Project ePera

By: Pratye Aggarwal

I. Abstract

Wallets are an integral part of our daily lives. They make it easy for us to carry cash and credit/debit cards. There are countless pickpocketing incidents, which have become a big concern in our daily lives. Paper notes are also prone to falling onto the ground in modern wallets when the wallet is folded without the owner's knowledge. The deterioration of leather mainly causes this. The notes are prone to unnecessary wear and tear due to the wallet's constant folding and unfolding. To address such concerns, we developed the **ePera**, the smart wallet. The intelligent wallet offers utilitarian features such as on-the-go digital payment, payment tracking, and connectivity with online banking, among others. Not only this, but it also uses the latest technology of Blockchain to match the Next Big Technologies coming to the world.

II. Research

Objectives

Wallets store cash, cards, and important documents like our driver's licenses, Aadhar card, and other kinds of personal identity. As a result, losing our wallets may be a frustrating experience. According to the Times of India, wallet thefts in Mumbai, India, increased from 654 to 19,458 in 2018. Our team created ePera to address the concerns listed in the problem description while providing the customer with an easy purchasing experience. The wallet seeks to be financially feasible, user-friendly, and long-lasting.

Our prototype is built to cover the following objectives:

1. Cash count: The cash count system will count the cash the user puts into his wallet and give information about it on a small screen attached to the wallet and the app.

2. Transaction records: The wallet will automatically generate records for our previously spent money and show it in the app.

3. To prevent pickpocketing: The anti-theft system comprises different mechanisms to identify and notify the user about any pickpocketing.

4. Easy transactions: Security features like fingerprint recognition and encryption help keep the whole process easy as well as secure. At the same time, contactless payment gives an added advantage to the user.

5. Blockchain: Uses Blockchain to store all sorts of transactions that take place through the wallet.

6. Low Power Consumption: We have designed ePera to adapt its screen brightness and enter low power consumption mode when not in use.

7. Encrypted ID cards: Important documents like aadhaar card and PAN card will be safely encrypted 1 way using the mobile app.

Proposed solution in detail

The Wallet

Our wallet uses the Raspberry Pi Zero microcontroller, which controls the various sensors for our different modern mechanisms. A Lithium polymer battery powers the system. The battery can be charged wirelessly. The wallet has been designed to store cash which can only be accessed by the people whose fingerprint has been saved before. A camera has been used to identify the color of the paper notes as well as their serial number and therefore identify how much money has been put into/taken out of the wallet. A screen is attached to the wallet that will display basic information about the current available balance and the previously spent amount.

Tracking and anti-theft

A GPS module will be used to assist the anti-theft system as well in finding the misplaced wallet. Sensors like buzzers help in notifying the user in such cases. The users are also notified on the mobile app. The mobile app enables the user to customize its different settings like credit/debit card information, fingerprint settings, and trusted places; the wallet is not at threat of pickpocketing like at home.

IoT interface

The app and wallet are connected using IoT (Internet of Things). This allows the two to transfer information in real-time, without any discrepancies. The app provides a "Find My Wallet" feature which tracks the wallet in real time and helps to locate it when lost. The transactions are made more accessible and faster using the Bluetooth module that uses the power of NFC for contactless transactions.

Payments and Finance

Cash and paper notes are the primary mode of payment. The main compartment has been kept to hold an appropriate amount of cash along with a separate small coin compartment which might come in handy at petrol pumps, ration shops etc.

The wallet also allows the owner to pay through credit/debit cards by the mode of NFC i.e. the owner won't have to carry the card while being able to access and pay through them as and when needed.

Payment can also be done through UPI apps like Google Pay, Paytm etc. via QR code scanning. A camera module is incorporated, connected to the microcontroller for this purpose. The owner of the wallet can use any UPI platform after connecting it to the mobile app. This allows for nearly all possible payment methods and provides the user with a lot of options.

Security implementations

ePera has been designed with security as one of the apex priorities. By adopting proper security practices and safe authentication methods, one can prevent unauthorized access to the wallet. Our prototype uses the following authentication methods:

1) Username and password PIN: It is one of the most popular methods of authentication. A user can register their wallet through the iwallet app and set a secure username and pin

2) Digital Certificates: A digital certificate is an important aspect of the device. It proves the device's authenticity through PKIs and cryptographic methods. This will help only registered devices to connect to the network.

3) Fingerprint recognition: Biometric forms of identification are an easy to use method of authentication. Using the latest technologies we can help users access their devices on the go securely.

4) Each wallet stores a digital certificate and allows us to uniquely identify the wallet and to avoid fraudulent requests that can be made using the account or the wallet. PKA allows us to further encrypt the messages.

5) The Bluetooth interface for ePera uses v5.2 of the Bluetooth wireless communication standard. Once the devices have been connected, the host initiates link-layer encryption (eg: AES 128 block cipher protocol). This ensures that communication is not done in plain text and to preserve message integrity.

We use secure and tested 3rd party libraries and APIs for initiating UPI payments. All transactions use standard cryptographic methods such as SHA-256 and SHA-512

Blockchain

The blockchain is a distributed database that is shared across computer network nodes. Blockchain is like a database that saves information electronically in digital format. They are well recognised for their critical function in cryptocurrency systems such as Bitcoin in keeping a secure and decentralized record of transactions. The blockchain's novelty is that it ensures the accuracy and security of a data record and produces trust without the requirement for a trusted third party. This technology can dramatically impact the security when integrated into the smart wallet.

