Testudo Bank Cryptocurrency Feature

Owners: Adithya Solai (adithyasolai7@gmail.com), Hrishik Rajendra (hrishik@terpmail.umd.edu)

Problem Statement

Customers of Testudo Bank are currently limited to transactions in US Dollars. As digital currencies are gaining more popularity, customers at Testudo Bank would benefit from a service that enables them to invest their money in popular cryptocurrencies. This service would help create an influx of younger customers who wish to start building their cryptocurrency portfolio at Testudo Bank.

Solution Requirements

- Customers should be able to buy cryptocurrency using the account balance.
- Customers should be able to sell cryptocurrency, and the appropriate amount should be incremented in the user's account balance. If a user is in overdraft, the cryptocurrency sell should immediately contribute to paying off their overdraft balance instead of going into the user's main account balance.
- Customers should have a place on the Testudo Bank application front-end to view the current price of Cryptocurrencies supported by Testudo Bank, as well as the current US dollar value of their cryptocurrency holdings.
- Customers should be able to view their Crypto trade history in the front-end.
- Customers should not be able to go into overdraft while purchasing Cryptocurrencies. This will reduce the likelihood of unhealthy investing habits like betting on Cryptocurrencies using money borrowed from Testudo Bank.
- For now, customers will only be able to purchase & sell **Ethereum** (https://ethereum.org/en/).

Solutions Considered

One Account for All Approach

In this approach, customers will purchase and sell Cryptocurrencies through the same account and account balance that the user currently uses for banking transactions.

Checking Account vs Investing Account Approach

In this approach, the existing customer accounts are re-classified as **checking accounts** (keeping all its existing features). Customers will also be eligible to open an **investing account** where the USD balance indicates the total value of the customer's cryptocurrency holdings. Customers will have to transfer money from Checking Account to Investing Account before purchasing cryptocurrencies.

Pro/Con of all approaches considered:

One Account for All Approach

Pros:

- Customer can directly use their existing account balance to purchase Cryptocurrencies. This makes it really easy and intuitive for Crypto Newcomers to start buying and selling Crypto.
    - Also keeps customer front-end experience largely the same as before.
- Customer only need to track their existing balance and the current US Dollar value of their Crypto holdings. They don't need to worry about depositing into a separate Investing Account and managing that balance.
- Much easier to implement.
    - No new buttons for transferring money into (and out of) a separate Investing Account need to be added.
    - Don't need to track another Investing Account balance for each customer in our DB. Simply keep track of how much of each Cryptocurrency that each customer has, and then sum up the US Dollar value of all the holdings dynamically when the `account_info` page needs to be served to the user.
- More flexibility. It is still possible to move to a logically-separated Investing Account approach in the future if the customer demand leads Testudo Bank to add more Crypto options.

Cons:

- Harder to set boundaries on how much a customer can spend on Cryptocurrency purchases in one day without having the logical separation of an Investing Account. Less safeguards to prevent customers from being irresponsible with their investing habits.
    - Implementing a daily buy limit could be a future feature or a stretch goal.
- Very likely for this implementation to be deprecated if the Cryptocurrency feature is very popular with customers, and Testudo Bank wants to add more Cryptocurrency options besides Ethereum. It makes more sense to switch to the other approach if there will be many investment options.

Checking Account vs Investing Account Approach

Pros:

- Follows the Checking/Savings/Investing Account paradigm followed by most commercial banks. More intuitive for customers familiar with other banking applications.
- More flexibility for Testudo Bank to apply different rules and features to each account type to better serve and protect the customer.
    - For example, a $1000 per day instant deposit could be applied to the Investing Account in the future, which would limit the customer to only immediately invest $1000 of freshly-deposited money from their Checking Account (they would need to wait a few days for the remaining deposit amount to appear in their Investing Account). This is a paradigm followed by most modern crypto and investing retail brokers (like Coinbase and Robinhood). This feature would safeguard the customer from impulsively investing too much money at one time on volatile cryptocurrency assets.
    - Another common example is how Savings Accounts limit the number of withdraws and provide some passive interest yield in most commercial banks, while checking accounts don't have that feature.
- Allows Testudo Bank to neatly encapsulate all investment activity in a logically-separate Investment Account environment. This will be very valuable when the investing side of Testudo Bank becomes more complex in the future when more Cryptocurrencies besides Ethereum are available for purchase.
    - Also makes it much easier to pivot into allowing customers to purchase Common Stock equities as well as Cryptocurrencies.

