engagement through a real-time dashboard. After the ML model predicts addiction levels, the React.js frontend dynamically fetches data from Firestore and updates the user interface. Recharts.js is integrated for graphical representation of trends, allowing users to visualize weekly and monthly mobile usage patterns. If no data is available, users receive a prompt to upload their mobile usage history.

Automated Notifications & Insights

Once predictions are generated, results are securely stored, and users receive automated notifications with personalized recommendations. Users can track their historical trends through interactive reports and graphs. A rule-based or supervised learning approach ensures reliable classification, making real-time digital addiction monitoring efficient and user-friendly.

This structured multi-layer architecture ensures dependable data acquisition, efficient analytics, and seamless user interaction, making it a robust solution for mobile addiction monitoring.



System Architecture

3.2 Firebase Setup and Configuration

The Firebase setup and configuration for the Mobile Addiction Prediction System ensures secure authentication, real-time data management, machine learning integration, and historical data storage. The system is designed to authenticate users, store mobile usage data, process machine learning predictions, and provide insights through a real-time dashboard.

3.2.1 Firebase Authentication:

Firebase Authentication is configured to manage secure login and user verification, ensuring that only authenticated users can access the system. Users sign in using email/password authentication or OAuth-based authentication for seamless access. Role-based authentication is implemented to manage different levels of access: regular users can upload their mobile usage data and view predictions, while administrators have additional privileges to monitor and analyze trends across users. The authentication system is secured with JWT (JSON Web Token)-based security, preventing unauthorized access to sensitive data and ensuring secure user sessions.

3.2.2 Firestore Database Configuration:

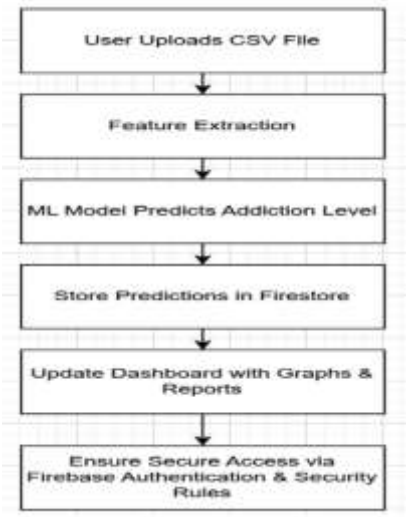
Firebase Firestore is a cloud-based NoSQL database that serves as the central data repository for the Mobile Addiction Prediction System. It efficiently manages user data, mobile usage history, and addiction prediction results, ensuring a seamless and scalable data management process. The system securely stores user authentication details, uploaded mobile usage statistics, and machine learning-based addiction predictions in a structured format. Each user's profile is linked to their historical addiction trends, allowing them to track behavioral changes over time.

3.2.3 Firebase Functions for Backend Processing:

To automate the processing of mobile usage data and addiction predictions, the system utilizes Firebase Functions, a serverless backend that connects the frontend, database, and machine learning API. Firebase Functions play a crucial role in validating uploaded CSV files, extracting necessary features, and triggering ML-based predictions. Once a user uploads their mobile usage data, a Firebase Function automatically processes the file, extracts key behavioral metrics such as screen time, unlock frequency, social media usage, night-time activity, and gaming habits, and forwards the data to the Flask-based machine learning model for classification.

To maintain a high level of security and data privacy, the system implements strict Firestore Security Rules, restricting access to only authenticated users. Each user's addiction data is stored in an encrypted format, ensuring data integrity and confidentiality. Additionally, Firebase Storage is used to securely store user-uploaded CSV files, preventing unauthorized access or tampering. The JWT-based authentication mechanism further enhances data protection, ensuring that only the rightful owner can view or download their addiction history.

Beyond security, the system offers real-time insights and data visualization, providing users with a clear understanding of their mobile usage habits. The dashboard dynamically updates based on the latest predictions, displaying charts and graphs that illustrate addiction patterns over time. Users can analyze their screen time trends, unlock frequency, and other behavioral indicators, empowering them to take necessary actions to reduce excessive mobile usage. By leveraging cloud-based data storage, automation, and real-time insights, the system ensures an efficient, secure, and user-friendly approach to mobile addiction analysis and self-improvement.



Firebase Setup

3.3 Backend Logic with Firebase Functions

The backend logic of the Mobile Addiction Prediction System is powered by Firebase Functions, ensuring real-time data processing, secure data handling, and automated machine learning workflows. This cloud-based backend enables seamless communication between the React.js-based frontend and the Flask-based ML model, facilitating data processing, addiction level prediction, storage, and real-time notifications.

