Autonomous Quadrocopter

Project Proposal

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PROJECT SUMMARY

The autonomous quadrocopter project is a project designed to implement navigational controls hi chase on a quadrocopter platform using minimal sensor input. The project will consist of obstacle detection using image processing, navigation using detected obstacles in conjunction with IR range-finders, and wireless communications with a base station. The quadrocopter will then be programmed to autonomously navigate through a narrow passage, avoiding walls and obstacles.

GOALS

- To develop a quadrocopter platform
- Autonomously navigate through narrow passages using onboard and stationary sensors
- Avoid obstacles using video and other sensor feedback
- Implement backup fly-by-wire controls for safety and testing

BLOCK DIAGRAM AND FUNCTIONAL DESCRIPTION

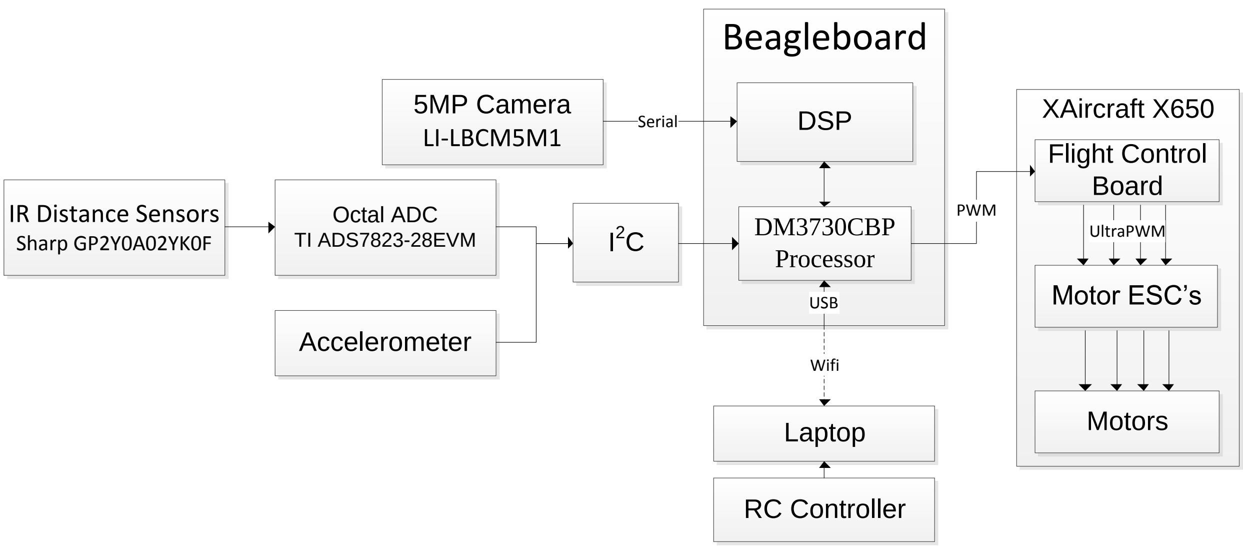


Fig 1.1 System Block Diagram

The quadrocopter consists of the following subsystems:

- XAircraft X650 quadrocopter platform with onboard flight control, ESC's and motors
- Beagleboard for onboard processing and control
- 5MP camera for obstacle avoidance
- Wireless communication to PC for safety
- IR distance sensors and octal ADC with I^2C interface
- Accelerometer with I^2C interface

The system functions as follows:

The Beagleboard will be attached to the quadrocopter and will perform the following functions:

- Video processing
- Sensor processing
- Movement controls
- Wireless Communication

The process flow for processing the sensors will be as follows:

1. The DSP will process camera input as it comes in
2. DSP information is output to the µC
3. Distance information is brought into the µC over I^2C
4. Control parameters determined by µC
5. Control parameters output to the X650 flight controller

MODES OF OPERATION

- Parked (off)
- Take off
- Landing
- Hovering
- Fly towards a specified relative coordinate in line of sight without obstacles, turning while moving
- Fly towards a specified coordinate, turning in place

SENSORS

The sensors used for this project include:

- IR distance sensors (Sharp GP2Y0A02YK0F)
- 5MP camera (LI-LBCM5M1)
- Accelerometer

IR DISTANCE SENSORS

There will six IR distance sensors onboard, one in each of the +/- x, y, z dimensions. The sensors output an analog voltage based upon how far they are from an obstacle (between 7 and 60 inches). To interface these sensors with the Beagleboard, an octal ADC module (TI ADS7823-28EVM) will be used that will communicate over an I^2C bus that is shared with the accelerometer.

CAMERA

The camera will be positioned on the platform directly attached to the Beagleboard pointing forward. The camera plugs directly into a socket on the Beagleboard and communicates over a serial protocol. The DSP chip will be responsible for processing all camera input.

ACCELEROMETER

An accelerometer will be mounted near the platforms gyroscope to aid in navigation. It will communicate over I^2C and will be processed on the µC.