One of the primary tasks accomplished by our wallet is to keep track of the transactions made by the user in paper currency. This task requires proper security features so as to protect it from cyber crimes. Not only this, but the chances of our wallet being a target of pickpocketing also increases due to the cash count feature. The Blockchain gives a surety to such problems. By storing the transaction details on the blockchain, the chances of such issues nullify.

The data stored regarding the transactions consist of the serial number of the note as well as its value and the wallet ID of the person who is giving and taking that note. This keeps a track of the notes that the government issues as well as helps in reducing the problem of black money. Every note registered on the blockchain network will have its associated history, starting from its first registration on the network. The first registration will usually be done by the paper currency issuing department (RBI in India). This will make it difficult for people to work in Black Money, hence reducing corruption.

Novelty of approach

Our team has built ePera in alignment with our larger aim of delivering an innovative and secure wallet. The wallet makes use of some of the most advanced technology in a small form factor, while giving it a futuristic look. No modern-day wallet has ways of keeping the stored money and credit cards safe while keeping track of where and how much money is being
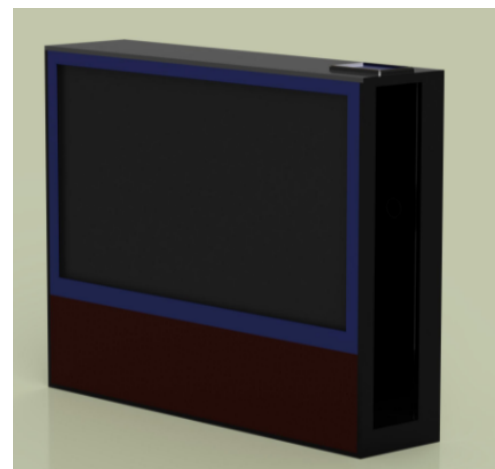
spent. While at the same time, it provides a direct and convenient user experience through the use of modern technology.

Credit/debit cards can easily be stolen in modern-day wallets without the owner getting a single hint about it. Our prototype provides a way to pay through credit/debit cards without the owner carrying the card itself. Hence, the owner does not have to worry about his/her credit card being stolen. The mobile app gives the user many options and features. The Encrypted ID Cards feature comes as an advantage over the conventional wallets. The user would not need to carry his or her ID Cards at all places and the hassle of misplacing them completely finishes.

No modern day wallet allows for UPI payment. Using ePera, instant transactions can be made through popular UPI platforms. This never-before-used feature gives the wallet great versatility and covers all fronts of payment. This allows the owner to pay any way he/she likes.

The transaction records are safely stored on the blockchain network while the users can easily access their previously done transactions via cash or digitally. The whole economy becomes even more transparent within the public people as well as the government. The government will be able to keep a close eye on corruption. While government officers can now be questioned regarding any sought of bribery or any other malpractices.

Most electronic devices require external charging ports with wired chargers, while ePera also gives the option of wireless charging. This means that the wallet can be charged hassle free using a wireless charger as well as via a Type-C cable.

Technical Report
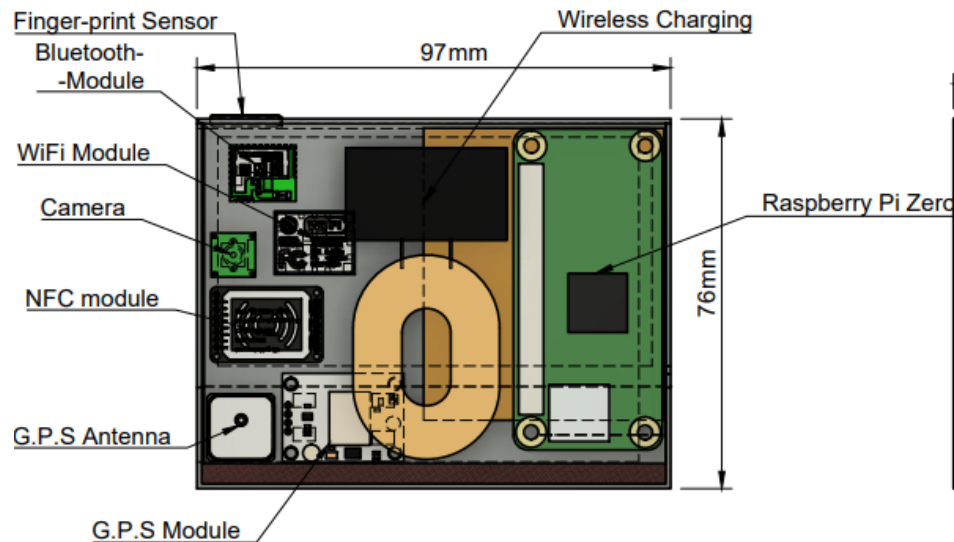
ePera is a light and compact wallet which can very well fit into people's pockets just like any other regular wallet while carrying it's features backed by modern technology.

