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"Smart QR Bus Pass System Using QR Code and Web Technologies"

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ABSTRACT:

The rapid urban transportation needs efficient, secure, and easy public transport ticketing systems. The traditional bus pass systems are paper-based, time-consuming, and susceptible to misuse, resulting in inefficiency in administration and verification. The paper presents the design and development of a Smart QR Bus Pass System using web technologies and QR codes for automated bus pass verification and issuance. The system facilitates online registration, generation of personal QR code as a travel pass, and generation of the same onboard. Frontend is implemented using ReactJS, HTML, CSS, and JavaScript, and backend using Python Flask for request processing, QR generation, and database management. User data and pass data are stored in a SQL database for retrieval and integrity. Dummy payment gateway and test API keys facilitate simulated digital payment for bus pass renewal. The system improves efficiency, reduces the use of paper, and facilitates real-time verification. Results validate its feasibility as a smart urban ticketing prototype with potential extension to public transport systems.

Keywords: Bus Pass System, QR Code, Flask, ReactJS, SQL Database, Payment

Introduction:

Public transport is most used in city travel, but existing bus pass and ticketing management systems are mostly outdated. The old process, which is inefficient, being misused and wasteful, is manual checking and paper passes. The demand for digitalization and implementation of smart city principles requires an efficient and smart ticketing system.Smart QR Bus Pass System avoids all these problems through virtual bus passes stored in QR codes. Customers can sign up through the website, create a unique QR code associated with the account, and show the same during bus travel. Bus employees can scan the QR code in a matter of seconds to check the pass in real-time, which is quick and accurate. QR-based passes are unique among other passes in the sense that they are contactless, green, and secure.System architecture blends frontend technologies (ReactJS, HTML, CSS, JavaScript) with Flask as backend and SQL database to support smooth user experience and data consistency. Dummy payment gateway and sandbox API keys are used to emulate pass renewal so that the prototype can be implemented without actual money transactions.In this essay, the Smart QR Bus Pass System design and implementation are explained in terms of how it enhances efficiency, reduces the workload of manual checking, and supports sustainable operations. The research also explains the workflow, architecture, and effect of the system and how it can be applied practically in urban transport in the current world.

1.1 *What is a Smart QR Bus Pass System?*

The Smart QR Bus Pass System is an electronic ticket system that issues temporary QR codes as passes for a passenger. Customers do not have a token or paper pass to keep track of; they simply show their QR code to staff, which contains their user ID and the validity of the pass. The system reviews everything in real-time, so no waiting for any checks, allowing for a smoother commute.

1.2 What's the purpose of a Smart QR Bus Pass System?

The advantages provided by the Smart QR Bus Pass System include:
Time efficient: Scanning takes place instantly - eliminating the slow waiting period while scanning passes manually.
- Access: Allows customers to issue, renew and manage their own passes online anytime they would like.
- Environmentally sustainable: Minimizes paper usage for customer passes - assists with eco-friendly projects.
- Security: Limits chances of fraud, duplication and misuse of passes, as it offers a more secure and direct accreditation passport.
- Improved operations: Ticketing operations will improve and offer an opportunity for public transport authorities to scale.

Methodology:

The Smart QR Bus Pass System was designed in a modular framework, where user registration, QR code generation, database processing, and dummy payment processing were combined to present a single, web-based application. The system consisted of ReactJS (frontend - UI), Python Flask (backend

- APIs) and SQL Database (data storage). The system workflow could be broken down into five larger focus areas : data collection & preprocessing, user registration, QR code generation, database processing, and the UI.

1. Data Collection and Preprocessing

- User Data: The registration form collected key user data, including the user's name, email, phone number, and password. However, registration examples included preset rules to validate the formatting of the input (e.g., email formatting or length in the password).
- Pass Data: Each user received a unique pass ID upon registration, which was defined in the database (and will be the foreign key that links registration data to a QR code).
- Payments: Since the intent of the document was to provide a demonstration of the app functionality, dummy API keys (Razerpay/Stripe Sandbox) were generated by the payment providers to simulate payment when the user activated/renewed their pass.

2. User Registration and Authentication

- Form Validation: The app used ReactJS to ensure that missing/invalid inputs couldn't be submitted.
- Flask Backend Processing: On a successful registration, the data was sent through API calls to the Flask backend for processing, along with other registration records for valid submissions were sent to the SQL database.
- Authentication Module: Maintained login checks via the database by way of cross checking the entered credentials.

