2. Functional design for the Mars Rover(brief) and for each module ()

The command module is responsible for the web application that displays rover status and provides a manual control interface. Using a cloud AWS server written in Express.js based on Node.js framework as the backend, the command system retrieves status information about other modules and sends back optional manual commands through HTTP requests with the control module, including the distance travelled by the rover, positions of the rover, aliens, towers, and underground infrastructure. The coordinates information is saved by the server in a database through SQLite. The rover and alien information are displayed on a frontend webpage, which is written in React.js, in the form of a ‘status meter’ and a live map. The website also includes a control panel with buttons for manual control.

Command

1. Technical details of subsystems (related theories)

Diagram

Description automatically generated

* + Communication with HTTP

The Command subsystem is concerned with two main communications –between server and ESP32, server and webpage client. HTTP is used for both communications through the methods of GET and POST in the form of JSON objects, where the clients send requests to retrieve information or upload information from and to the server respectively, while the server responds to the requests. Although there are other commonly used protocols such as TCP, web socket, socket.io etc, HTTP is chosen concerning its reliability due to it is based on connection-oriented TCP, also allowing the specific endpoints to construct independent connections to different components in the frontend, and to keep the inter-system and intra-system communication protocol consistent.

* + Backend

The backend server is written with Express.js, a framework based on Node.js to implement HTTP requests through built-in HTTP, provided routing and more powerful methods of sending responses.

The server is run on an AWS EC2 instance as a cloud service. Rather than a local server, a cloud server is used it allows for remote hosting for the independence of physical location of users and clients, flexibility for configuration. With a Node.js module of sqlite3, an SQLite file-based DBMS database is used alongside with the server in EC2. The server stores the coordinates data in 3 tables. It stores a large quantity of data during communication rather than a server buffer variable and keeps a retraceable backup when the program ends. It is chosen due to its configuration-free, lightweight properties.

* + Frontend

The frontend website is built with React.js using hooks and styled with CSS, reusable objects as an imported file. Hooks are used to implement event handling user pressing on-screen buttons or keyboard input to send rover manual commands. A library, React Konva, is used to render a fixed-sized live map. When given coordinates, basic shapes are drawn with Konva on the screen to represent aliens, towers, infrastructures, and a rover path. Grid is a layout library used to divide the screen into sections for a clean, panel-like look.

1. Practical examination of individual modules

Diagram

Description automatically generated

1. Evaluation

Overall, the command module fits its purpose of reliable data transmission to and from the ESP32, displaying a map with correct positions and well-defined labels given inputs, and allows user to input manual control with self-explanatory arrow buttons.

The design abides with the REST architecture for web server. The server is platform independent as both the ESP and React.js website can access this API; the URI has resource-oriented endpoints for different clients and purposes; the server side contains a central database that reduces the size of variables in the server program and provides backup; the information exchange with clients is through JSON objects.

Limitations:

The server has no security system where can cause confusion to the server if several clients attempting to connect to the same URI endpoints. HTTP sends a request for building connection for every communication round which has a header of 700-800 bytes on average which makes transmission slow and expensive.

Improvement:

* + Use secure data transmission protocol of SSH instead of all-TCP.
  + Login System (Andy加这儿)
  + Use faster and less expensive communication concerning practically the large amount of information collected on mars and the cost of transmission
  + Page design can be improved to be more engaging by adding animation and user interactive features given more time.

[1] GeeksforGeeks. 2022. *What is web socket and how it is different from the HTTP? - GeeksforGeeks*. [online] Available at: <https://www.geeksforgeeks.org/what-is-web-socket-and-how-it-is-different-from-the-http/> [Accessed 11 June 2022].

[2] GeeksforGeeks. 2022. *Node.js vs Express.js - GeeksforGeeks*. [online] Available at: <https://www.geeksforgeeks.org/node-js-vs-express-js/> [Accessed 13 June 2022].

[3] Tutorialspoint.com. 2022. *SQLite - Overview*. [online] Available at: <https://www.tutorialspoint.com/sqlite/sqlite\_overview.htm> [Accessed 14 June 2022].

[4] "How to create a React frontend and a Node/Express backend and connect them", *freeCodeCamp.org*, 2022. [Online]. Available: https://www.freecodecamp.org/news/create-a-react-frontend-a-node-express-backend-and-connect-them-together-c5798926047c/. [Accessed: 11- Jun- 2022].

[5] "react-konva", *npm*, 2022. [Online]. Available: https://www.npmjs.com/package/react-konva. [Accessed: 20- Jun- 2022].

[6] "React Grid component - Material UI", *Mui.com*, 2022. [Online]. Available: https://mui.com/material-ui/react-grid/. [Accessed: 20- Jun- 2022].

[7] "Web API design best practices - Azure Architecture Center", *Docs.microsoft.com*, 2022. [Online]. Available: https://docs.microsoft.com/en-us/azure/architecture/best-practices/api-design. [Accessed: 19- Jun- 2022].

[8]"The Top Advantages of Cloud Hosting over Traditional Hosting | AdEPT", *AdEPT | Technology Group*, 2022. [Online]. Available: https://www.adept.co.uk/the-top-advantages-of-cloud-hosting-over-traditional-hosting/. [Accessed: 20- Jun- 2022].