Descriptions of Concepts

Wallet Specifications

A. **Material**

The smart wallet has been designed to be comfortable, productive and strong. The body of the wallet uses a carbon fiber sheet as primary material. The fiber sheet provides high tensile strength while keeping a lightweight and sleek design. Due to its crystalline structure the carbon fiber proves its formidable strength and longevity to keep the wallet durable. Studies show that while carbon fiber responds to weather conditions in different settings, in the long run, the effects are negligible on the scale of a pocket wallet. Since the material shows low thermal expansion, the wallet's shape, area and volume remain consistent.
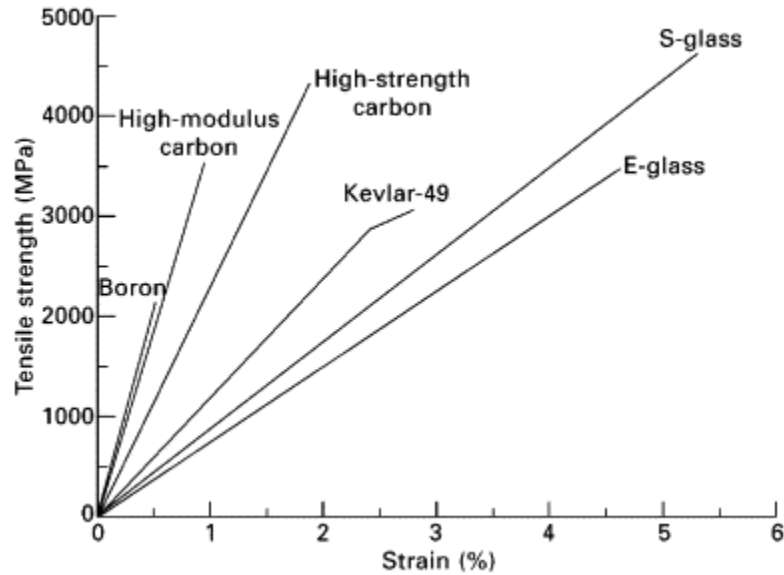
Stress Strain Curve of Fibers

Other popular materials include leather and different metals. While leather wallets are cheap and widely available they are thick and bulky and not resistant to water. Overtime, leather wallets start wearing out and lose their strength. On the other hand, metal wallets are heavy and can tear fabric or leave scratches on other surfaces. Carbon fiber is a cheap alternative to other materials and provides additional features such as a wide range of color choices.

B. **Dimensions**

Our wallet aims to be compact yet easy to use. The wallet measures 97 x 76 x 23.07 mm.
The thickness of the wallet is kept to a minimum while keeping necessary features such as cash storage, GPS and bluetooth modules, battery, buzzers etc. The back of the wallet includes a coin compartment accessible through an easy open and close zip mechanism (as shown below).

The wallet is incorporated with a 1.33mm x 10.1mm screen providing an easy interface for initiating payments and checking information on the wallet.
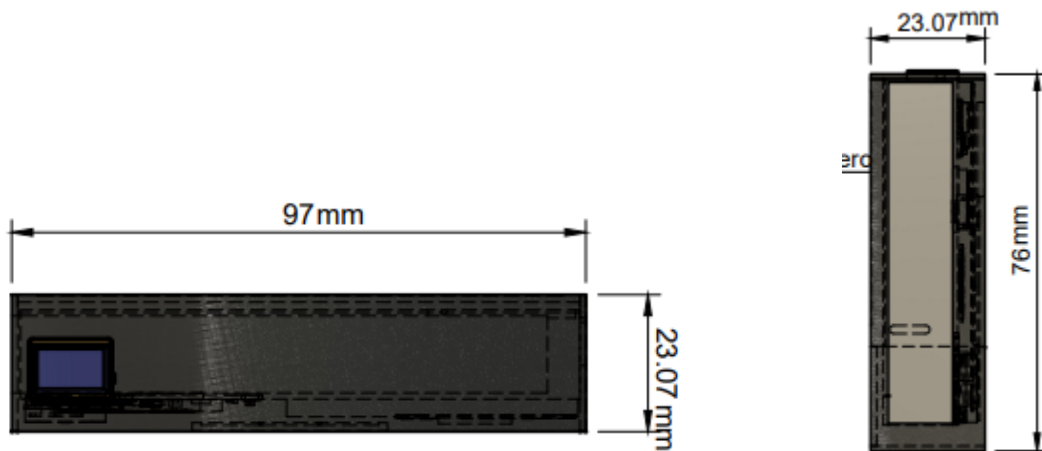
IoT interface and Mobile Application