PERFORMANCE REQUIREMENTS

DSP AND IMAGE PROCESSING

- Canny edge detection
- Corner detection using Hough transform
- Image capture rate >10Hz
- Image processing time <40ms
- Image processing rate > 10 FPS
- Image size of 640x480

PLATFORM CONTROL OUTPUTS

- Update rate faster than 10Hz
- Sensor propagation time <100ms
- Avoid obstacles closer than 1m
- Maintain constant altitude when necessary
- Turning radius < 1m while moving
- Maintain position and altitude within .1m
- Maintain approx. walking speed during flight

DISTANCE SENSORS

- 6 sensors in Euclidian directions
- Capture rate >100Hz
- Minimum distance of 20cm
- Effective range of 150cm
- Precision to 10cm

WIRELESS COMMUNICATION

- 802.11bg
- UDP transmission
- Timeout detection of 250ms
- Accurate reception of 100 commands/sec when applicable

DETAILED EQUIPMENT LIST

New Project Equipment:

- XAircraft X650 Quadrocopter Platform
- BeagleBoard xM
- Leopard Imaging 5MP Camera
- Belkin Wireless G USB card
- PC with Joystick
- IR distance sensors (Sharp GP2Y0A02YK0F)
- Octal ADC TI ADS7823-28EVM
- TI Logic Level Converter (1.8V to 5V)
- Accelerometer/Telemetry Sensor
- Batteries (A123 cells or TBD)

Bench Equipment:

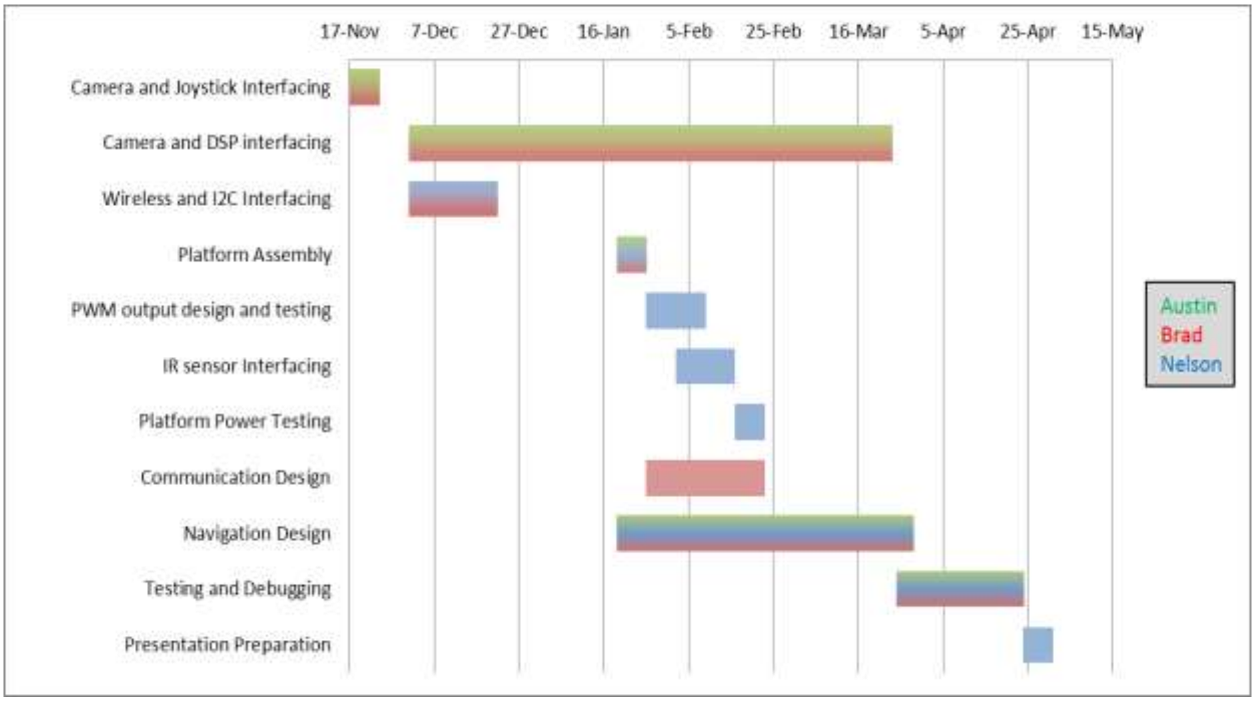
- **EQ-2690** Tektronix TDS 2024B Oscilloscope
- **EQ-2385** Agilent E3630A DC Bench supply
- **EQ-2140** Fluke 45 DMM
- **EQ-2700** Agilent 33220A Waveform Generator

WORK COMPLETED

We decided upon the platform, sensors, and BeagleBoard. Components for the project were researched heavily before decisions were made for purchasing items. The BeagleBoard environment was established including wireless communications, camera header drivers, and native software development environment. In addition, we demonstrated an ability to manipulate joystick information which will be useful later on. Initial test were run on an in stock version of the IR distance sensors to ensure effective ranging and accuracy.

SCHEDULE

The Gantt chart below describes the approximate schedule of work and events to occur in the remaining fall and spring semesters. Each individual is represented by a color on the chart, with multicolor bars indicating multiple individuals working on a part together.



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