International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 10 October 2024
Page No: 2463 - 2469
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0337

# Advanced Personal Budget Analytics: Combining Optical Character Recognition and Natural Language Processing for Automated Budget Categorization and Insight Extraction

*S. Harsshita[1], A. Shruthi[2], B. Kanaka Srinidhi[3], Dr. A. Sandhya[4]*
*[1,2,3]UG Scholar, Dept. of CSE-BDA, SRM Institute of Science & Technology, Ramapuram, Chennai, India.*
*[4]Assistant Professor, Dept. of CSE-BDA, SRM Institute of Science & Technology, Chennai, India.*
***Emails:*** *sv6285@srmist.edu.in[1], as3103@srmist.edu.in[2], br3561@srmist.edu.in[3], sandhyaa@srmist.edu.in[4]*

## Abstract
*A budget tracking system is a tool designed to help users monitor their financial resources, categorize expenses and control their financial resources. An Intelligent Personal Budget Analysis System is designed to redefine personal finance management. IntelliFinance is a user- friendly app designed for seamless and efficient daily expense management removing the necessity for conventional paper documentation. This project inculcates the concepts of Computer Vision, Machine Learning and Data Analytics, aims to surpass traditional budget tracking by incorporating innovative features such as receipt scanning and analysis. The project is implemented using Android Studio and Firebase, incorporating advanced features such as Optical Character Recognition (OCR) to capture receipt images, extract text, and process it for further analysis. Firebase ML Kit is utilized for scanning and text recognition, while Natural Language Processing (NLP) is applied for categorizing the extracted text. The system provides a personal budget analysis that enhances the accuracy of financial tracking by offering users a comprehensive overview of their spending habits, complemented by detailed reports and visualizations. Ultimately, this project serves as a financial companion, empowering users to take control of their finances, make informed decisions, and achieve their financial goals.*

***Keywords:*** *Computer Vision, Machine Learning, Data Analytics, Optical Character Recognition, Firebase, Budget Analysis, Natural Language Processing, Finances, Google ML Kit, Android Studio.*

## 1. Introduction
In today's fast-paced world, where keeping track of financial commitments and obligations amidst distractions can be challenging, this app could serve as avital reminder tool, acting as a reliable aid in keeping track of bill payments and other financial obligations. Traditionally, paper bills have been used to record and store information about financial transactions. While this method is dependable, it can be incredibly time-consuming and cumbersome to search through physical bills, making it tedious to locate a specific transaction. Rapid technological advancements, combined with the growing complexity of personal finance, necessitate a sophisticated approach to budget management rather than tracking expenses in the conventional, monotonous and error- prone method. With the surge in the use of smartphones, people are increasingly turning to mobile applications to help with most if not all of the daily tasks, thereby simplifying their lives. Such apps fall under several categories including Education, Sports, Entertainment, Finance and more. The personal budget analysis system falls under the finance category, playing a crucial role in managing personal finances which is essential to daily life. Several surveys across the globe suggested that most of the population, when faced with queries regarding their expenses, struggled to provide accurate figures which in turn points towards insufficient awareness about their spending patterns. This highlights the need for improved budget analysis systems to help people gain clear insights of their financial habits and help manage resources effectively. The integration of machine learning and scanning of receipts is a crucial feature of this application. Once the users register and enter their login credentials, they can create a record distinctive to the user that covers all the required financial details. This would enable the user to capture images of the receipts and bills via their

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 10 October 2024
Page No: 2463 - 2469
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0337

smartphones or other devices and upload them and the application automatically extracts the data using the OCR feature and classify the expenses without the need for manual input. This feature significantly saves time and enhances the accuracy of financial tracking as they provide a visualization of the expenses for the month, that is, an all- encompassing report of monthly expenses including groceries, rent, bills and several other expenses in the form of pie charts or bar graphs for users to easily understand about their expense patterns. Additionally, by leveraging machine learning algorithms such as natural language processing for text recognition and classification and others, this application provides valuable insights to the users about their spending habits, facilitating a more effective budgeting. This intelligent budget analysis system combines advanced technology with practical functionality, setting new standards in personal finance management. It aims to make budgeting easier, more precise and more insightful to users and stay on top of financial responsibilities.

