

# A Novel Personalized Mobile Application for Systematically Monitoring Cash Transactions

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**Abstract-** Today many people face difficulties in having no proper method or technique to monitor their daily personal expenses, which finally lead to great wastage of money unknowingly. This has been a problem due to people's busy lives. They do not have time to manually record personal expenses and even if manual methods are there, they may not be efficient and reliable. At present, many systems to manage expenses exist such as web applications, mobile applications software, and other financial management systems. However, the question arises as to whether these applications give the required output for the user and if they are secure for the user to use. The proposed system works as a solution for this problem. With this system, the user can monitor financial expenses with the use of receipt images, without providing delicate information like credit card details or any other bank account details. Simply, the user does not need to link their bank or credit card accounts to analyze their transactions. The only thing needed to be done is to take an image of a receipt and upload it to the application. With the use of various image processing techniques, the text in the uploaded image is recognized and further processing is done to the recognized text to obtain details such as total cost, date of purchase, and receipt category. The user will receive a display of all these details in the mobile application and also an alerting system that would warn if one's expense goes beyond limit.

**Keywords:** *Natural Language Processing (NLP), information extraction, image processing, receipts, mobile application.*

## I. INTRODUCTION

Nowadays, the Sri Lankan people carry out a busy life working throughout the day. They do not

have time to focus on their daily expenses. Thus, they become more stressed out once they see their monthly or yearly expenses in bills. It has become necessary to have some sort of a financial tracking system with

them or they will face immense financial problems. So, they need a more efficient system that will automatically calculate and show their daily expenses to them. We can see a lot of such systems present now like web platforms, mobile applications, software, and so on. But most of them do not provide an effective solution for the user. Some apps keep track of sensitive data like credit card details, bank account details, and other financial information which the user may refuse to provide. The user may not feel safe to use such platforms though they automate the process of financial flow management and make their task easy. Also, in some apps, the user must enter all the transactions manually to obtain analyzed expenses results. It is a waste of time for the user. The proposed solution will not only automate the process of managing cash flow but also will safeguard the user's privacy. The user will not need to expose such sensitive data and can rely on it without any discontent. The app will only deal with snaps of receipts from the user as inputs and provide him/her with the analyzed expenses. This proposed solution is a mobile application that when a user uploads an image of a receipt, this app will convert the image into a text file using Image processing. Then using Information Extraction in Natural Language Processing, the specific information like total cost, date of purchase is extracted from the text and categorized into various categories as Food, Transport, Fuel, etc. The expenses for each category are shown and the user can even see the overall expense. The user can set a limit of

expenses that he likes to spend for a day, month, or year. Then if the expense for a particular day, month, or year goes beyond the limit, the user is warned about that. Some features like image uploader, letting the user customize his list of expenses, a dashboard to show analyzed budget spent daily, monthly, or yearly (also statistically in graphs), Notification tab to notify about over-limit expenses, and Category-wise view of budget spent can be seen in this app. The overall process is to input a receipt and to get the budget analyzed for the user to make reliable decisions.

## II. RELATED WORKS

Most individuals fail in achieving their financial goals and several methods are implemented to help them sort out their financial problems and to make precise decisions. Several works have been successful, but they still have their flaws, and their effects may dissipate in the long run. One such work is a mobile app using fintech nudges sends the recipients overspending messages and showing them how to manage finance. They alert the users through these messages of how much their spending on a particular date deviate from their usual spending patterns. This study states how the sending of these overspending message alerts will cause a change in household behaviors. The researchers use a regression discontinuity design to compare the overspending message recipients and non-recipient and find out that the recipients have reduced a significant amount of overspending on the next day of the use of this app than the non-recipients. The overall cumulative spending gap between these people has been increased by a two-day horizon according to what is stated by the researcher. But with the increase of days, this gap has been negative. The use of nudges as stated has affected much of the new users and the old, wealthy, highly educated people. Also, this effect has been spread from one app user to another app user in the same household. But this effect only long lasted until there is a lower likelihood of logging into the app. This work concludes that the power of nudges can be amplified if it is integrated with technological advancements when building the app (Lee, 2019). Another work 'Design and Implementation Money Management Web-Based Application for personal and family proposed for