Cons:

- Customer has to transfer money from Checking Account into Investing Account each time they want to buy Cryptocurrencies, which is tedious.
- Harder to implement.
    - Testudo Bank will have to start maintaining records of each customer's Investing Account balance in addition to their regular balance, since it is possible for customers to put money in their Investing Account and not immediately buy Cryptocurrencies.
    - Testudo Bank will also need to provide new buttons in the front-end to enable customers to transfer money from Checking Account to Investing Account (and the reverse). Also, there will likely be a need to add an extra button for customers to withdraw directly from their Investing Account so that they don't need to transfer back to their Checking Account before withdrawing from the bank.

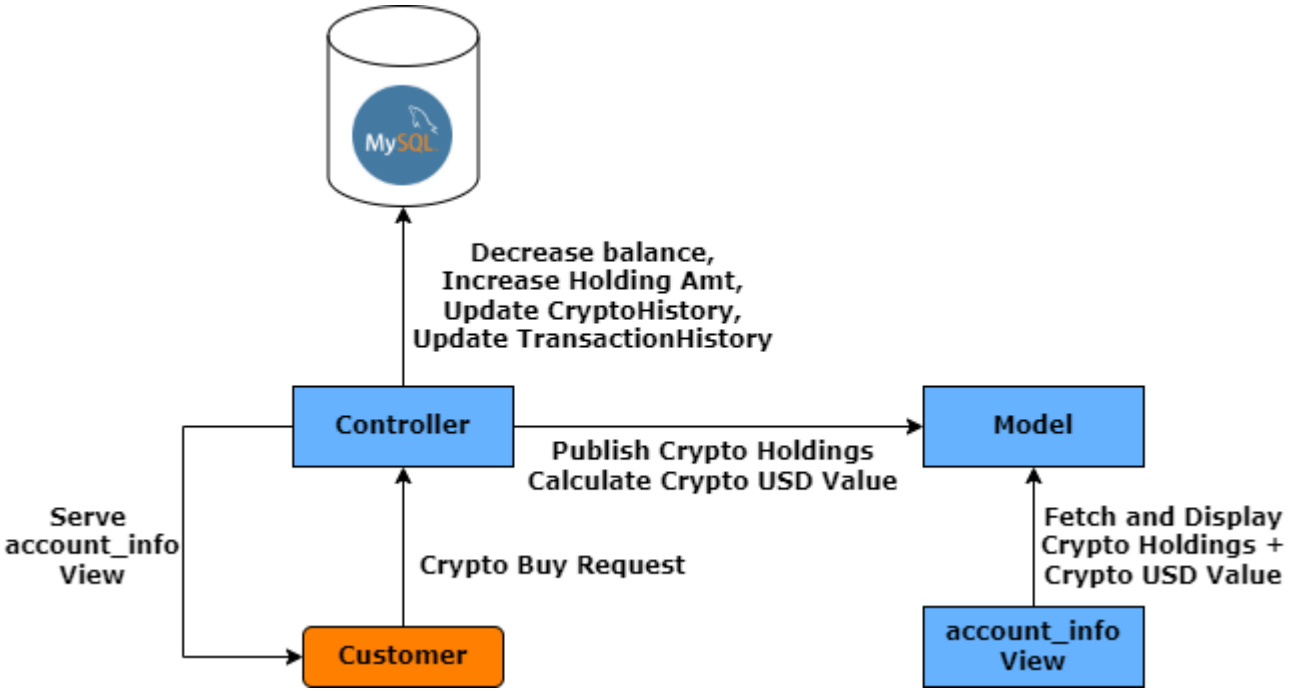
Proposed Solution

The proposed solution is the **One Account For All Approach** because it enables Testudo Bank engineers to quickly ramp up to a Minimal Viable Product (MVP) that can be quickly deployed to gauge customer interest. With this approach, Testudo Bank still has the option to move to the **Checking Account vs Investing Account Approach** in the future. The fast development speed for the chosen **One Account For All Approach** makes it OK to quickly scrap the MVP in the future to build a more robust, long-lasting **Checking Account vs Investing Account Approach**.