A mobile app has been built which is directly connected to the wallet. The app stores the owner's past transactions data and important banking details. This enables the owner to keep important documents with him/her without having to carry them, relieving him/her from the tension of them getting stolen from their pockets. Screenshots of the App:
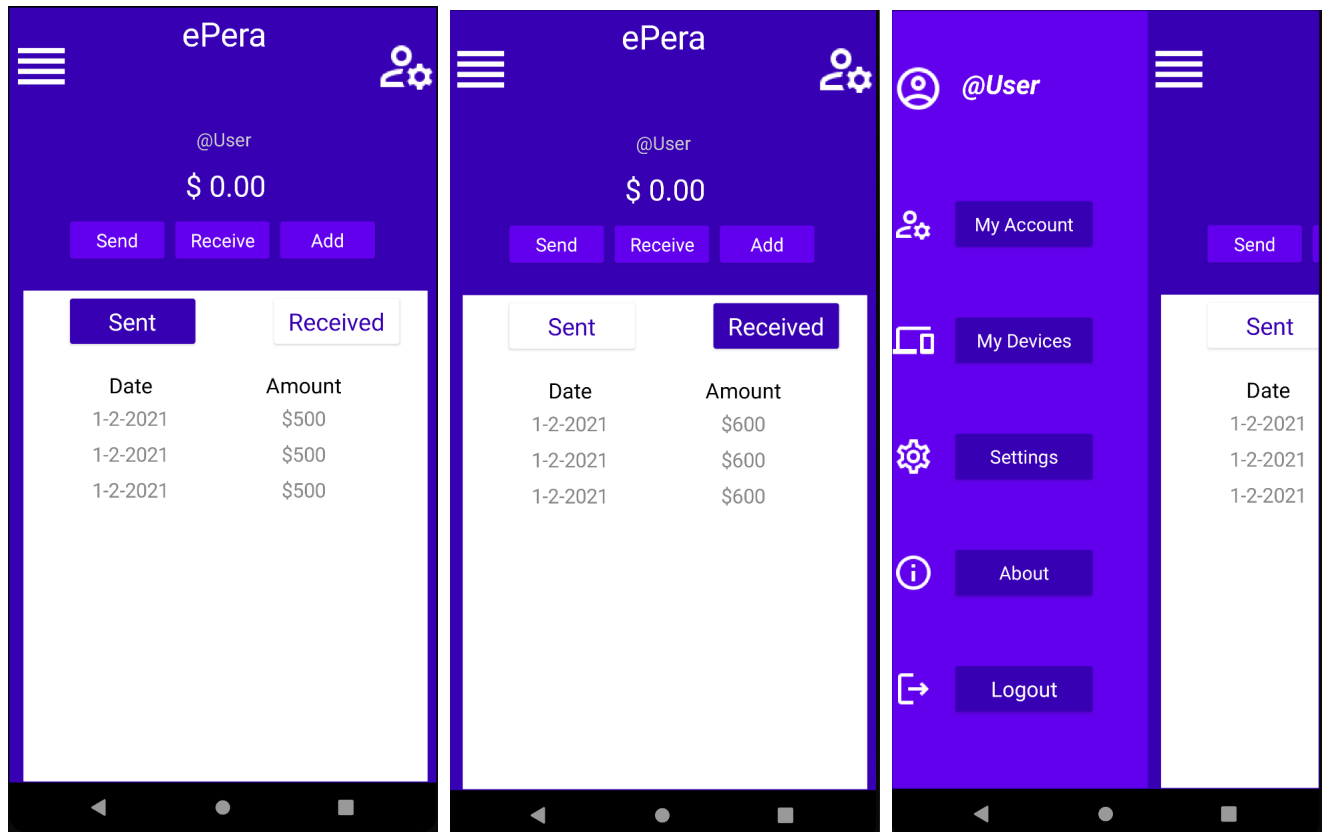
A powerful Bluetooth Module (compatible with the microcontroller used) allows the user to make cashless transactions while having the phone and wallet connected through bluetooth. By the help of bluetooth, wifi and NFC (Near Field Communication), the app contents get loaded to the LCD screen on the wallet, allowing the user to access encrypted ID cards, credit/debit card details etc whenever needed. The mobile app also contains a section which has all relevant tutorials and instructions for operating the wallet and can be accessed anytime when needed.

Location Tracking and Anti-Theft mechanism

A GPS module allows for location tracking and assists the wallet-app interface in keeping record of past monetary transactions. Also, it helps keep track of any robber who manages to escape the owner and police while stealing the wallet.

If the wallet is anywhere beyond the 2 meter radius of the person in a non-trusted place, the buzzer automatically starts buzzing which alerts the owner of theft. At a trusted place, the mechanism is automatically deactivated.

Payment Mechanisms

Payment can be made through the following methods:

1) Cash: The wallet has a compartment where the owner can put cash and use it to make everyday payments. The compartment opens when the owner scans his/her fingerprint by pressing his/her finger on the fingerprint sensor.

2) Credit/debit cards cashless (through NFC): The Tap To Pay technology uses NFC to make the payment process more easy and hassle free. On taping or hovering the NFC-enabled smart wallet near a contactless PoS, encrypted data is sent through radio waves, and payment is completed.

3) UPI softwares: The app allows the user to connect any third party UPI app for making payments. The wallet contains a camera sensor connected to the microcontroller via the camera port for scanning QR codes.

Security Analysis

ePera implements a secure payments interface and wallet access. The ePera mobile application requires wallet registration through email or phone number. After registration, the

wallet is paired to the mobile device using Bluetooth. The mobile application has a pin / fingerprint option for logging in.

A digital certificate is an important aspect of the device. It proves the device's authenticity through PKIs and cryptographic methods. Each wallet will have a digital certificate and allows us to uniquely identify the wallet. Digital certificates create a unique endpoint for the wallet so that no fraudulent requests can be made using the account or the wallet.

The Bluetooth interface for ePera uses v5.2 of the Bluetooth wireless communication standard. Once the devices have been connected, the host initiates link-layer encryption (eg: AES 128 block cipher protocol). This ensures that communication is not done in plain text and to preserve message integrity.