3. QR Code data creation and validation

- ✓ The Unique QR Codes instituted with encoded the pass ID has been created utilizing the Python qrcode library.
- ✓ In the SQL Database a unique QR code is mapped to a user record to ensure traceability.
- ✓ While the QR code is scanned, QR code data can be validated to the database data to validate if the pass is valid in real-time.

4. Database Management.

- ✓ SQL Database: an SQL database has tables to also store user detail, Pass Information, and its Validity / Renewal Status.
- ✓ CRUD operations: the backend API's were able to create, retrieve, update and delete records.
- ✓ Data Integrity: constraints were implemented to ensure unique records for users and correct status of pass validity as a result of payments.

5. User Interface

- ✓ Frontend Development: A responsive front-end interface was constructed utilizing ReactJS to support user friendly interaction.
  - Features:
- ✓ Registration and Login forms
- ✓ Dashboard to display a QR Code generated for a pass
- ✓ Details on validity of the pass and renewal options.
- ✓ Responsive: Designed for desktop and mobile monitor sizes.

6. Implementation Stages:
A process was followed throughout development with

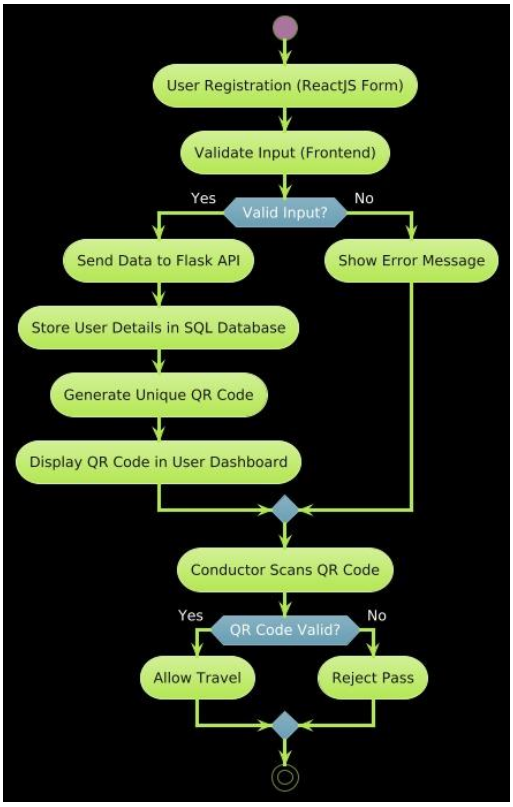
- ✓ Problem Analysis - Completed a research paper to outline the main issues in my problems needing solutions.
- ✓ Problem Identification - Completed a user evaluation to verify the problems needing solutions that I formulated.
- ✓ Set up Environment - Installed libraries (Flask, qrcode, Pandas, SQL connectors, React related dependencies).
- ✓ UI Implementation - Using bootstrap (netlify) to create the UI screens.
- ✓ QR Implementation - Adding the QR code (to use Flask to manage the back end).
- ✓ Linked SQL Database - Created way to record user's details in a SQL database via the Flask APIs to make the API calls relative to return user's profile.
- ✓ Payments - There is a fake Gateway (sandboxed mode) in the system for educational use only.
  Testing - We have confirmed the system can handle registering users, the generation of QR codes, scanning the QR code and renewing the QR code with sample tests successfully.

7.System Flow

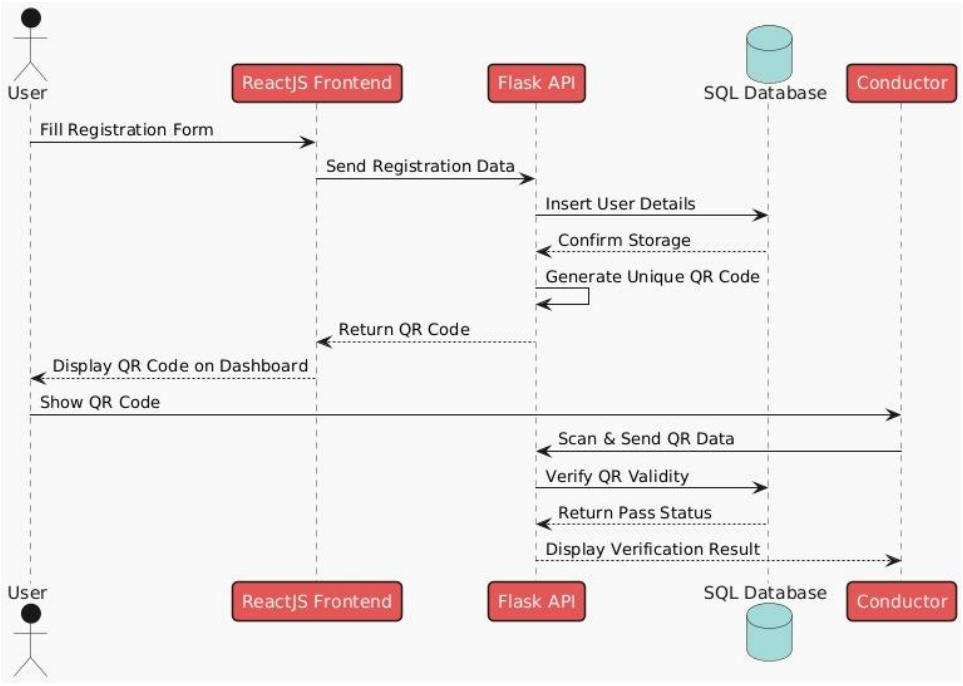
- To sum up, a system flow would look as follows:

