Azimuth: A Software Tool for Simulating GPS Data From Indoor Motion Capture via NMEA Protocol for Robotic Vehicles

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Motivation

Robotic vehicles that use position data from a motion capture system behave differently than a vehicle that uses Global Positioning System (GPS) for positioning when in GPS relient flight modes. This prevents researchers from testing outdoor operations inside easily. We create a software we call Azimuth to bridge this gap by simulating a hardware GPS connection with position data from a motion capture system.

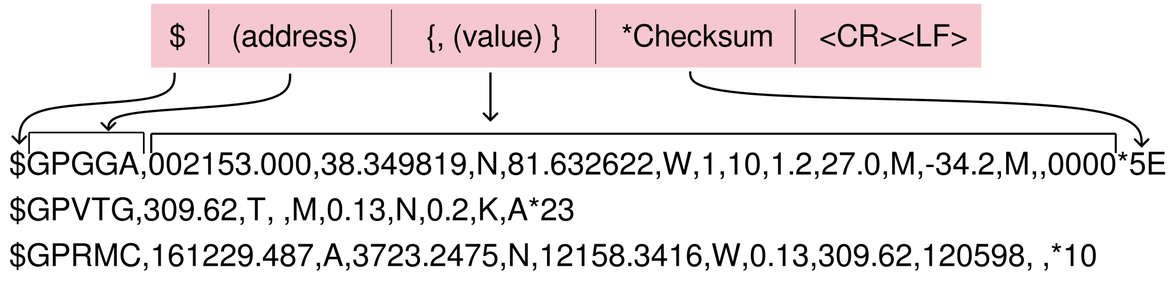
Questions

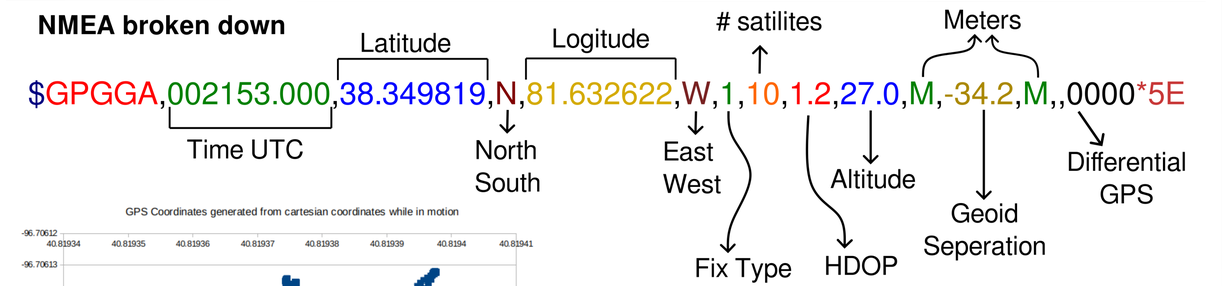
- Is it possible to emulate a hardware gps through a robotic vehicles GPS port with software?
- Will a software gps be good enough to pass vehicle safety checks?

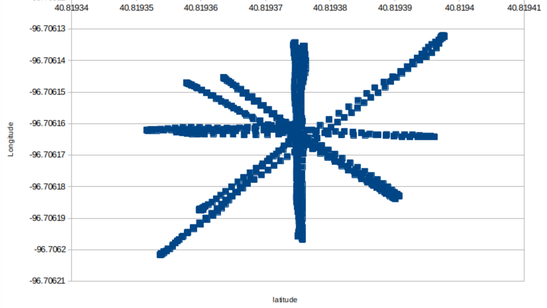
Implementation

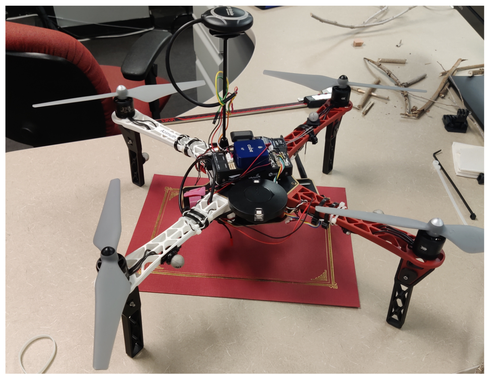
- **Vehicle:** a F450 quad copter equipped with a Pixhawk blue cube autopilot was used for the creation of the system. A Raspberry Pi companion computer is attached to the vehicle that will act as the GPS for the drone.
- **Protocols:** GPS data is transferred over a serial connection using the National Marine Electronics Association (NMEA) protocal to the drone. Only 3 messages are needed for flight [2]:
  - **GGA** = Global Positioning System Fix Data [1]
  - **VTG** = Track made good and speed over ground [1]
  - **RMC** = Recommended minimum data [1]
- **Data** is collected with a Vicon system and is then sent to a Raspberry Pi over wifi. This data is used to calculate the necessary values to craft the NMEA messages. Namely latitude, longitude, speed, and course. The GPS corridantes we generate are accurate to 1.11cm with 7 decimal places of accuracy. These messages are then sent to the flight controller at a rate of 8hz over a serial line that is connected to the GPS port.

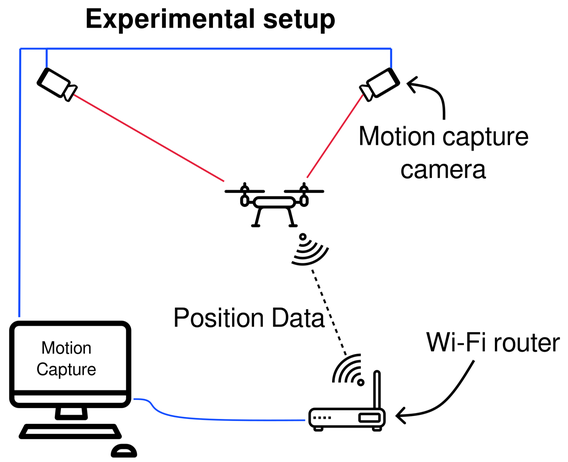
NMEA: GGA messages provide GPS information [1]





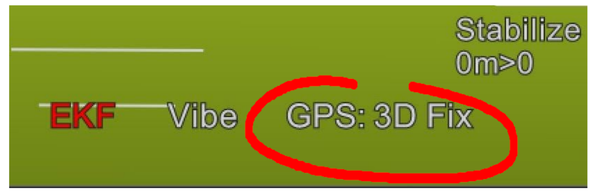






Results

Once connected and activated It takes about 5 seconds for the drone to accept the data and establish a 3D fix This allows the vehicle to arm for flight and to enable GPS reliant flight modes. In the ground station you can see the drones GPS indicator activate and its location change to the emulated GPS position.



Future Work

Due to the nature of modern construction indoor flight with a software gps alone may not be sufficient. Magnetometers are necessary for guided flight but perform poorly indoors. This is due to the magnetic interference present in buildings from electronics and the metal in the structure itself. Using rotation data from a motion capture system it is possible to create a software Inter-Integrated Circuit (I2C) compass. This would eliminate the problem of magnetic interference and would allow for better testing of outdoor navigation indoors. Adding this magnetometer date would greatly increase flight performance

References

[1] NMEA Reference Manual, SiRF, San Jose, California, 1996, Part # 1050-0041, Jun. 2022.
[2] ArduPilot Open Source Autopilot. http://ardupilot.org/, Jun. 2022.
[3] Tracker motion capture software. https://www.vicon.com/products/software/tracker Jun. 2022.
[4] B. Liu and N. Paquin, "ViconMAVLink: A software tool for indoor positioning using a motion capture system", Jun. 2022.

Acknowledgements

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