

Telemetry Tracker

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Written report Object Oriented Programming project

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1. Introduction

The Telemetry Tracker project consists of monitoring, collecting and managing telemetry sensor data. Its main goal is to develop an application that facilitates the visualization and management of sensor data in a user-friendly and efficient manner.

Telemetry refers to the process of collecting, transmitting, and receiving data from remote sources, typically sensors, and transmitting it for monitoring, analysis, and decision-making.

This project focuses on finding a solution that enables the user to interact with sensor data, providing features such as data visualization, data storage, adding, editing and deleting sensor data, moreover searching for a particular sensor through the sensor JSON file that a user can load and edit.

The telemetry focuses on monitoring and optimizing the performance and safety of vehicles. Among the key sensors chosen for this project are the tire pressure sensor, the brake temperature sensor and lastly the fuel flow sensor, each playing a critical role in enhancing the vehicle performance, efficiency and safety.

The tire pressure sensor, a vital component of modern automotive systems, monitors tire pressure levels. The remaining sensors, that is the brake temperature sensor and the fuel flow sensor monitor the brake temperature levels and the flow rate consumption of a vehicle.

The sensors can be created or loaded through a JSON file through the specific Open file button, and can be selected from a sensor panel where they are listed vertically. The user can select a specific sensor from the list and he can visualize it on the chart displayed on the right. The chart shows the numeric values of the sensors on the y axis in relation to the timestamp on the x axis.

The user can search for sensors through a search bar shown above the sensor panel, and the number of search results can be seen in the status bar; the matching sensors are updated dynamically whenever the user makes a research.

2. Model description

The logical model can be divided in two sections: the sensor management, which includes operations such as creating, reading, updating, deleting and searching as indicated for the requirements of this project; the second section represents the data visualization on the charts. The first section includes both the classes that represent the sensors and the classes that allow the user to manage JSON files and data. Qt libraries were used for these tasks, such as `QJsonObject`, `QJsonDocument`, `QJsonArray` and `QFile`.

The model starts from an abstract class `AbstractSensor` that represents the shared information for all sensors that is the sensor identifier, the timestamp and the sensor type.

Concrete classes deriving from the `AbstractSensor` class are `TirePressureSensor` which represents the tire pressure of a vehicle; `BrakeTemperatureSensor` which represents the brake temperature of a vehicle, and lastly the `FuelFlowSensor` that measures the rate of fuel consumption in the vehicle engine.

The sensor management operations were implemented in the user interface, they can be activated through the specific buttons that run them. The “Add sensor” button uses a dialogue window that allows the user to insert the data such as the identifier, the sensor type (that can be selected through a list menu in the dialogue window), the timestamp and the numeric value. According to the sensor type selected, the user can insert the specific numeric value for each sensor.

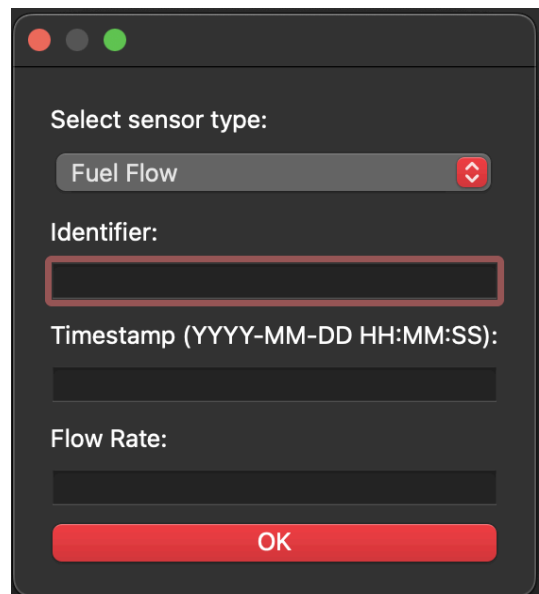
The user can load a JSON file through the “Open” button and visualize the sensor widgets created for each sensor inside the sensor panel, he can also save a JSON file through the “Save” button.

The design pattern Visitor was used for visiting the JSON objects representing sensor data, creating corresponding widgets for displaying the data in the user interface. The `JsonControllerVisitor` is tasked with visiting JSON objects, extracting the data and setting the data in the user interface. Sensor widgets are displayed in different colors according to the sensor type visited by the `Json` visitor.

The application provides a Delete sensor button that allows the user to remove a specific sensor by inserting a particular identifier that corresponds to the sensor that has to be deleted. The chosen identifier will therefore be removed both from the sensor panel within the user interface and from the JSON file that has previously been loaded. This way data will be consistent and changes within the user interface can be reflected throughout the JSON file.