We use secure and tested 3rd party libraries and APIs for initiating UPI payments. All transactions use standard cryptographic methods such SHA-256 and SHA-512. Additionally, the mobile application provides a "lockout" mode, which disables access to the wallet if stolen.

Power Consumption

Lithium Polymer batteries have a decent lifespan if used properly. The Lipo battery used provides enough power for all the systems to run efficiently without disruptions. They can be charged really quickly.

When the user goes to a "trusted" place that is; somewhere where there is no threat of robbery and theft (for example to a relative's house), the anti-theft mechanism automatically stops working, reducing the load of the battery and therefore saving power and allowing to maintain optimal performance for as long as possible.

While not in use, the LCD doesn't consume any battery power thereby leading to minimal power consumption when inactive, also reducing the load on bluetooth and wifi modules.

Components and Modules

Finger Print Sensor
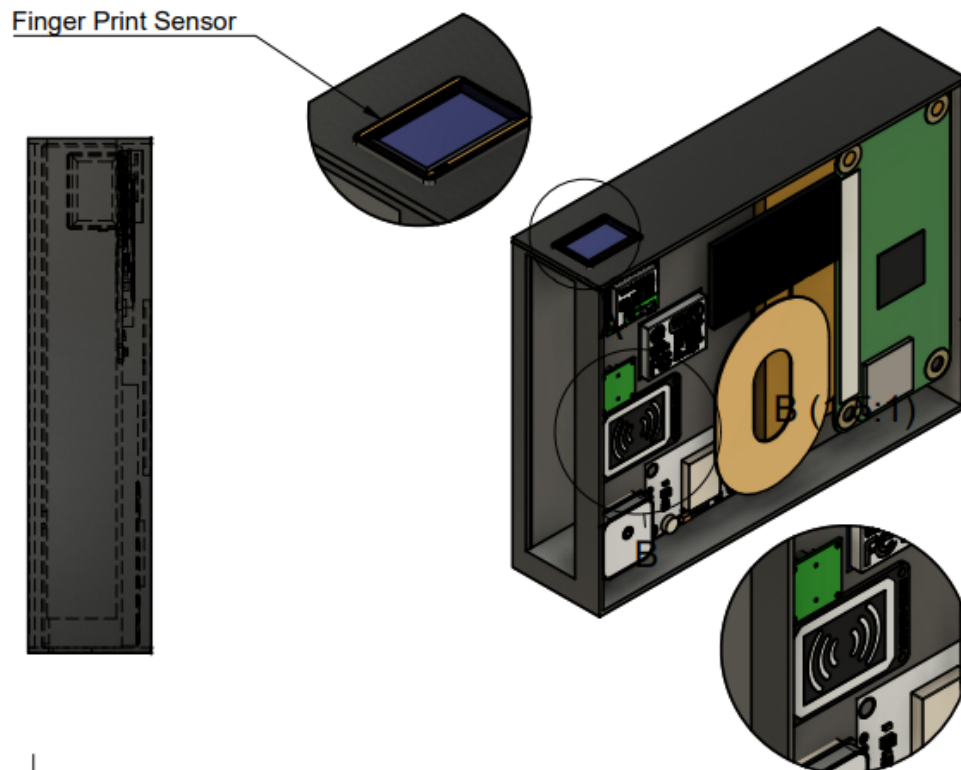
The wallet consists of the following components(all listed prices are in wholesale market value which may vary from other websites and may not include shipping cost):

1) TFT IPS LCD display: It is a touch multi color graphic LCD display with a 4.3 inch diagonal length as well as an impressive HDMI display of 800 x 480 pixels specifically made for Raspberry Pi. It has a 24-bit RGB interface capable of displaying over 16,000,000 colors. It also supports upto 5 points capacitive touch control through the I2C touch screen interface. It has dimensions of 106 x 68 mm and weighs merely 90 grams. It costs INR 233 per piece.

2) KP-045060 Lipo battery: This is one of the most crucial components along with the microcontroller. This battery is very thin, light and powerful, having a voltage rating of 3.7 volts and capacity of 2000 maH. It has wide industry applications such as MP4 players, DVDs, bluetooth speakers and IoT to name a few. It can be recharged using a Li-ion charging module. It has an approximate size of 60 x 50 4 mm. It is highly cost effective costing only INR 74 per piece.

3) TP4056 Li-Ion battery charging module: It is a tiny Type C battery charging module which offers 1 Ampere charge current and is perfect for charging a battery with voltage rating of 3.7 volts and maH rating of 1 aH or higher. It is based on the TP4056 charger IC and DW01 battery protection IC. When the battery voltage drops below 2.4 volts the protection IC switches the load off to protect the cell from running at a dangerously low voltage. It also gives protection against over- voltage and reverse polarity. It usually destroys itself instead of the battery. It has dimensions of 25 x 6 mm(height) and is very light when it comes to weight (20 grams only). It costs only INR 58 per piece.

