# ECE 8 Robotics Notes 10-11-22

- Professor is not here today

- drones are passed out and video recording of the professor is presented

- IMPORTANT: this lecture is only to expose the class to all the different things involved in building and implementing a drone. We are not expected to know any of the information or recall it for later. So, the following notes are just fun facts.

- NOTE: there are several acronyms without formal explanation to what they mean/are that's because the presentation was too fast. So these are very-very relaxed notes. (Any line ending in (?) means I didn't understand what was mentioned)

## Video: Applications

- Applications of Drones:
    - farmers use drones
        - gives birds eye view of land
        - multispectral camera
        - map terrain
        - process data to understand the dynamics of the terrain
        - vineyards most often because of difficult terrain
    - search & rescue
    - construction site evolution process
    - warehouse logistics
        - location of items with drones to prevent potential injury and monitor stock items
    - delivery of goods
    - entertainment

## Drones

- use GPS
    - positioning
    - used this to create a map of a region of for example: a farm
    - can be adapted with cage to prevent damage to propellers
- types: classification by propulsion
    - wing type
    - rotor type
- other classification
    - military
    - weight dependence
    - capabilities
    - maneuverability
    - flight time
        - examples:
            - fly up to 5 min
            - 30 min for delivery etc.
    - data gathering options
        - send the data back to the user while in air
        - network in-able
        - onboard storage only
    - payload
        - carrying capabilities for subsystems
    - See links in references (in slides) for more information/applications/math-focused papers
    - Next Module: we will see a Quadrotor Drone and how it's currently used

End of 1st video

## Jake (tutor for the class):

- About Jake : helps in the lab and he is the one that designed the lab
- Quadrotor:
    - ST (company?) I didn’t catch the name
        - the chip found on the drones which were passed around
        - hobby drones’ hardware was compressed to the ST chip
    - FRAME
        - 3D plastic mechanical frame
        - not injection molded
        - Stratus printer used (?)
    - ACTUATOR:
        - motors found on the drone
        - small cheap DC brushless motor (there are brush motors but brushless is preferred) (?)
        - single pull has no steps and are preferred (?)

- PROPELLERS:
    - size and weight
- SENSORS
    - IMU: Internal measure unit
    - can check acceleration
    - gyroscope: understand self-rotations
    - magnetometer: for relative position
    - pressure sensor: for altitude sensing
- COMPUTING:
    - microcontroller
    - ARM cortex
    - ST microcontroller
- COMMUNICATION
    - Bluetooth
    - RX controller
- POWER
    - liPo batteries
    - 5 min life
    - ESC electronic speed controller
    - have mosfets: they switch the power of the rotors on and off to test the speed of the rotor (?)
- USER INTERFACE
- something, he was too fast
- keywords:
- microcontrollers

## 2nd Presentation

- presentation gives specs
- at home drones can be built simply
- question posed by student:
    - what is the purpose of the tape on the ground?
        - it is a defined space for the drone, as the origin point/reference point
        - this is referencing a video we watched of a drone

## 3rd Presentation

- Principles of motion and physics
- 4 motors have 6 degrees of freedom (i.e. less actuators than degrees of freedom)
    - the 6 are x,y,z, pitch, roll, yaw
        - Vertical motion
        - ascend and descend
        - propellers give thrust (the faster the spin the more thrust)
- translational
    - roll or pitch the drone
        - to pitch or roll we can make the front 2 propellers to move faster than the back 2
- Yall:
    - rotation in the plane
    - speed up the CW(clockwise) propellers and slow down the CCW (counterclockwise) propellers
    - we need math to further understand but again it's the idea of isolating rotations

- Math used
    - torque
    - the moment about a body
    - the sum of tau = I alpha
        - the sum of torques is equal to the moment about a rigid body times alpha
        - analogous to F=ma
        - I:moment of inertia
            - resistance of motion
    - rigid body model for the quadrotor
        - see slides for the equations

## Circuitry presentation

- Components
- power
- signals
- FCU: flight control unit
- Capacity = discharge * discharge time
    - 100mA will take 65h to drain a 6500mAh battery
- discharge rate
    - max discharge = burst rate * mAh
    - e.g.: 10C * 650mAh will give 6.5A
    - 10C is usually written on the battery
- clock switch analogy (motors) (?)
    - light switch
    - multipole motor (stepper motor)
    - the switch is the PWM (pulse width modulation)
        - duty cycle is a period s.t the % of time that the signal is high
    - single pull motors best used with duty cycle PWM

## Programming /Computing pt1 presentation

- software/coding

- material is lost on me

## Last presentation

- controllers are on the drone and there is one not on the drone
- in any control system we require:
    - a command to tell the desired state
    - a command to tell the current state
- PID: (?)
    - commands the rotors and reduces the error between the current and desired angle
    - cannot have one PID do all 4
    - we use several PID controllers and outputs the motor commands

- within a PID (?)
    - it has 2 PID's in series
        - takes in current and outputs desired rates
        - the error is given to the 2nd controller and the 2nd one is then the one that outputs the commands
    - update rate:
        - inner loop runs faster than the outer
        - this is a good convention
        - the inner loop should converge before the outer system changes "its mind"
- Position feedback control (?)
    - optitrack IPS: indoor positioning system
    - computes similar to PID but relative to the space it is in to move the drone to a new position

## Info on Lab 2

- Leaning control flow of programming
    - if statements
    - loop statements
- if:
    - starts with if
    - ends with end
- condition: is it true or false
    - e.g: given x = 2
    - if x > 4
    - print (x)
    - since this is not true it will not print
        - see lab for a better example
- if vs switch
    - if our if blocks are 5 or more then use a switch instead
    - the compiler will use jump tables and it uses an inefficient compile
    - switch uses HashMap
- Loops
    - while
    - for

- Due 10/21 next Friday 6pm