The “search sensor” edit line allows the user to search for a particular sensor through the identifier or the sensor type. The sensors can be searched for even through a partial string inside the edit line. The sensor panel will be updated automatically as soon as the user writes a text inside the edit line.

As for the visualization of sensor data, the application creates a chart if a sensor widget has been selected and clicked in the sensor panel.

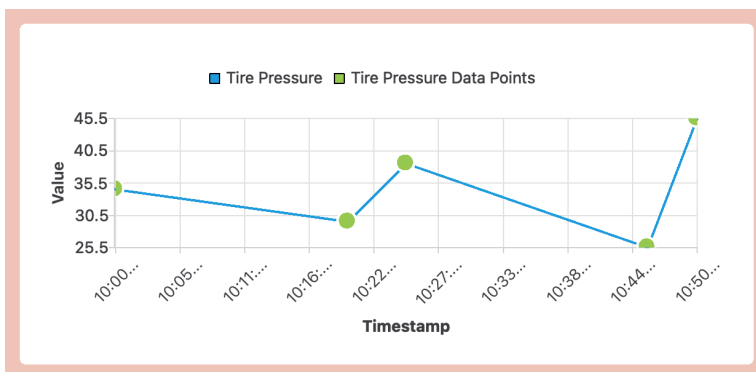


3. Polymorphism

Polymorphism was mainly implemented in the JSON Controller file. In the "jsonControllerVisitor" class the "visit(const QJsonObject&)" method was implemented, which is called when the visitor encounters a JSON object representing a single sensor. In this method the application creates a "SensorWidgetVisitor" object, which displays sensor data in a widget inside the sensor panel; we can see different widget backgrounds according to the sensor type displayed in the sensor panel, all of this because of polymorphism.

Another way of implementing polymorphism was through the methods of adding, deleting and updating sensor data. For example, when updating some sensor data, polymorphism is used to determine the sensor type and the associated value name, then the data will be updated in the corresponding JSON object. The update method is able to dynamically handle different types of sensor types of sensors and their respecting data without the need to explicitly know the sensor type.

Another way of implementing polymorphism was through the creation of a graphic chart used to visualize the sensor data according to the selected sensor within the sensor panel. When displaying sensor data on the chart the appropriate derived class implementation of the virtual functions are dynamically bound and executed based on the actual type of sensor data being processed. Sensor visitors were used for these implementations .



Timestamp: 2024-04-20
11:11:11
Brake Temperature: 111.11

Identifier: 555555
Type: Fuel Flow
Timestamp: 2024-04-19
15:55:55
Flow Rate: 15

Identifier: 123456
Type: Tire Pressure
Timestamp: 2024-03-10
10:00:00

Add Sensor

4. Data persistence

The data persistence aspect of the project involves managing JSON files to store and retrieve sensor data efficiently.

The project uses `QFile`, `QJsonDocument` and `QJsonObject` classes in Qt to handle reading from and writing to JSON files. This allows for seamless interaction with JSON files on the filesystem. The application can read existing JSON files containing sensor data and parse them into `QJsonDocument` objects for further processing. Conversely, it can also write sensor data into JSON files. JSON files serve as a structured format for storing sensor data.

Each sensor is represented as a JSON object with key-value pairs containing information such as sensor identifier, type, timestamp and specific data values.

When new sensor data is generated, the application appends this data to existing JSON files. This ensures that historical sensor data is preserved and allows for the accumulation of data over time.

This project incorporates error handling mechanisms so that the user can deal with situations such as inability to open or write JSON files. These error messages provide feedback to users.

The application can retrieve sensor data from JSON files as needed for visualization purposes. This enables users to access historical sensor data.

Examples of the file structure are given through the JSON files presented along with the code, there are 3 different documents containing alternate combinations of sensors.

5. Implemented features

The following features enrich the project with ulterior details in addition to the former requirements given for the assignment.

Graphic implementations and logical implementations were developed.

Logical implementations:

- Conversion and storage of JSON files

Graphic implementations:

- Logo inside the logo frame
- Menu bar above the main window
- Status bar below the main window, showing the search results, whether a file was saved successfully or not, whether a sensor was deleted successfully or whether sensor data was updated correctly
- Each type of sensor has its own personalized chart for the sole purpose of managing the main window in an efficient and polymorph way
- Data points markers for each data value retrieved from the JSON file
- Each type of sensor has its own personalized widget inside the sensor panel, so the user can easily identify the different types of sensors displayed
- Sensor widgets can be selected and clicked within the sensor panel
- Focus and border added to a selected widget within the sensor panel