4) Raspberry Pi Zero: This microcontroller is the backbone of the project. It has onboard bluetooth along with wireless internet and is perfect for purposes such as prototyping. It carries a BCM-2835 1GHz processor 512 mb RAM. It also has a CSI camera connector which has been utilized to connect the camera sensor in order to execute UPI transactions. It uses bluetooth 4.1 which helps establish a wireless connection between the mobile app and the wallet. It has composite video headers with a 1080p video output. It doesn't consume a lot of power and has a weight of 9 grams. With so many mesmerizing features, it costs only INR 150 per piece.

5) G5 Ultra-slim wireless charging module: This modern super-light and compact module enables the wallet to charge wirelessly with a voltage rating of 5 volts. It measures nearly 70 x 46 mm and costs merely INR 80 per piece.

6) NEO-6M GPS module: This module makes use of modern technology to give accurate and reliable positioning information along with a high sensitivity for indoor applications. It also has a built-in 25 x 25 mm built-in GPS antenna with a UART TTL socket. It also has a battery for power backup, hence reducing the battery load along with EEPROM for storing configuration settings. It is also possible to set custom configurations between 4800 Baud to 115200 Baud rates. These features make it one of the most important components of our project. It is highly cost effective as well costing merely INR 320 per piece.

7) UYS NFC module: This powerful module enables the wallet to execute cashless transactions in which communication protocol is byte oriented. It has a ARM Cortex M0 core running upto 50 MHz. It supports low power idle mode which helps save battery power. The transmission speed for this module varies from 19200 to 115200 bps. It can be stored intact in the temperature range of -40 to 85 degrees Celsius. It has 32 KB flash memory for program memory as well as configurable flash memory for data memory. With all of these features, it is highly economical costing only INR 440 per piece.

8) Camera sensor: The Raspberry Pi 5 mp camera has been used in the UPI and blockchain sections. It is an add-on to the Raspberry Pi Zero microcontroller and hence is ideal for the project. It makes use of the dedicated CSI interface. The CSI bus exclusively carries pixel data at extremely high data rates. Also, the camera is capable of capturing 2592 x 1944 pixel static images along with supporting 1080p30, 720p60 as well as 640x480p60/90 video. Since it is an add-on to the Raspberry Pi microcontrollers, it directly connects into the camera ports and doesn't require an adapter. The board is very small, having dimensions of 25mm x 23mm x 8mm while costing only INR 290 per piece.

9) HC-05 Bluetooth module: This powerful bluetooth module has been used in our project in order to establish safe and secure wireless connection with the mobile app. It can operate at any frequency up to 2.4 GHz and has Gaussian Frequency Shift Keying (GFSK) modulation. The security features like authentication and encryption allow for safe wireless connections. It also has decent emission power and sensitivity making it a very important component. It consumes minimal power and has wide industrial applications. It is a very small module with dimensions of 26.9mm x 13mm x 2.2 mm and costs merely INR 200 per piece.

10) ESP-01 ESP8266 Wifi Transceiver module: This module has been used so as to establish wifi connections which will be handy for making cashless transactions. It gives microcontrollers access to wifi connections through an integrated TCP/IP integrated stack. The pre-programmed ESP 8266 module helps in establishing safe Wifi connections. It has negligible standby power consumption along with 1 MB flash memory. This tiny module has dimensions of 25 x 15 x 11 mm and costs merely INR 120.

11) Active buzzer module: The buzzer plays a key role in alerting the user about theft. It is very small sized with PCB dimensions being 34.28mm x 13.29 mm x 11.5 mm. It costs only INR 30 per piece.

12) CAMA SM27 Fingerprint sensor module: This is one of the key components of the project. The wallet can be unlocked only upon finger detection on this module. It gives enough space for a person to scan the fingerprint and unlock the wallet while costing only around INR 80 per piece.

13) ROB-09454 phototransistor module: This powerful module is crucial for the cash count system It is also very light while costing only INR 221 per piece.
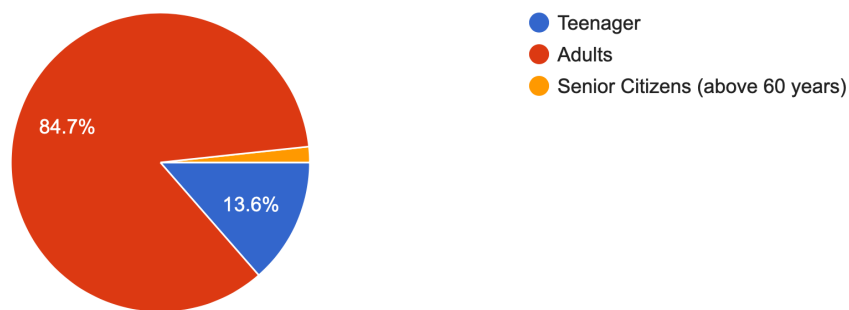
Cost Analysis

S. No	Component Name	Per piece cost	Quantity(per wallet)	Overall component price
1	LCD	₹223	1	₹223
2	Lipo Battery	₹70	1	₹70
3	Lipo Battery charger	₹58	1	₹58
4	Raspberry Pi Zero	₹150	1	₹150
5	GPS module	₹320	1	₹320
6	NFC RFID module	₹440	1	₹440
7	Bluetooth module	₹200	1	₹200
8	Wifi-Lifi sensor	₹120	1	₹120
9	Buzzer	₹30	1	₹30
10	Wireless charger module	₹80	1	₹80
11	Camera sensor	₹290	1	₹290
12	Fingerprint sensor	₹80	1	₹80
14	Phototransistor (reflector)	₹221	1	₹221
Total components price for 1 prototype				₹2282 (approximately)