CV.X' states about an easy and quick money management software for the Indonesian people. This software has 4 main features: Sub-account and transaction management, financial plan calculation, investment calculation, and money management and financial statement. The development process is done using a rational unified process framework. This is a cheap, fun, and smart way to manage personal finance and helps customers to reach financial goals by providing accurate information about personal finance (Mumpuni and Sukarno, 2014). 'Stulogger' a multi-functional application is a time and financial management application for students who are unable to plan their time and money simultaneously. It aims to improve student's knowledge and promote self-reflection which encourages the students to give attention to their time spent and allows them to track financial activities easily. It allows the user to set expenses and income from various categories like food, transport, etc. Other features like the availability of a calendar, notes, and reminders for the user to organize their daily activities. (Yeo et al., 2020) A Proposed System for Forecasting of Personal Cash Flow and Saving Prediction was studied upon, and the aim is to develop an interactive and effective application that will help the user to regulate expenditure and encourage them to save money. They aim to estimate the forward cash flow by obtaining information like personal regular and irregular historical financial data, future full or partial specific data, and they aim to estimate the dynamic date of when a person will reach the target for accumulation after a long term. In the first stage, to estimate the forward cash flow they have designed a fast microservice-based architectural system that collects instant data. In the second stage, they have adapted the most often used neural network algorithms and applications to estimate the dynamic date. This prediction helps the user to save their cash as well to plan a loan. Personal Financial application based on a hybrid mobile platform (utilize social media activity) is another application which is developed to help people manage their finances, utilize social media activity like update status photo sharing, location sharing as a trigger to record the financial transaction and support mobility of user online and offline. Using

HTML5 and web service, the developer can cut out wasted effort and build a cross-platform app that works on all current mobile devices, this technology is called a hybrid mobile platform. The process in this work is it records financial transactions and processes data into financial reports. The app can operate in iOS, android, windows phone, and web browsers. It uses social media sharing to share public content to social media while saving financial content automatically to the app database. Using this app users can monitor financial transactions and use their money in the right way. Future work proposed in this work is to develop personal financial analysis based on recorded financial transactions data to give users the best information and best advice on how to use money. The article (Gafrikova et al., n.d.) states about some mobile applications which serve as financial management apps. One app is 'Mint'. It manages cash flow, budgets, bills via computer, tablet, or smartphone. There is also a web platform and a mobile app for iOS and Android. On the signup page, the user must provide information about bank account and credit card. Features like allowing the user to store financial account information in one location, keeping track of their spending, creating budgets, setting up reminders, and accessing their credit score and credit report for free are present. This app automatically updates bank, credit card, and retirement account information and uses that information to make recommendations to find savings and unnecessary fees. Calculates average spending, displays pending patterns, adjusts budget to respond to actual changes. User can see their available cash and credit limits before paying bills, receive reminders to pay bills and schedule bill payments and receive alerts when account balances are low. Another app is 'Future Advisor' which offers to invest information on its website and mobile app. The goal of this app is to make investments management available to average investors. It also provides services for investing, retirement planning, college savings. Design and implementation of a personal cash flow program using MS Excel (Bhar, 2019) is another work which is an easy, highly intuitive method of tracking financial dealings, budgeting, and forecasting persona; financial expenditure using MS Excel. Following are the features it

provides:

- Aids in implementing financial strategies designed to meet specific goals based on percentages in specific categories.
- Can make predictions and build mathematical models
- Helps any business. Two main parts are there in this app: Money-in and money-out. Analyzing is done using graphical trends that summarize entries for a year. From the curves produced realized mathematical models. These models were then used for effective forecasting purposes, prediction helps in accommodating future expenses and sacrificing non-mandatory expenses, helping a person to achieve personal or cooperate financial goals. They recommend modifying this app with easy based on individual desires as future works. A Personal financial management system, method, and program using programming methodology (Wood, n.d.) is serving to model past and current spending and budgeting, It enables the user to match the current activities with the planned activities, then it identifies and corrects the differences and shortage in projected activities. It provides the user with a to-do list with reminders of pre-planned actions to be done. The objects represented in his are the entities like accounts, loans, assets/expenses, and financial activities like withdrawals, transfers, or deposits. The user can create customized objects to fulfill special financial requirements. The graphical user interface allows the user to create objects and place them on a graphical timeline providing a financial activity from all selected objects within a selected period. Another study was conducted on 8 financial apps; YNAB (You Need A Budget), Mvelopes, Mint, Quicken, CountAbout, MoneyDance, and Personal Capital. (Balance et al., n.d.) Here Mint was gone through on a paper mentioned above. YNAB is a solid budget practice teaching finance app. It allows the user to share budgets among multiple users as there is a function that lets many devices be connected at once like laptops, tabs, smartphones, and even can connect to Amazon Echo for verbal budget reports. This can run on Windows and Mac devices. It was designed for budgeting beginners. They provide signups for classes with live instructors for the people who need help. Also, there is an accountability partner to indicate a red flag if a person goes beyond the budget they created. Mvelopes is also an app that uses digital