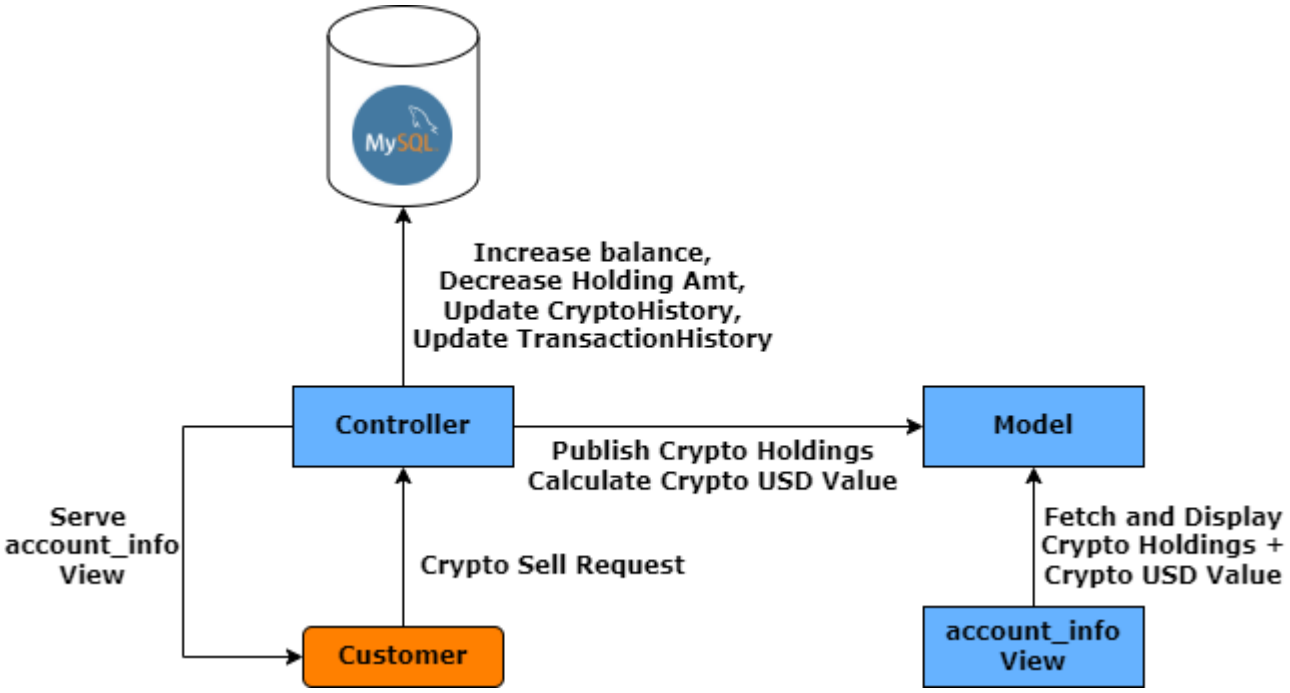
Technical Architecture

MVC Logic Diagrams

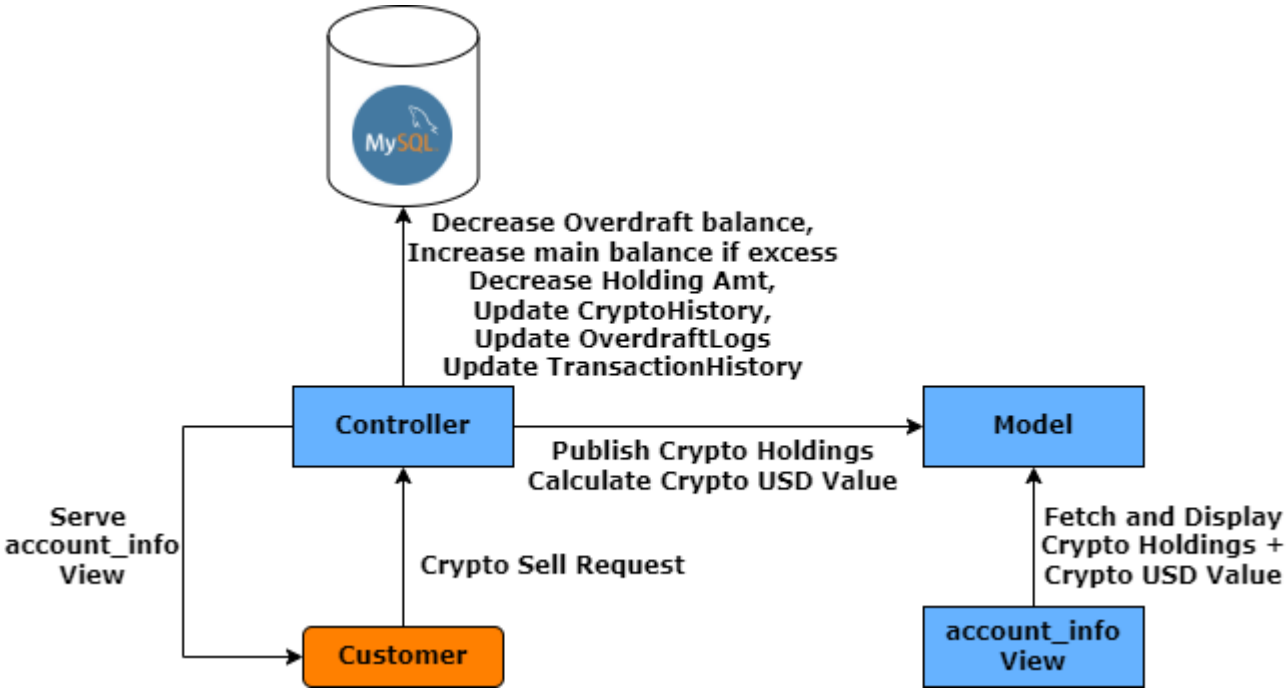
Crypto Buy Case



Crypto Sell Case



Crypto Sell Case While in Overdraft



MySQL DB Schema


OverdraftLogs
CustomerID varchar(255)
Timestamp DATETIME
DepositAmt int
OldOverBalance int
NewOverBalance int
Passwords
CustomerID varchar(255)
Password varchar(255)
TransactionHistory
CustomerID varchar(255)
Timestamp DATETIME
Action varchar(255)
Amount int
Customers
CustomerID varchar(255)
FirstName varchar(255)
LastName varchar(255)
Balance int
OverdraftBalance int
NumFraudReversals int
TransferHistory
TransferFrom varchar(255)
TransferTo varchar(255)
Timestamp DATETIME
Amount int
CryptoHoldings
CustomerID varchar(255)
CryptoName varchar(255)
CryptoAmount float
CryptoHistory
CustomerID varchar(255)
Timestamp DATETIME
Action varchar(255)
CryptoName varchar(255)
CryptoAmount float
1
1

DB Schema Notes

- `CustomerID` from `Customers` table has a **one-to-many** relationship with `CustomerID` in both `CryptoHoldings` and `CryptoHistory` table. This is because a single customer can hold more than one Cryptocurrency (eventually, when we expand beyond just Ethereum) and will buy/sell more than once (which means more than just 1 record in `CryptoHistory` table).
- `Action` in `CryptoHistory` is limited to the Strings `"Buy"` or `"Sell"`.
- `CryptoName` in `CryptoHoldings` and `CryptoHistory` will be limited to just `"ETH"` for now.
- `CryptoAmount` is a `float`, which diverges from the USD-to-pennies (as `int`) paradigm that the rest of the codebase follows. Just use the Cryptocurrency value returned by the JSoup API.