## 2. Literature Survey

The paper [1] proposes an automated system named eExpense for storing and calculating data. This Android application allows users to save expenses by scanning receipts, extracting textual information for further processing, and tracking SMS notifications to monitor income and savings. In [2], the use of Optical Character Recognition (OCR) for extracting and organizing information from images of bills and receipts is discussed, with techniques like image bifurcation and shadow removal being employed to handle watermarks, long invoices, and shadows effectively. The dissertation [3] introduces a budget tracking application developed using React Native, aimed at simplifying financial management by addressing the complexities of budget tracking through mobile solutions. The development of a mobile application for budget management is described in [4], where users can scan receipts using their phones. The image is pre-processed, text recognition is applied, and selected data is saved to a database. Despite the challenges in developing an effective text recognition algorithm and identifying and organizing the required data, the tasks were successfully completed. The "Mobile Bookkeeper" application [5] allows users to scan receipts, with details automatically transcribed using OCR. The app's usability and satisfaction were tested according to ISO standards, revealing its necessity and challenges in OCR integration. Another study [6] presents "My Money," an Android application developed using an iterative methodology, employing Firebase for the database to help users track their finances and monitor income and expenses. The study [7] assesses various NLP techniques for extracting data from receipts by analyzing models like BiLSTM, GCN, BERT, and a rule-based model across 790 receipts. Although BERT attained the top F1 score, all models faced challenges with product lists, and OCR inaccuracies impeded results, underscoring the necessity for enhanced approaches. The paper [8] focuses on tracking daily expenses for managing personal finances using Tesseract OCR version 5 with long short-term memory to extract data from receipts. The "Smart BAT" program [9] proposes simplifying budget tracking by using OCR and machine learning to digitize physical bills. "CashSave" [10] aims to create a mobile app to assist people in managing their finances, with features like a recommender system for personalized advice and expenditure visualizations. The study [11] discusses a mobile application that enables users to track and monitor expenses by scanning receipts using OCR technology. The paper [12] introduces an Android API constructed with Firebase to improve text recognition by translating text from scanned images into the user's preferred language. Lastly, the paper [13] presents a dedicated OCR system tailored for retrieving details from grocery receipts, including item names, prices, quantities, and units, leveraging the Tesseract OCR engine with heuristic techniques and intelligent rules to enhance precision [14].

## 3. Existing System

The current system for personal finance management heavily relies on manual data entry into budgeting tools like spreadsheets or finance apps. This process is time- consuming and prone to errors, such as typos or incorrect categorization of expenses, often leading to inaccuracies [15]. Users typically categorize expenses manually, which can be subjective and inconsistent, making it difficult to get an accurate

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 10 October 2024
Page No: 2463 - 2469
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0337

picture of spending patterns. Handling paper receipts or digital images adds further complexity, as they often need to be manually inputted or stored separately, making integration with expense tracking systems cumbersome. Additionally, the lack of real-time financial insights hampers users' ability to adjust budgets or make informed decisions promptly [16]. These challenges highlight the need for automated solutions using technologies like Optical Character Recognition (OCR) and Natural Language Processing (NLP), which can streamline the process, improve accuracy, and provide up- to-date financial insights, ultimately enhancing personal finance management.

## 4. Proposed System

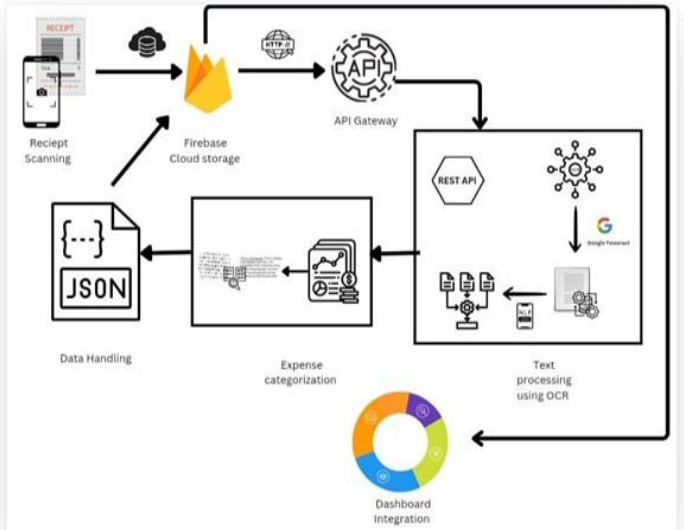


**Figure 1 Architecture Diagram of Intelligent Personal Budget Analysis System**

The system is designed to efficiently manage and analyze budgets through a user-friendly mobile application. It starts by collecting user input on income and expenses. To ensure data security, it uses Firebase for robust authentication and authorization. Once verified, user data flows into the budget management module, which is central to the system. This module includes an income tracker to record all income sources and an expense tracker to log and categorize expenses. The expense tracker uses Natural Language Processing (NLP) technology and Optical Character Recognition (OCR) to extract and categorize text from scanned receipts. The processed data is securely stored in the Firebase database. The system includes a report generator that creates insightful reports on financial health and an analytics engine that performs in-depth data analysis to reveal trends and patterns using dashboards. This comprehensive solution as shown in Figure 1 helps users effectively manage their finances by tracking income, expenses, generating reports, and providing valuable insights.

