Progress Presentation-I

e-Yantra Summer Internship 2017

Control and Algorithms Development for Quadcopters

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Overview of Project

Control and Algorithms Development for Quadcopters

- To develop custom firmware for quadcopter for 32-bit microcontrollers on STM32F1xx (ARM Cortex-M3 core).
- Control parameters such as the throttle, yaw, pitch and roll and to develop algorithms considering various motion and dynamics.
- To analyse the control algorithm to identify effects of various parameters and to optimize it for stable motion.
- Develop a wireless joystick controller for maneuvering of the quadcopter.

Overview of Task

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Task No.	Task	Deadline
1	Study of datasheet and user guide of Pluto Drone.	2 days
2	Installation and Setup of IDE and tools.	1 day
3	Libraries development for GPIO, Timers, PWM, UART, I2C interface. Interfacing IMU to obtain filtered pitch, roll and yaw angles.	3+4 days
4	Code development for control of quad-copter for stable flight.	12 days
5	Wireless joystick control (using Node MCU).	6 days
6	Documentation for testing and debugging the drone.	6 days

Task Accomplished

Task 1
Study of datasheet and user guide of Pluto Drone

- Brief study on the ARM Cortex-M3 architecture to understand how the various peripherals (such as the timers, GPIO ports, I2C ports) have been interfaced the APB.
- 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

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 for various data types.
- I2C port was configured for sensor interfacing.
- MPU9250 Accelerometer and Gyroscope was interfaced.
- AK8963 Magnetometer was also interfaced.
- 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

Sensor Calibration and Data Visualization

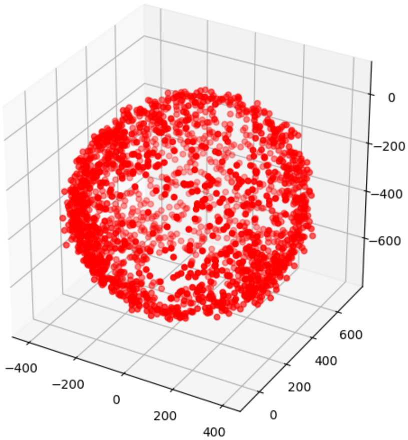
- The MPU9250 and AK8963 sensors were calibrated for offsets.
- The calibrated data was visualized using Python.
- Currently working on real time data visualization using Python. Successfully implemented data frame transmission with checksum.
- Process of plotting the real time data and development of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

Task Accomplished

Calibration Process

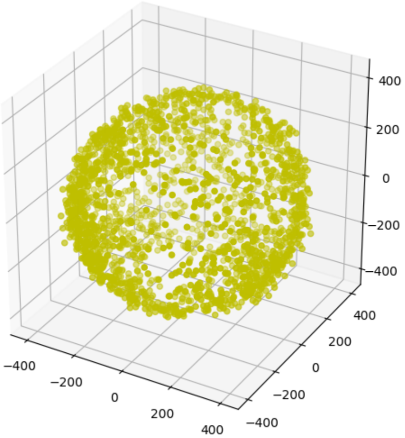
- Around 6,000 raw data samples were recorded.
- Average offset value was calculated as (MAX + MIN)/2 for all axes.
- Scaling factor was calculated as (MAX - MIN)/2 and then normalized.
- 3D scatter plots for all axes were visualized in Python.

Task Accomplished



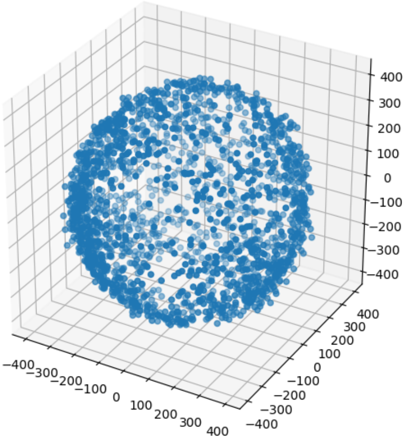
Raw Data from AK8963 Magnetometer

Task Accomplished



Offset Corrected Data

Task Accomplished



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 !!!