Progress Presentation-I

e-Yantra Summer Internship 2017

Control and Algorithms Development for Quadcopters

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Overview of Project

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Control and Algorithms Development for Quadcopters

The project deals with the study of control algorithms for quadcopter. The goal is to develop custom firmware for quadcopter (or flight controller) for 32-bit microcontrollers such as the CleanFlight firmware on STM32F1xx (ARM Cortex-M3 core). The flight controller is designed to control parameters such as the throttle, yaw, pitch and roll and to develop algorithms considering various motion and dynamics. The next step is to analyse the control algorithm to identify effects of various parameters and to optimize it for stable motion. The final step is to develop a wireless joystick controller for simple maneuvering of the quadcopter.

Overview of Task

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Task 1
Study of datasheet and user guide of Pluto Drone.

Task 2
Installation and Setup of IDE and tools.

Task 3
Libraries development for GPIO, Timers, PWM, UART, I2C interface.
Interfacing IMU to obtain filtered pitch, roll and yaw angles.

Task 4
Code development for control of quadcopter for stable flight.

Task 5
Wireless joystick control (using Node MCU).

Task 6
Documentation for testing and debugging the drone.

Task Accomplished

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Task 1
Study of datasheet and user guide of Pluto Drone

A brief study on the ARM Cortex-M3 architecture was done to understand how the various peripherals (such as the timers, GPIO ports, I2C ports) have been interfaced the APB (Advanced Peripheral Bus) of the STM32F10xx. Study of the clock distribution (RCC) and configuration of various clock sources.

Brief study of existing flight controllers such as CleanFlight and Naze32 for 32-bit micro-controllers.

Task Accomplished

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Task 2
Installation and Setup of IDE and tools

Successfully installed TrueSTUDIO IDE, GNU ARM Tool-chain, Windows Build Tools, OpenOCD, Device Packs and Drivers for STM32F10xx. Hardware debugging was successfully completed.

Task Accomplished

Task 3
Libraries development for GPIO, Timers, PWM, UART, I2C interface

Developed libraries for GPIO pin control, configured timers for PWM control of motors, serial communication over UART was successfully achieved for various data types, I2C port was configured and setup for sensor interfacing, with the help HAL drivers.

MPU9250 Accelerometer and Gyroscope was interfaced and libraries were developed for the same. AK8963 Magnetometer was also interfaced. Raw data was successfully obtained and a complimentary filter was implemented to find pitch and roll angles. Finding the yaw angle required a more complex algorithm and this was achieved using Madgwick's AHRS filter. However, the angles obtained are not yet accurate due to certain problems with Accelerometer interfacing.

Task Accomplished

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Sensor Calibration and Data Visualization

The MPU9250 and AK8963 sensors were calibrated for offsets. The calibrated data was visualized using Python. Currently working on real time data visualization using Python. Successfully implemented data frame transmission with checksum. Process of plotting the real time data and development of a GUI is ongoing.

Task Accomplished

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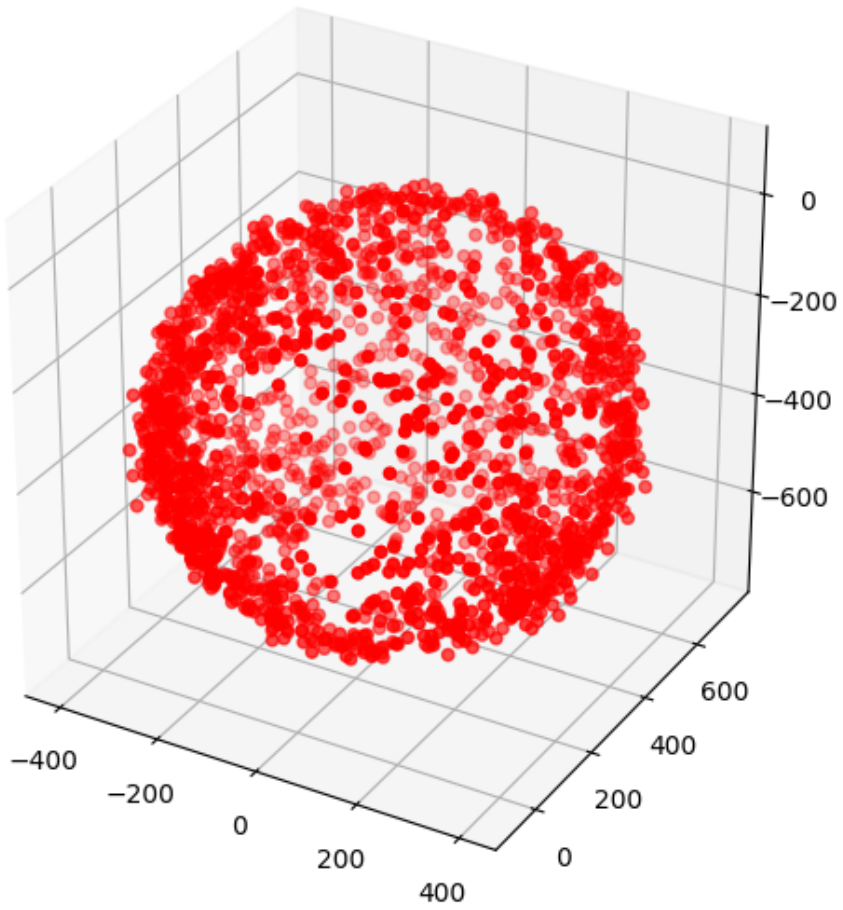