## 5. Methodology

This Budget Tracking System is based on a Modular Software Development methodology as it involves breaking down the app into independent and self-contained modules that perform specific functions [17]. Each module is developed, tested and integrated separately and hence forms a scalable, organized and maintainable system. This enhances flexibility and code reuse. The modules of this Budget Tracking Application are:

- **User Authentication Module:** Manages user registration, login, password reset, and profile management using Firebase for authentication and secure storage.
- **Receipt Scanning and OCR Module:** Enables users to capture receipts using the device's camera, processes them with Optical Character Recognition (OCR), and extracts important details such as bill number, amount, and image data for storage in Firebase.
- **NLP-Based Expense Categorization Module:** Automatically categorizes expenses by analyzing the text data extracted from receipts and user input through Natural Language Processing (NLP).
- **Expense Tracking Module:** Provides users with options to log, categorize, and view their daily expenses, allowing them to manage their spending efficiently.
- **Budget Management Module:** Allows users to set budgets, track their spending against these budgets, and visualize their expenses using charts and graphs for better financial management.
- **Reporting and Analytics Module:** Generates detailed reports and provides visual

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 10 October 2024
Page No: 2463 - 2469
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0337

insights into users' spending patterns, helping them make informed financial decisions.

- **Alerts and Notifications Module:** Notifies users of budget limits, due dates, and any unusual spending activities through custom alerts and notifications.

The implementation follows a phased approach, starting with the creation of the project and connecting it to Firebase, then developing the user interface and backend functionality for each of the modules. In the implementation of the expense tracking application, the workflow begins when the user opens the app and is presented with a login and sign-up page. Users can sign in using their username and password, with error handling in place for incorrect credentials. New users can register, while existing users can log in. The login information is stored in Google Firebase for secure authentication purposes. Upon successful login, the user is directed to the main activity page, which displays four primary options: Camera, Search, Manual Data Entry, and Dashboard. as shown in Figure 2.

