Ground Control Systems Software for CUBESATS

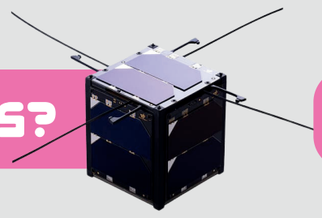
WEBSITE: VIDEO:

Ayşe İrem YALÇIN | 21946696 | Advisor: Doç. Dr. Adnan ÖZSOY

BBM479/480 Design Project | Department of Computer Engineering

This project provides a Ground Station Systems Software for CubeSats on Low Earth Orbit. It facilitates communication with satellites thanks to its user-friendly interface. Using the application, We can track our Satellite on LEO orbit and establish data communication. The GCS application sends the requested files and commands to the satellite when it enters the coverage area of the ground station. It also collects telemetry packets from the satellite. It saves this data to the database and thus allows us to analyze it.

WHAT ARE CUBESATS?



A CubeSat is a small and modular type of satellite, usually 10x10x10 cm in size and about 1-1.33 kg in weight. It is used in various fields like scientific research, education, technology demonstrations, and Earth observation. Because of its small size and standard design, the development and launch costs are low, making space missions more accessible.

PROBLEM DEFINITION

The main problem is how to effectively manage and control CubeSats in Low Earth Orbit (LEO). CubeSats can only connect with ground stations a few times each day, for about 10 minutes each time. This short communication time makes it hard to send and receive data. The application solves these problems by automating the communication process.

LANGUAGES & TECHNOLOGIES

- The design phase involved using Figma, a powerful design tool.
- The frontend of the application is built with React. CSS, HTML, and JavaScript languages were used to create the user interface.
- The backend of the application is built using the Java programming language and the Spring framework.
- Maven is used for dependency management and project configuration.
- MongoDB is used as the database because its flexible document-based structure easily adapts to the application's needs.

PROJECT REQUIREMENTS

- Selecting a code file from local storage for transmission.
- Autonomous file transmission at predetermined intervals.
- Determining the frequency for the telemetry packets sent by the satellite.
- Displaying the latest telemetry packet.
- Graphical representation of the ground station antenna's movements.
- Displaying the satellite's location and upcoming passes using N2YO data.
- Storing all received data in a database.

POSITIONS & NEARBY PASSES

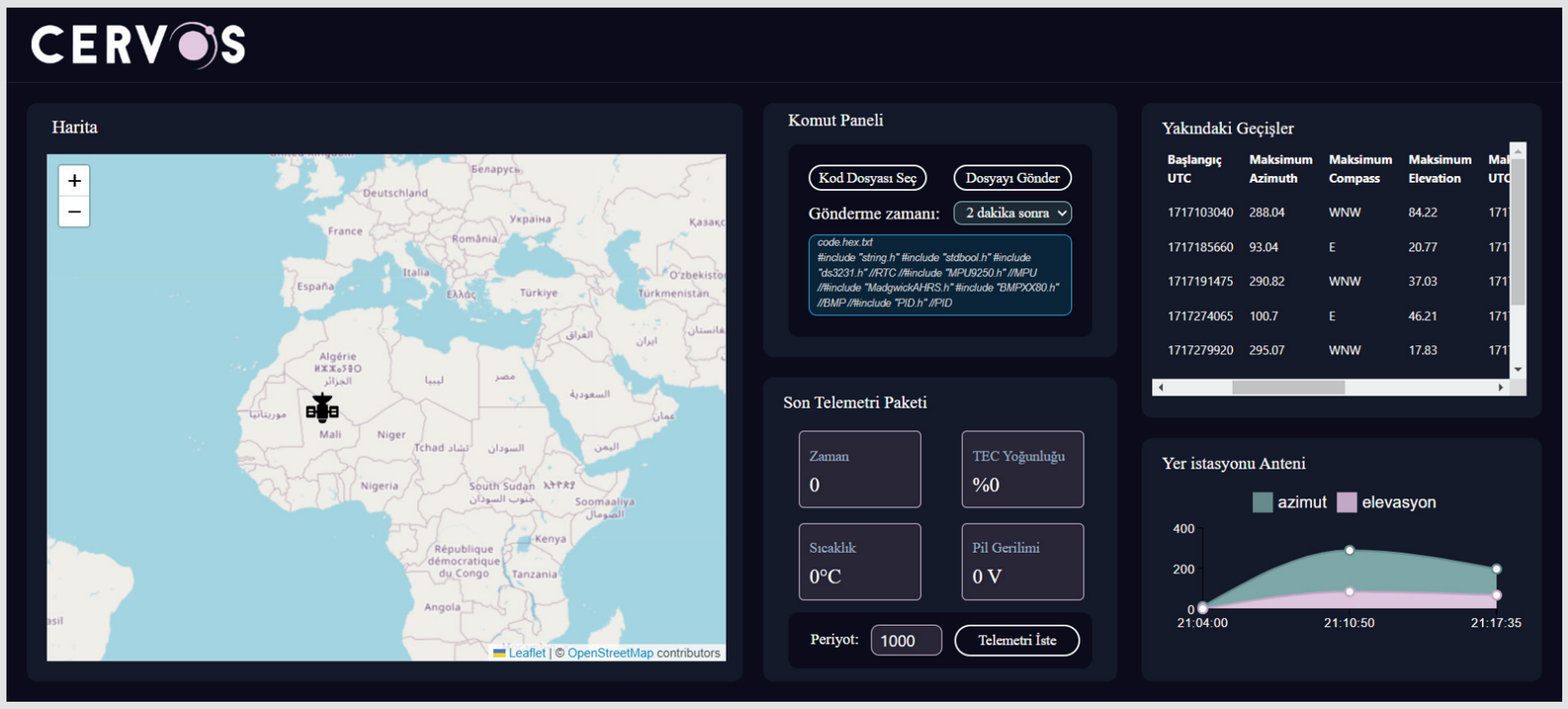
The application collects data from N2YO.com sharing information from radar systems. And it displays this data in the interface. The backend of the application makes HTTP get requests to N2YO.com using the Feign Client library. The frontend of the application receives position and nearby passes information by sending an HTTP post request to the backend. It displays position information in the interface using the Leaflet library. Nearby passes data is listed in the nearby passes table. This information is also used to draw the ground station antenna graph.

TELEMETY & TELECOMMAND

The application allows users to set the frequency at which telemetry packets are sent by the satellite. Telemetry data corresponding to the specified frequency is subsequently received from the satellite by the backend. These telemetry data are then transmitted to the frontend through a WebSocket connection. WebSocket architecture is chosen due to its capability to handle continuous data streams. The SockJS library is utilized for WebSocket implementation.
Also the Application was designed to allow users to select a code file from local storage for transmission to the satellite. A POST request is made to the backend with the code file using a REST API. The backend of the application sends the code file to the satellite via serial port. jSerialComm library was used here.

TESTS

The Ground Station Application, although designed for a real cubesat in its orbit, currently does not have an actual CubeSat. During tests, TÜBİTAK's observation satellite IMECE in LEO was used. A test application is created. it displays all the received data on the interface.



The result of the project is the development of a specifically designed satellite control station application and efficiently manage satellite systems in low Earth orbit. Moreover, it is accessible through a user-friendly interface. The aim of this application is to enhance the efficiency of satellite systems by providing satellite operators with the ability to monitor, control, and intervene in satellite missions as necessary. The developed application holds significant potential impacts for both users and industries. Efficient satellite systems could provide more accurate data collection and communication in various fields, particularly in communication, geographic monitoring, and scientific research.