3.3.1 Cloud Storage and Processing:

The backend stores and processes user data, addiction prediction results, and historical insights using Firebase Firestore and Firebase Storage. Firestore Database provides real-time synchronization, ensuring that users always have access to the latest prediction results and past records. Firebase Storage securely holds uploaded CSV files and processed ML predictions, allowing users to access their past assessments at any time. JSON Web Tokens (JWTs) are used to generate secure, time-sensitive access tokens to ensure that only authenticated users can retrieve their stored predictions and insights. Data visualization dashboards dynamically update in real time, reflecting the latest user predictions and behavioral trends.

3.3.2 Backend Configuration:

The backend automation in Firebase Functions handles all core functionalities, including data validation, addiction prediction processing, result storage, and automated user notifications. When a user uploads their mobile usage data, Firebase Functions validates the format and extracts behavioral metrics such as screen time, unlock frequency, and app usage. The extracted data is forwarded to the Flask-based ML API, which processes the information using the trained machine learning model. The predicted addiction level (Low, Moderate, High) along with personalized recommendations is stored in Firestore, ensuring users can track trends over time.

3.3.3 Nodemailer:

A crucial aspect of the backend configuration is automated email notifications and request tracking. Firebase Functions work in conjunction with Nodemailer to send real-time email alerts whenever a new addiction assessment is completed. Users receive automated emails containing their latest addiction level, a summary of key usage statistics, and tailored recommendations for improving digital habits. If the user has multiple predictions stored, the email includes a historical trend analysis, helping them compare their past and present addiction levels. The email also contains a secure link to view/download detailed addiction reports, ensuring easy accessibility.

3.3.4 Visualization and Dashboard Development:

The React.js-based frontend dashboard interacts with the backend using secure API calls, allowing users to upload their data, track addiction predictions, and visualize reports in real-time. The dashboard dynamically updates predictions whenever a new assessment is completed, enabling users to monitor their screen time trends and behavioral changes. Interactive data visualizations such as graphs, bar charts, and progress indicators display insights into daily, weekly, and monthly addiction trends. Real-time Firestore updates ensure that users always see the latest predictions and recommendations without needing to refresh the page. The backend automation ensures that predictions are processed within seconds, eliminating manual delays and providing instant insights into mobile addiction behavior. Users can also filter their history based on date ranges, addiction severity, and behavioral factors, enabling them to understand their digital usage trends more effectively.

3.4 User Interface and Notification System Configuration

The Mobile Addiction Prediction System is designed with a user-friendly interface and real-time notification system to provide users with instant insights into their addiction levels and ensure seamless interaction with the platform. The system ensures that users can upload mobile usage data, receive instant predictions, track their addiction history, and receive notifications about their digital well-being trends without any manual follow-ups.

3.4.1 Web Dashboard:

The web-based dashboard, built using React.js and TailwindCSS, serves as the central hub where users can

Upload mobile usage data (CSV format) for addiction prediction. View real-time predictions based on machine learning analysis. Track past predictions and trends in an interactive and structured format. Receive personalized recommendations based on their addiction levels (Low, Moderate, High). Access real-time analytics via graphs and charts, providing a visual representation of their screen time, unlocks, and social media usage. For administrators, the dashboard provides a centralized view of user predictions, allowing them to monitor usage patterns, analyze trends, and generate insights into digital well-being concerns. The dashboard ensures seamless synchronization with Firebase Firestore, keeping all data updated in real-time.

• To keep users informed and engaged, the system integrates a real-time notification system using Firebase Functions and Nodemailer to provide Instant email notifications when a new prediction is generated. Periodic reports summarizing their addiction trends and personalized suggestions for improvement.

• Alerts for excessive screen time, unlocks, or late-night phone usage, providing users with recommendations to reduce dependency.

3. CONCLUSIONS

The Mobile Addiction Prediction System effectively analyzes smartphone usage patterns using machine learning and cloud technologies, providing real-time addiction assessments and personalized insights. By integrating Firebase Firestore, Flask-based ML predictions, and interactive visualizations, users can track their digital habits and receive actionable recommendations. The system enhances self-regulation through automated data analysis, secure authentication, and real-time notifications.

Future improvements include integrating Android and iOS APIs for real-time data collection, refining ML models with advanced deep learning techniques, and introducing personalized coaching, smart alerts, and gamified incentives to improve user engagement and digital well-being.

ACKNOWLEDGEMENT

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BIOGRAPHIES (Optional not mandatory)

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