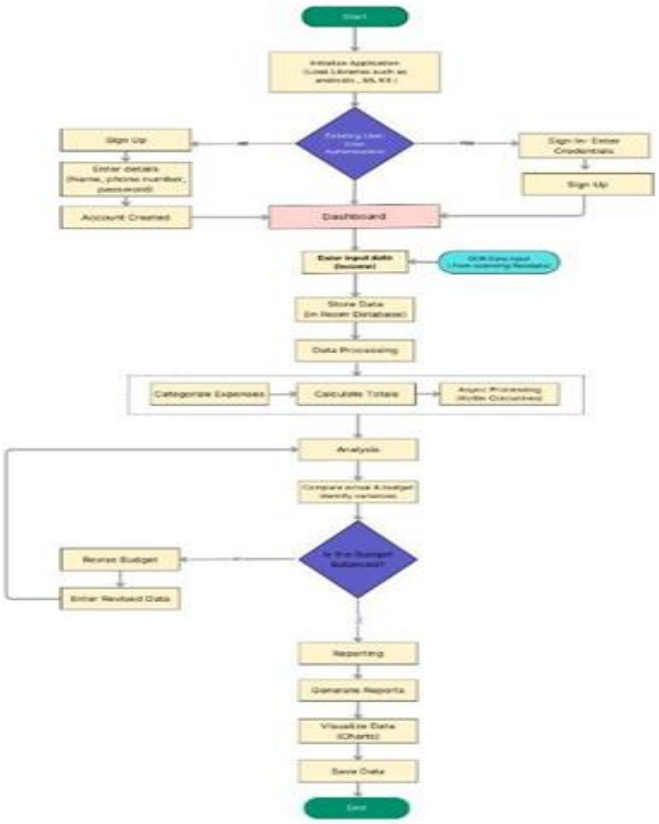


**Figure 2 Workflow of Intel Finance App**

**The Main Activity Provides Two Core Functionalities:** capturing images of receipts and searching for items. Upon capturing a receipt, the image is stored in Firebase, and the user can access the detailed breakdown of their expenses. When the user selects the Camera option, it navigates to a camera activity page that implements Optical Character Recognition (OCR). Initially, the screen is blank, prompting the user to capture an image. The application requests camera access, which provides three options - allow only once, allow while using the app and deny the request. Once the request is granted, the device's camera interface is activated, offering filters if necessary. The user captures a photo of a receipt, and the image is successfully saved in Firebase. The application notifies the user, and the OCR processes the image to extract details such as the bill number, the URL where the image is stored in Firebase, the image size, and the specific details from the bill, including the total amount. Permissions for camera access, internet usage, and storage are specified in the Android Manifest file to ensure the app functions smoothly. The Search activity allows users to look up previously purchased items, providing detailed information such as the quantity of items bought and the purchase date. This search feature is linked to the stored data from receipts. For manual data entry, the user can input their income and add bill amounts. The application subtracts expenses from the income to calculate savings, which is displayed in the Dashboard. The Dashboard may use visualizations such as pie charts or bar charts to present the user's financial data, including expenses and savings. Technically, the application is built using Kotlin (.kt) for backend operations and XML for frontend layouts. These components are connected through Android's framework. The application relies on various dependencies for camera access, internet connectivity, and OCR implementation, which is managed through ML Kit. Firebase is integrated to handle authentication, email storage, and image storage. Specific rules for Firebase storage are established to ensure read, write, and edit capabilities for images, which are crucial for splitting the items in the image and extracting relevant data. A real-time Firebase database is used for dynamic storage and retrieval of user data.

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 10 October 2024
Page No: 2463 - 2469
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0337

## 6. OCR Functionality

The OCR functionality in the budget app begins when the user selects the camera option within the app. The app requests permission to access the camera, and once granted, it opens the camera interface. The user takes a picture of the receipt, and the image is immediately captured.After the image is captured, the app automatically preprocesses it to ensure the text is clear and legible. This preprocessing includes adjustments to brightness and contrast, as well as filtering out noise that may hinder text recognition.

The image is then passed through the OCR engine powered by Firebase ML Kit. The OCR engine scans the image, identifying and extracting text elements such as the bill number, vendor name, purchase date, itemized products, prices, and the total amount spent. These details are converted from the image into structured digital data. The extracted data is organized into relevant fields. Items listed on the receipt are categorized based on their descriptions, placing them into predefined categories like groceries or entertainment. This data is saved alongside the receipt image in Firebase, ensuring that both the raw image and extracted information are stored securely.Once the data is saved, the app notifies the user, displaying the receipt details. Users have the option to review the extracted data and manually adjust any inaccuracies if necessary. After confirming the details, the data is finalized and integrated into the app's expense tracking system. The expense tracking system updates the dashboard, reflecting the newly added data. The app uses the data to generate visual reports, including pie charts and bar charts, allowing users to view their spending patterns and gain insights into their financial behavior. The app continuously ensures security by employing Firebase's encryption protocols and access controls, safeguarding the stored data.

## 7. Result & Discussion

The implementation of the personal budget analysis system demonstrated high efficiency and accuracy across its core functionalities. The use of Firebase ML Kit for Optical Character Recognition (OCR) yielded consistent and precise extraction of text from receipts. In various tests, the OCR functionality reliably identified key information such as total amounts, itemized expenses, and dates, significantly reducing the potential for human error in data entry. This accuracy not only ensured that the financial data was captured correctly but also facilitated seamless integration into the real- time database for subsequent analysis.


**Figure 3 Login and Receipt Scanning Functionality**


**Figure 4 Search Activity and Dashboard Functionalities**

The user interface (UI) of the personal budget analysis system was designed with a focus on simplicity and ease of use, ensuring a seamless user experience. The login page, as shown in Figure 3 and Figure 4, provides a clean and intuitive layout, allowing users to efficiently enter their username, email, and password. Validation features ensure that all fields are properly filled before proceeding, contributing to a secure and error-free authentication process. On the main activity page, the "Capture Receipt" feature is prominently displayed, offering users an easy way to photograph and upload receipts. The UI guides users through the process with clear

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 10 October 2024
Page No: 2463 - 2469
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0337

instructions and well- labelled buttons, making the experience smooth and straightforward. Once receipts are captured, users are presented with a summary of the extracted information, including the total amount and itemized details, displayed in a clear, easy-to-read format. This enhances the user experience by providing immediate feedback and confirmation that the data has been successfully processed. The application also features a search functionality, allowing users to retrieve previously saved receipts or items. This feature is designed for quick navigation and retrieval of data, making it convenient for users to track and analyze their financial history. Furthermore, the integration of graphical visualizations in the reports section offers users an in-depth look at their spending habits, displayed in visually engaging charts and graphs. This intuitive design aids users in making informed financial decisions by presenting complex data in a user-friendly manner.