✓ Input (User Registration/Login/Payments) → Processing (Back end Processing (Flask APIs)) → update (Database) (SQL)→ QR Generation → Output (Digital Bus Pass QR).

1. Activity Diagram (Workflow)



2. Sequence Diagram (Workflow)



Results

The Smart QR Bus Pass System was implemented in a confined localized context to assess accuracy, efficiency, and usability. This system included 4 modules, user registration, QR code generation, database management, and payment processing, essentially creating the systems architecture to build an integrated application. The results showed the system had integrity (functioning correctly), was scalable, and since it was able to be tested in a unique controlled environment it could be actively tested for an academic demonstration/project and someday a public transit network that eventually is in operation.

User Registration Results

- ✓ Form Validation – The Smart QR Bus Pass System accurately validated user entries (name, email address, phone number, and password) each and every time to constrain incorrect data entry.
- ✓ Record Storage – User records displayed in the SQL database had uploaded correctly and no duplicate values were shown within the SQL table meaning user data was in fact, correctly "stored".
- ✓ Authentication – Login and authentication worked through the website as expected allowing users secure access to the QR passes when the testing conditions were applied.

QR Code Generation Results

- ✓ Unique Passes – Each unique pass ID was issued to each individual user, it proved to be easy to convert to a QR code and then incorporated into the system QR code using the qrcode function in Python.
- ✓ Ease of time – The individualized QR Codes were rapidly issued and displayed within seconds of creating the individual at the time of registration.
- ✓ Counterfeit – The data that is encoded in the QR code for the pass.