Results

In order to get a better understanding of the market and the people, we planned to do a survey. The survey gave us better insights on the different aspects of what type of features would people like to have in their smart wallets and whether the features we are providing will actually help them or are redundant for them. We used Google Forms as a mode of survey and we got over 50 responses in total.
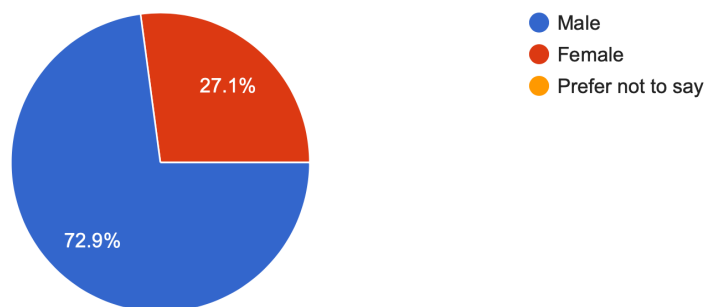
Age Category:

59 responses

- Teenager
- Adults
- Senior Citizens (above 60 years)

84.7%

13.6%

Gender:

59 responses

- Male
- Female
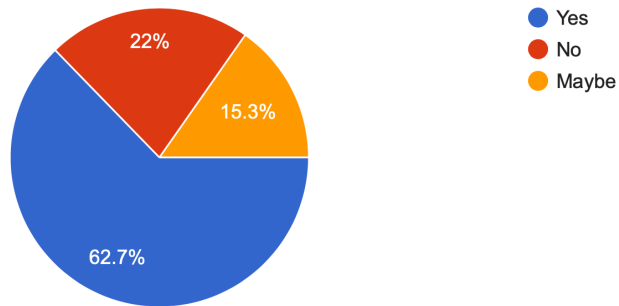- Prefer not to say

27.1%

72.9%

The above Pie-Charts gave insights to the age category and the gender of people we will be catrotring. As estimated, the majority of people buying and using our wallets will be adult males along with a few percent of teenagers and female buyers.
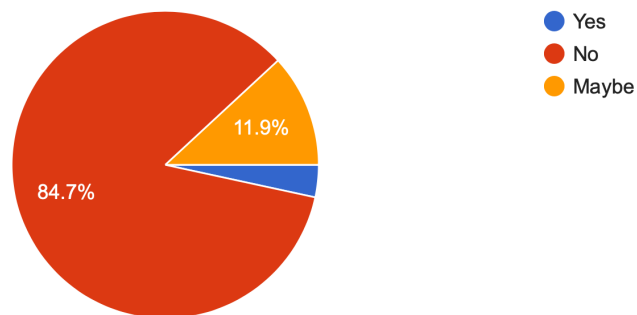
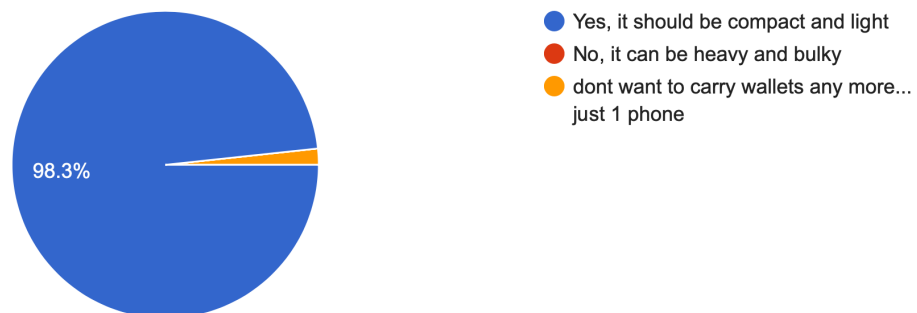## Would you like a coin compartment in your wallet?
59 responses

- Yes
- No
- Maybe

22%
15.3%
62.7%

Would you like ads (posters) in the corner of the screen?
59 responses

- Yes
- No
- Maybe

11.9%
84.7%

Would you like your wallet to be light and compact?
59 responses

- Yes, it should be compact and light
- No, it can be heavy and bulky
- dont want to carry wallets any more... just 1 phone

98.3%

Problems Faced

1) Income through Ads: The blockchain network has regular rates for using this technology. These rates are minimal and can be fulfilled by the income generated through the Ads. But as seen in the Pi-Charts before, over 84.7% of the people chose the option of not having any Ads in the app or the wallet screen. Hence, we came up with the idea of showing ads as the background of the wallet. Inspired by the Awards feature of the Brave Browser, we decided to use this as a solution to two problems, that is, Wallet UI and Blockchain Technology Rates.

2) Inclusion of coin compartment: There was an unsettled debate amongst teammates on whether to include coin compartment or not. It was decided to put this question in the survey conducted and received a positive response. Therefore, it was decided to put a separate coin compartment enclosed by a zipper.