envelopes to put your cash and mark those envelopes with what the cash is for. When the cash in that envelope is gone then the user cannot spend any more on that category. Example: - if the clothing envelope is consumed already the user cannot burrow it from the grocery envelope. When the envelope is empty the app will light up red. The user can sync to the bank accounts and credit cards. This app can be installed on both android and mac. Quicken is a bit old fashion app. It provides the usual management like an overview of your banking, credit card accounts, retirement, and investment, in one place, and keeps tracking your spending categories for you. CountAbout is a browser-based app and provides features like connecting automatically to a person's financial institutions and download the transactions and allows the customer to manually import transactions from other sites. MoneyDance is an app that provides many functionalities like helping the user to set a budget and sounding alarms when a bill is coming due. It allows the user to create charts and graphs for them to track their spending. It is compatible with windows, mac, and Linux. It keeps track of user's investments and alerts them about monthly changes in their total worth. But it is not appropriate for budgeting beginners and can deal only with more experienced personal money managers. Personal Capital is a software app that provides a lot of free tools. It allows the users to import transactions from various accounts. But it won't let the user create custom budget categories. Can create several charts for both spending and savings and do comparing of budget from one week or month to another.

### III. DESIGN AND IMPLEMENTATION

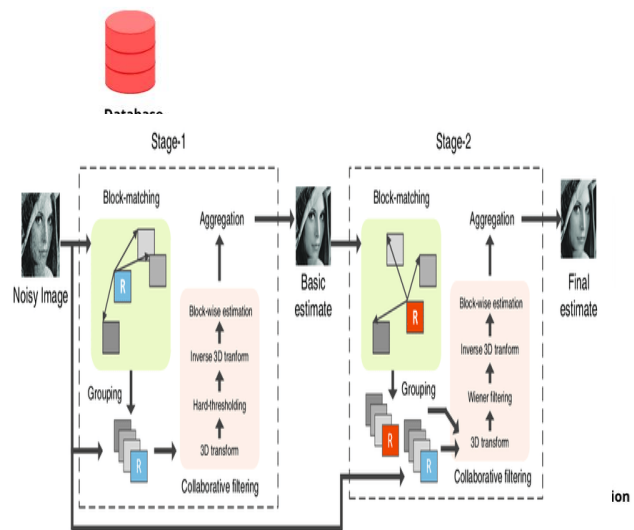


Figure 1. Overall System Design

#### A. Image Acquisition

In the proposed solution, the image of the receipt should be acquired from the mobile camera. The mobile application has an inbuilt camera and lets the user upload the image from the phone's gallery. Normally in image acquisition procedure, the optical signals are converted into electrical signals and then it is converted to digital signals to be readable by the digital device.

#### B. Image Pre-processing

Normally in the image acquisition process, various fluctuations may occur for the signal, and it may get disturbed by unwanted signals called noise. Here the resulting pixels may result in added values for their intensity. This reduces the quality of an image and becomes a barrier in the process of image detail recognition. Therefore, before further processing the image we should recover the original image to the best we can applying various image pre-processing techniques.

1). Denoising using Block Matching 3D Filtering: After a comprehensive research study (Alkinani and El-Sakka, 2017) done on noise removal techniques, we found out that BM3D (Block Matching and 3D) filtering is a good noise removing technique that can be used for the proposed research. BM3D filtering is comprised of 2 algorithms. The 1st algorithm is estimating the denoised image by doing hard thresholding in

the stage of collaborative filtering. The 2nd algorithm takes both the noisy image and the estimated image and applies Wiener filtering. In this stage, it matches blocks of the image with a reference block and stacks these 2D image blocks which are similar grouping them into a cylinder-shaped 3D array. Then for every group, filtering is done.

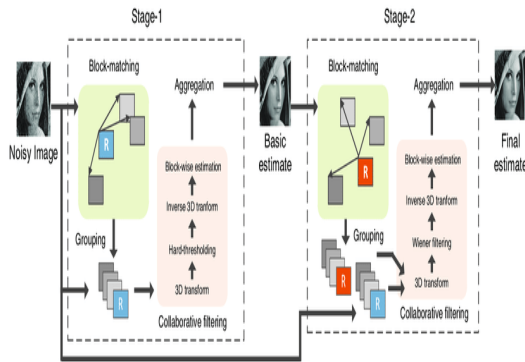


Figure 2. Working process of BM3D Filtering

Source: Internet

2) *Gamma Correction*: After an image is captured and displayed on a screen, its actual luminance is not shown on the display. Luminance is the brightness level taken by averaging r, g, b pixel values. To correct this, we have applied gamma correction.