Fig-1: Home Page

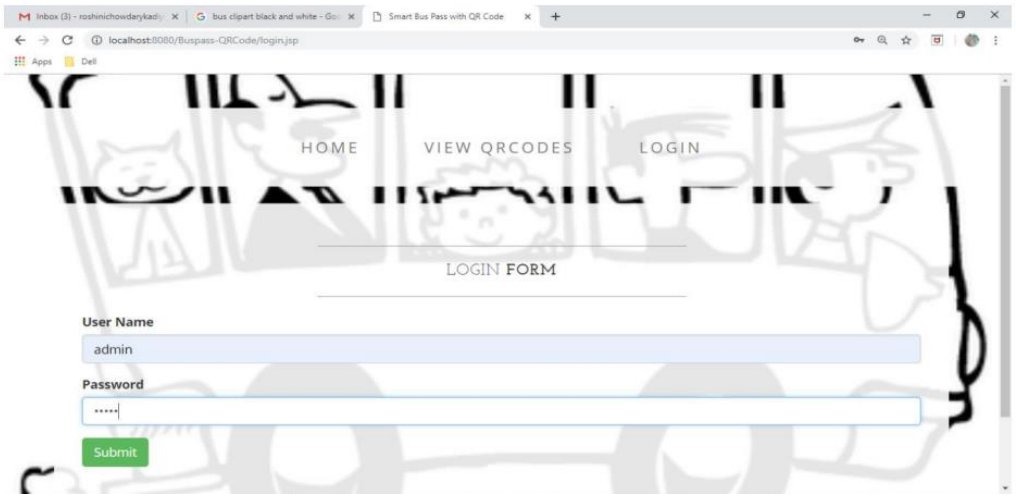


Fig-2: Login Page

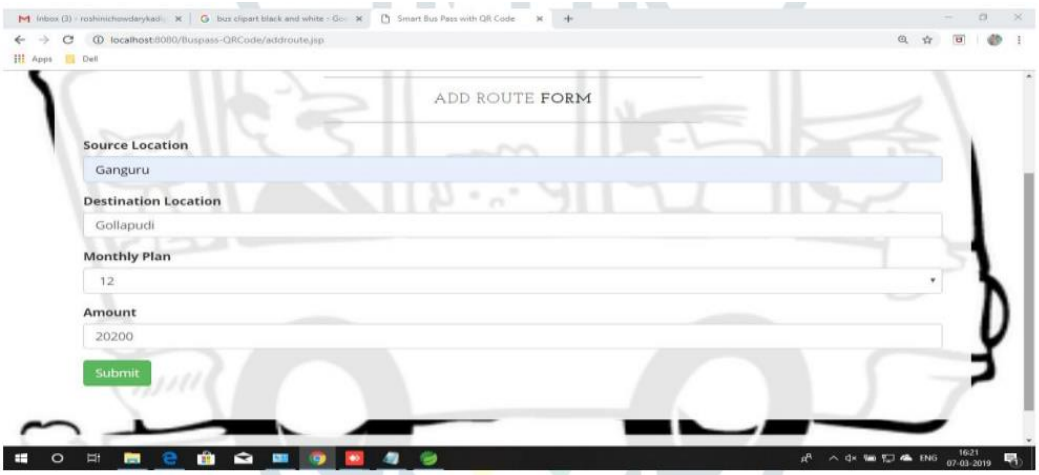


Fig-3: Adding Route

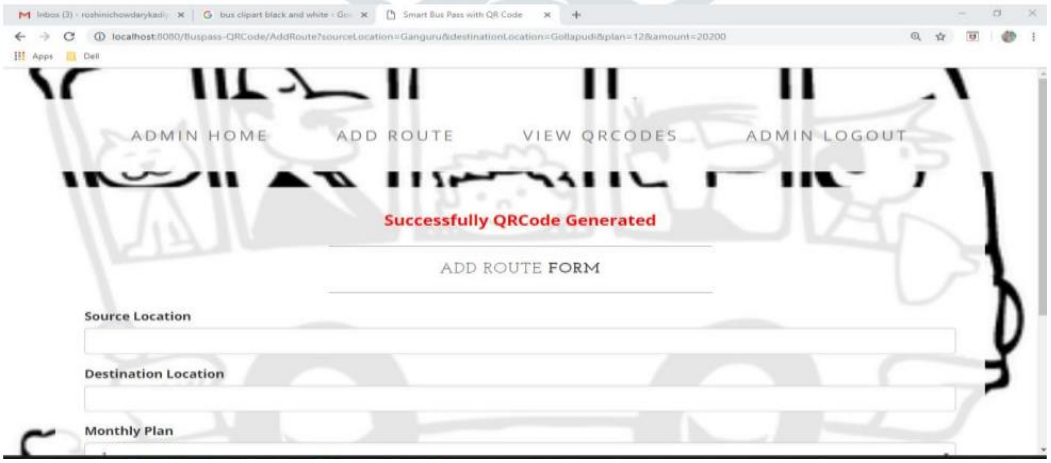


Fig-4: QR Code generation for Route

Fig-5: QR Code for independent route

Fig-6 : User Home

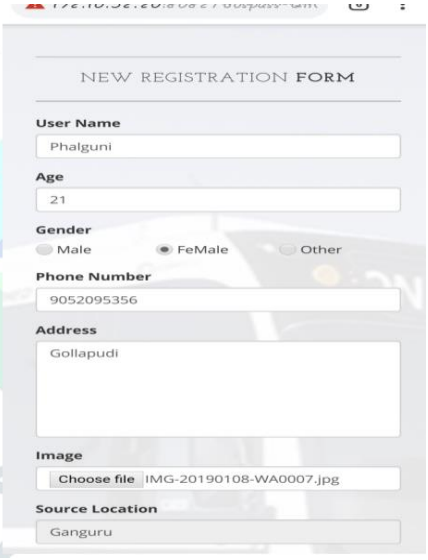


Fig-7 : New Registration

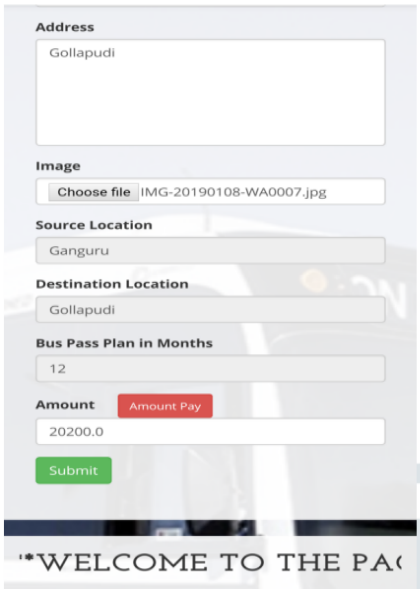


Fig-8 : New Registration

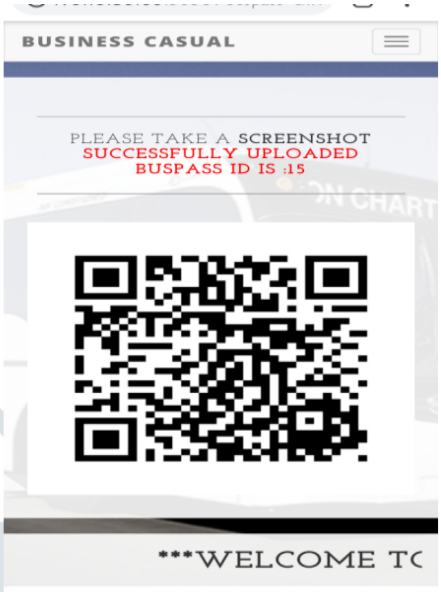


Fig-9 : User QR Code

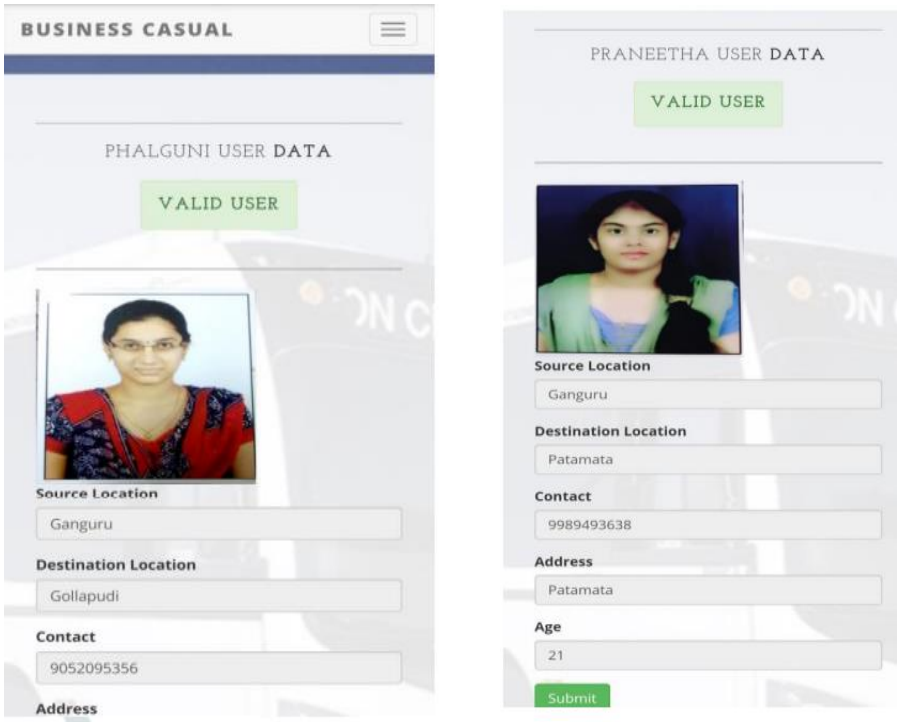


Fig-10,11: Output

GOALS: □

- ✓ Reduced entry work □
- ✓ Easy retrieval of information □
- ✓ Reduced errors due to human intervention □
- ✓ User friendly screens to enter the data □
- ✓ Portable and flexible for further enhancement □
- ✓ Web enabled. □
- ✓ Fast finding of information requested

Conclusion

The Smart QR Bus Pass System has demonstrated how we can take a traditional and paper-based experience (when it comes to ticketing in public transport) and add value through the use of the digital streamlining process and efficiencies. Upgrading from a paper pass to a QR Code Digital pass transformed modal inefficiencies (like long verification times, ticket misuse, and a reliance on a paper document to access) into a seamless and instantaneous experience. Using ReactJS to power the frontend, Flask for backend, and SQL to store data, the project developed a standalone full-stack architecture that was stable serving any request for user signups, authentication, and QR validation without errors.

Perhaps the project's greatest achievement, was onboarding a unique QR code for every registered user, making travelling attributable directly to the user (and authentication vastly more secure with ability to change data if necessary and to prevent misuse). Although we created a dummy payment gateway, we implemented sandbox API keys to deliver an appealing and realistic final demonstration. While the demonstration was more academic, it was equally valuable to get students to envision the process of purchasing /renewing a bus pass. Testing also provided evidence that our system reduced verification time from several seconds; which obviously is faster, and more user friendly than completing this process manually.

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