3) Encrypted ID cards feature: Initially it was decided that important documents such as aadhar and PAN card be encrypted 1 way by the help of the mobile app. The fact that this would give people a way to employ fake aadhar cards etc was not taken into account and hence, this feature was removed and a separate compartment was allocated for this purpose.

4) Potential Features: There were a couple of great features that we would have wanted to add to the Wallet, making it even smarter and futuristic. Features related to health and fitness had great potential. But, if we see how a normal person uses a wallet, features like these won't work. For the proper working of Health Features, it is necessary that the wallet stays with the person the whole time. Unlike mobile phones and Smart Watches, the wallets are put aside at a safe place on reaching the home or when someone goes for a walk. This stopped us from adding such prominent features.

Pros and Cons of the wallet

Pros

1) Considering all the features of the wallet, the wallet is very light and compact which can fit into any pocket which is slightly larger in size than a regular pocket.
2) It is highly cost effective with total components cost being around INR 2300, being much more buyer-friendly as compared to any other such product in the market.
3) It has an effective anti-theft system which keeps the owner's money protected.
4) It has all modes of payment including cash, credit/debit card and UPI transactions.
5) Uses Blockchain to secure store transaction data.
6) Helps in solving the problem of Black Money.

7) Non foldability makes sure that the notes don't get torn which happens due to rigorous folding and unfolding of current generation wallets.

8) The inclusion of a free screen guard protects the screen in case the wallet falls from the owner's hand.

9) Super low standby power consumption accounts for efficient battery performance and high durability.

10) Both wired and wireless charging capabilities are there which improves the user experience of the product.

11) The wallet is spacious and provides enough space to carry more than 50 notes in the cash compartment.

Cons

1) Due to the use of cutting-edge sensors and modules, the wallet is non foldable which might impact user experience.

2) Even though the wallet has been kept as light as possible, it is much heavier than current wallets due to the use of components like microcontrollers and Lipo batteries.

3) If the wallet falls inside a non anti-theft zone and gets crushed by a car/truck tyre or someone's foot the components can easily get displaced and there may even be a need to buy a completely new wallet.

Analysis

We performed extensive analysis of ePera on several parameters such as stress-strain and durability. The following are the results:

According to a research done in 1962, the average sitting pressure of a person is approximately 13,789 Pa.

Our model has been simulated to handle pressure and force for most real world scenarios.

The simulation was done using AutoDesk Fusion 360 with the appropriate values of moduli of carbon fiber..
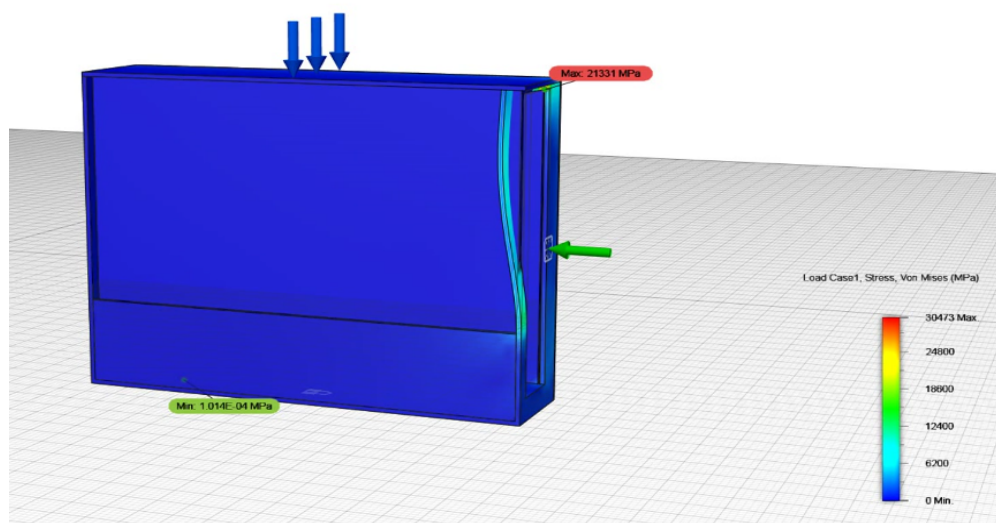
Resources:

Github Repository for source code: https://github.com/Pratye/iWallet-Techfest-ePera

Video link for the stress-strain simulation:
https://drive.google.com/file/d/1vNVYk3V6roIdPmSIE-d4uXNn1Vy_b_Hv/view?usp=sharing

References:

1. Tgprc. (n.d.). *An overview of advanced fiber reinforced POLYMER COMPOSITES and its applications*. TJPRC. Retrieved September 21, 2022, from http://www.tjprc.org/view_full_paper.php?id=10551&type=html
2. Acosta, G., & Netguru. (2021, August 25). *5 ways to create a safer bluetooth connection*. Custom Software Development. Retrieved September 23, 2022, from https://www.netguru.com/blog/5-ways-to-create-a-safer-bluetooth-connection
3. Wikimedia Foundation. (2022, January 19). *Carbon fibers*. Wikipedia. Retrieved September 23, 2022, from https://en.wikipedia.org/wiki/Carbon_fibers

Parts and Components:

4. https://electroniccomp.com
5. https://robokits.co.in
6. https://amazon.in
7. https://flipkart.com
8. https://alibaba.com
9. https://robu.in
10. https://thinkrobotics.in
11. https://digikey.in