Raw Data from AK8963 Magnetometer

Task Accomplished

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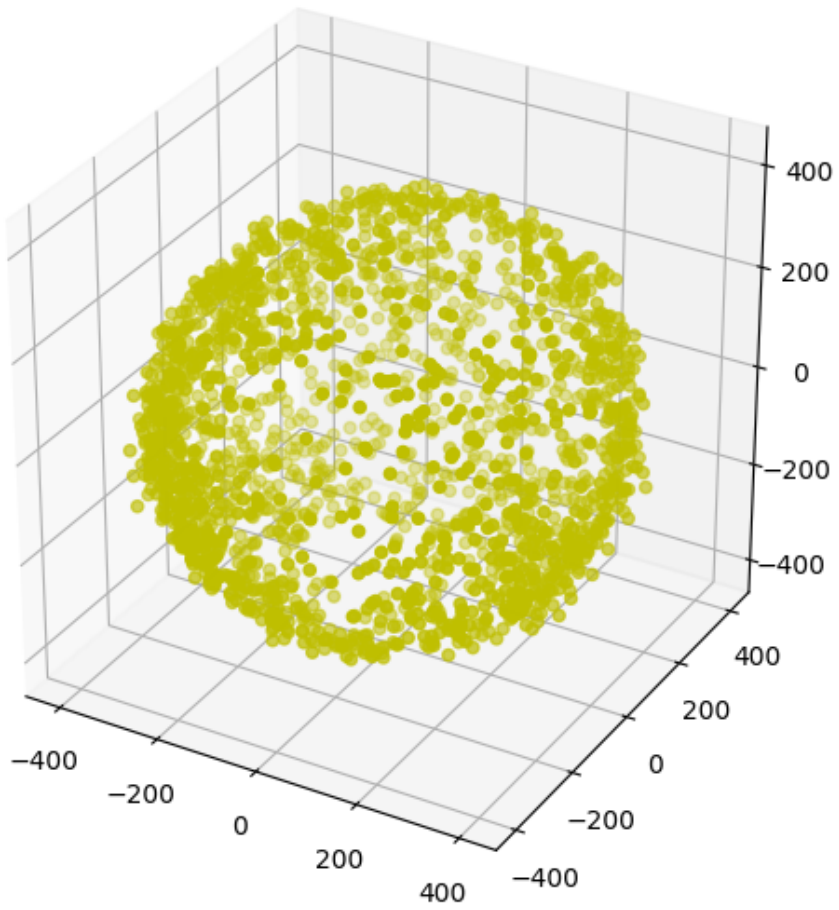

Offset Corrected Data

Task Accomplished

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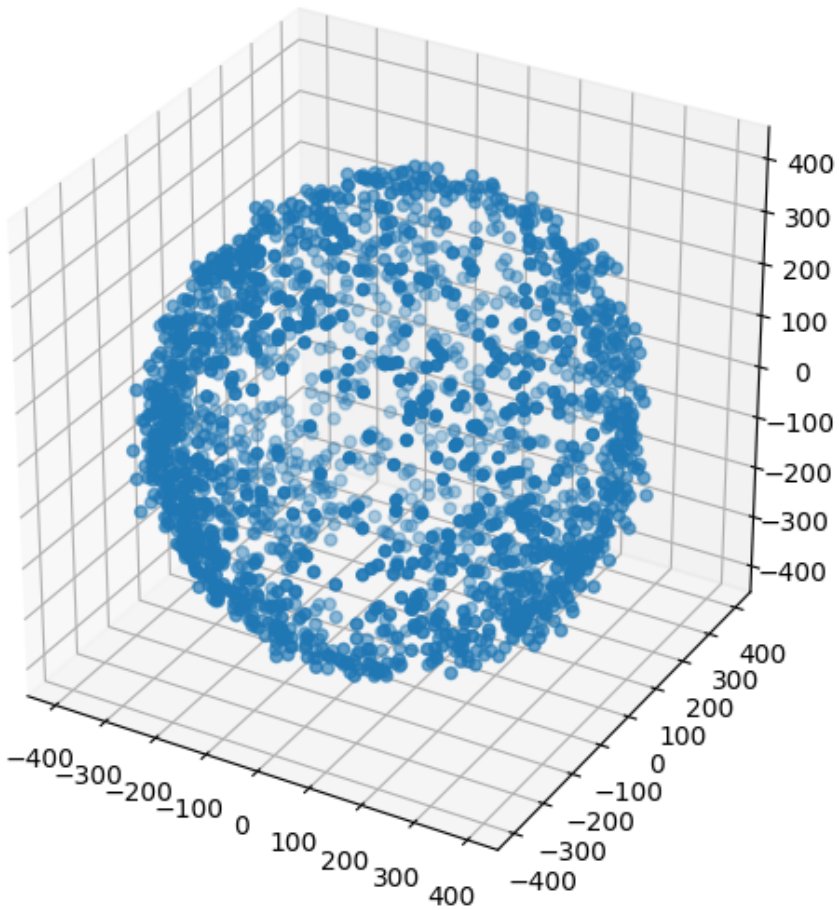

Scaled and Offset Corrected Data

Challenges Faced

- One of the main challenges was developing libraries for peripheral interfaces because of the vast array of documentation and software libraries to wade through [Solved].
- Sensor calibration to obtain accurate data which is required for sensor fusion [Solved].
- Interfacing the AK8963 magnetometer on the same I2C bus as that of the MPU9250 [Solved].
- Abrupt changes in the accelerometer data due to which angles computed are not stable [Debugging].

Future Plans

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- Perfectly calibrated pitch, roll and yaw with real-time data visualization (with GUI).
- Initial control algorithms for pitch, roll, yaw and throttle control will be developed.
- Barometer and VL53L0X ranging sensor interface for stable altitude control.

Thank You

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THANK YOU !!!