## Conclusion

The personal budget analysis system successfully delivers a user-friendly, visually intuitive, and efficient tool for managing personal finances. Through a well-designed user interface, users can seamlessly capture receipts, track expenses, and analyze their financial data with minimal effort. The integration of Optical Character Recognition (OCR) and real-time data updates ensures accurate and up-to-date financial records, while the categorization and reporting features provide valuable insights into spending patterns. By combining simplicity with powerful functionalities, the application empowers users to take control of their finances, make informed decisions, and ultimately achieve their financial goals. This project meets its objectives of providing a reliable, secure, and engaging financial management companion, making it a valuable tool for users seeking better control over their personal finances.

## References

[1]. Sabab, S. A., Islam, S. S., Rana, M. J., & Hossain, M. (2018, September). eExpense: a smart approach to track everyday expense. In 2018 4th International Conference on Electrical Engineering and Information & Communication Technology (iCEEiCT) (pp. 136-141). IEEE.

[2]. Kumar, V., Kaware, P., Singh, P., Sonkusare, R., & Kumar, S. (2020, September). Extraction of information from bill receipts using optical character recognition. In 2020 international conference on smart electronics and communication (ICOSEC) (pp. 72-77). IEEE.

[3]. Hezretov, M. (2021). Budget Tracker Highly Customizable Budgeting Mobile Application (Doctoral dissertation).

[4]. Yurochkin, D. E., Horoshiy, A. A., & Karpukhin, S. A. (2021, January). Development of an Application for Expense Accounting. In 2021 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (ElConRus) (pp. 753-757). IEEE.

[5]. Garcia, M. B., & Claour, J. P. (2021, November). Mobile bookkeeper: personal financial management application with receipt scanner using optical character recognition. In 2021 1st Conference on Online Teaching for Mobile Education (OT4ME) (pp. 15-20). IEEE.

[6]. Ngoh, G. J., & Darman, R. (2022). Money Management and Tracking Application. Applied Information Technology and Computer Science, 3(2), 442-459.

[7]. Lazic, M. (2020). Using Natural Language Processing to extract information from receipt text.

[8]. Koo, X. T., & Khor, K. C. (2023, July). Expense Tracking with Tesseract Optical Character Recognition v5: A Mobile Application Development. In 2023 IEEE Symposium on Industrial Electronics & Applications (ISIEA) (pp. 1-5). IEEE.

[9]. Shelke, S., Shingre, M., Lebisha, S., & Shaikh, S. (2023, October). Smart BAT-Smart Budget Analyzer and Tracker. In 2023 International Conference on Advanced Computing Technologies and Applications (ICACTA) (pp. 1-5). IEEE.

[10]. Wong, C. K., & Salleh, M. N. M. (2023). Personal Finance and Budgeting Mobile Application, “CashSave”. Applied Information Technology and Computer

International Research Journal on Advanced Engineering Hub (IRJAEH)
e ISSN: 2584-2137
Vol. 02 Issue: 10 October 2024
Page No: 2463 - 2469
https://irjaeh.com
https://doi.org/10.47392/IRJAEH.2024.0337

Science, 4(1), 1372-1387.

[11]. Garcia, M. B., & Claour, J. P. (2021, November). Mobile bookkeeper: personal financial management application with receipt scanner using optical character recognition. In 2021 1st Conference on Online Teaching for Mobile Education (OT4ME) (pp. 15-20). IEEE.

[12]. Neoh, D. K. S., Lock, E. C. M., Lew, K. H., Tang, H. Y., Tong, D. L., Tan, T. T., & Tseu, K. L. (2021, September). PictoText: Text Recognition Using Firebase Machine Learning Kit. In 2021 2nd International Conference on Artificial Intelligence and Data Sciences (AiDAS) (pp. 1-5). IEEE.

[13]. Odd, J., & Theologou, E. (2018). Utilize OCR text to extract receipt data and classify receipts with common machine learning algorithms.

[14]. N. G. Bourbakis, "Methodology of separating images from text using an OCR approach", IEEE Int. Jt. Symp. Intell. Syst., pp. 311-317, 1996.

[15]. “Money Lover: Budget Planner, Expense Tracker Apps on Google Play.” [Online]. Available:https://play.google.com/store/apps /details?id=com.bookm ark.money.

[16]. Nupur Sawarkar, Pranay Yenagandula, Devang Shetye and Prof. Shruti Agrawal, "Expense Manager: An Expense Tracking Application using Image Processing", International Research Journal of Engineering and Technology (IRJET), vol. 09, no. 04, pp. 2395-0056, Apr 2022.

[17]. Shivam Mehra and Prabhat Parashar, "Daily Expense Tracker", International Journal of Research in Engineering and Science (IJRES), vol. 09, no. 12, 2021.