Analysis of Flight Mission Situation based on Flight Sense Data

Report for master thesis entrance test

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Introduction

Due to recent research and development regarding drones, drone use in various areas is increasing day by day. One common use case of drone is detecting or inspecting object during its flight. For inspection drones are normally equipped with camera. Drones are able to inspect and fly at the same time without any pilot. This type of mission is called 'Autonomous Inspection Mission (AIM)'. For research and development purpose this type missions are to be tested. Different types of Flight Mission Situations can be defined considering criticality, risk criteria or phase of the flight. The Indoor Flight Centre, which is set up by Computer Engineering Professorship, has eight basic flight situations. This master thesis focuses on classifying flight mission based on Flight Sense Data (FSD).

Flight Sense Data

Drones normally have multiple sensors for the autonomous flight as well as observing the surrounding. Data collected from the mounted sensors of the drone are called Flight Sense Data (FSD). For autonomous flight, a drone must have an autopilot (flight controller) with various flight sensors and a computer. Autopilot may have this sensory data as logfile which can also be referred as Flight sense data. This flight sense data should be collected and analysed determine the flight mission situations.

Proposed Architecture

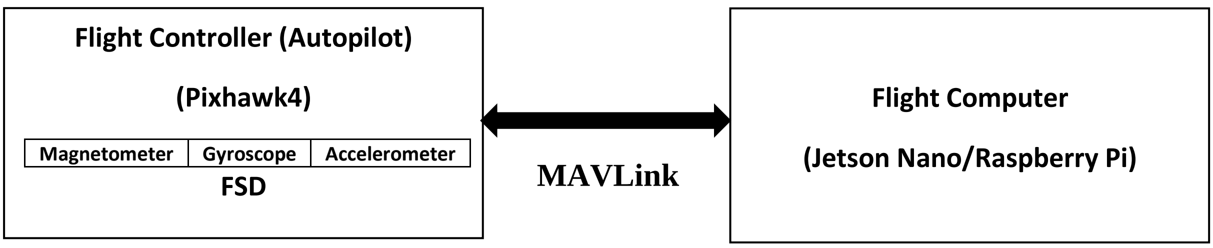

Figure 01. Accessing flight sense data (FSD)

A proposed architecture to communicate between the autopilot and the computer is via MAVLink. Telemetry connector and serial port is used with wires (power, ground, transmit, receive, etc) to physically connect the computer with Pixhawk. They can communicate with MAVLink API like Dronecode SDK or MAVROS. Data/Telemetry radio can also provide wireless MAVLink connection. MAVLink (Micro Air Vehicle Communication Protocol) is a standardized protocol for sending information. It allows bidirectional communication. So Pixhawk and the computer both can send and receive message. This protocol also defines what kind of message can transmitted for example what would be the data type, etc. Pixhawk can use SD card to store the flight log collecting from the sensors (FSD). This flight log can then be transferred to the ground computer or the companion computer via MAVLink Protocol as MAVLink message.

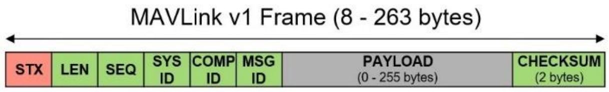

Fig 2. MAVLink message structure [ref: www.mavlink.io]

MAVLink message has a length of 17Bytes. First 6bytes are for message header which contains information about the message being transferred. Message payload is of 9Bytes which refers to the data of the message. Message also contains 2bytes checksum for verifying the integrity of the message making sure it was not altered during the transfer.

Critical Sensory Data

Various sensors are used by the autopilot system which determine the drone state and enable autonomous flight. This state may include position/altitude, airspeed, orientation, rates of rotation in different directions, etc. For autonomous flight autopilot system should have a gyroscope, accelerometer, magnetometer. Data from these sensor critical sensory data that assist the drone to fly without a pilot.

- Magnetometer sensor data: This sensor is used as a compass to determine absolute orientation of the drone.

- Accelerometer sensor data: An accelerometer measures the acceleration. It can tell the change of velocity and change of position of the drone. In general, it can measure the movement of the drone.

- Gyroscope sensor data: A gyroscope measures either changes in orientation or changes in rotational velocity. This sensor data is important to determine whether the drone is parallel to the ground or inclined to any side.

Additionally, A GPS or other positioning system is needed for all automatic flight modes. Pixhawk supports special GPS with centimetre level precision.

Store Sensor Data to Cloud

To handle, process and visualize large amount of data it is a good idea to upload them to cloud rather than using a personal server. Almost all the cloud service come with their API which allows the user to upload data from any platform. For example, google cloud storage API is for uploading data in python. For TUC Cloud an API service can be developed to store data or used if there is any. There is also platform like ThingSpeak that allows the user to store and collect sensor data on the cloud.

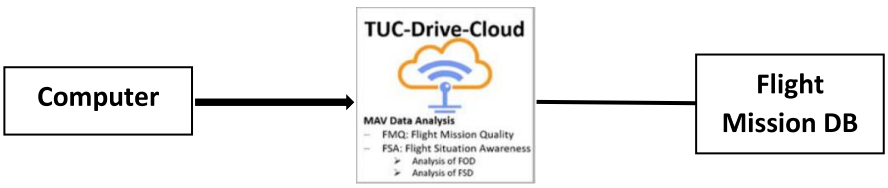

Figure 03. Store sensor data using cloud API

Database and Visualization

We can store the data as xml format or any other platform independent format. Then we can access and read them as Pandas dataframe and visualize them using data visualization library called Matplotlib in python. MySQL or MongoDB should be a good option for database.

References

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