- Two new allowed `Action` values must be added for `TransactionHistory`: `CryptoBuy` and `CryptoSell`. When a customer buys a Cryptocurrency, the reduction in the customer's main balance must be reflected in `TransactionHistory` with a new `CryptoBuy` record. Whenever a customer sells a Cryptocurrency, the US Dollar value of the sell should be logged in `TransactionHistory` as a new `CryptoSell` record. Additionally, any Overdraft Repayment that occurs when selling a Cryptocurrency must be logged in `OverdraftLogs` table.
    - **TIP:** Simply use the existing `submitDeposit()` and `submitWithdraw()` handlers to handle all this logic. The only new code that needs to be added is to make sure the `CryptoBuy` and `CryptoSell` actions are used. You can see an example of how this is implemented in `submitTransfer()`.

Simple, Error, and Edge Cases

Simple Cases

- A simple Crypto Buy when the customer is not in overdraft, and the US Dollar amount for the buy would not bring the customer into overdraft.
- A simple Crypto Sell when the customer is not in overdraft.

Error Cases (return `welcome.jsp` page in all of these cases)

- Customer attempts to Buy Crypto when the US Dollar amount for the buy exceeds their main balance. They should not be allowed to go into overdraft to buy Crypto.
- Customer attempts to Buy Crypto while currently in overdraft.

Edge Cases

- Customer Buys Crypto safely (like the Simple Buy case above). Then, they withdraw enough from main account that they go into overdraft. Then, the customer Sells their Crypto holdings. Ensure that the Crypto Sell first pays off the Overdraft Balance, **and any excess goes into main account balance**. (Again, this logic is already largely implemented for you in `submitDeposit()`, so just call that method in your new `submitCryptoSell()` handler.