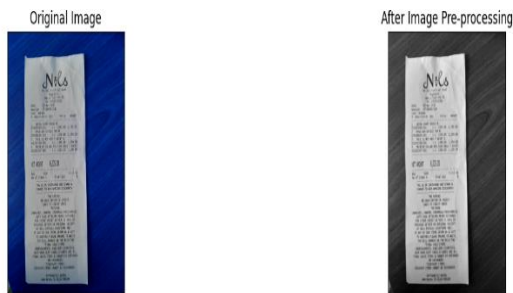


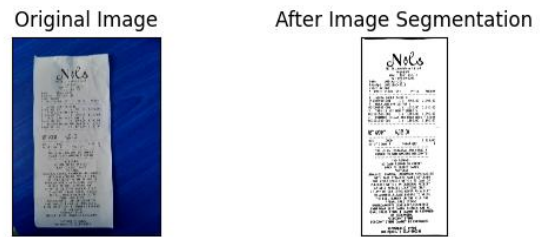
Figure 3. Original Image vs Image after Pre-Processing

### C. Image Segmentation:

The pre-processed image is then segmented to take the receipt object separate from the whole image. This makes the task of text recognition very efficient with fewer barriers. To do this, first,

edge detection should be performed. Then We have used Canny edge detection because it is a multistage algorithm that can detect many types of edges. Afterward contour detection is applied to the edge detected image to identify the receipt. An assumption was made when doing this. The receipt is having four corner points and it is the largest rectangular object in the image. Lastly, before cropping out the image, perspective transformation is performed to prevent any misalignments

Figure 4. Image after segmentation of the image.



### D. Text Detection and Recognition

1) *Optical Character Recognition (OCR)*: Here the process followed in OCR is, transforming 2D images into text that can be read by a computer. We have used Tesseract-OCR which is an OCR tool that has been developed using deep learning technologies and upgraded with the latest comprehensive research done in OCR.

### E. Receipt Categorization and Information Extraction

Using the Natural Language Tool Kit (NLTK), the extracted text in the text files can be processed to extract out the relevant information we needed like the total, date of purchase, and receipt category. The first step is to remove all the unwanted characters from the text file like special symbols. Then the text is sentence tokenized and then word tokenized. After this, all the words relevant for different categories that can be found commonly in each category are put into arrays which are defined for each category. We are using three categories in this research as Grocery, Clothing, and home appliances. Then for each receipt, it matches the tokenized words of a new text file of that receipt with those arrays and identifies for which category it belongs to. The total amount is taken by getting all the floating-point numbers are into an array from the text file and selecting the largest one out of it. If any discounts are given, it is subtracted from that

total value to get the net amount. The date of purchase is extracted with the use of regular expressions.

#### F. Database

The database which is going to be used is firebase. The image is stored in this database after acquisition. Then it is accessed from the database to do further processing. The result is also stored in the database.

#### G. Output

Following is a sample image taken to test the results and its results are also displayed below.

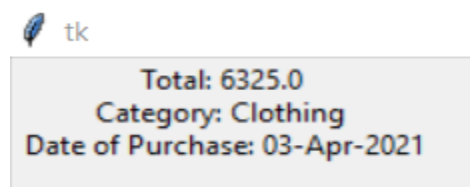


Figure 5. Results after extracting total amount, category of receipt and date of purchase from a receipt

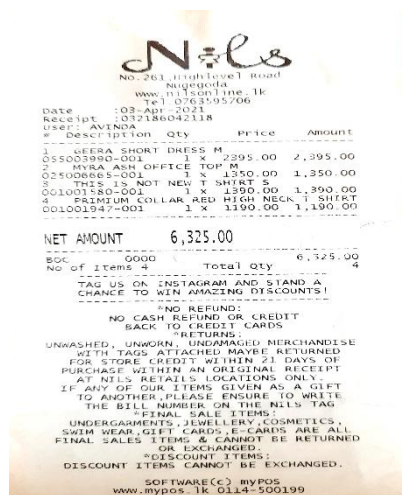


Figure 6. Receipt image from which the results were taken

### IV. CONCLUSION & FURTHER WORKS

This paper presents a solution for the personal cash monitoring problem faced by people. From an image captured from the phone camera, the receipt object is recognized and extracted through image segmentation. Here the main aim is to detect and extract the relevant information like the total amount, date of purchase, and category to which the receipt belongs. The main

techniques used here are image processing, Optical Character Recognition, and Natural Language Tool Kit (NLTK). To build the mobile application Android studio is used. The user can get an effective interaction as the interactions can be done using a mobile app. There are some limitations in this research work. The first one is that there is no finance guidance given to the user. The user can only monitor their transactions. Secondly, the app is made only for personal use and will not be suited for businesses. Another limitation is that there is no web application for this mobile app. As further works, we would recommend improving this mobile application with many more categories for receipts and also improve the above-mentioned limitations.

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