Positioning technologies

An overview

Goal

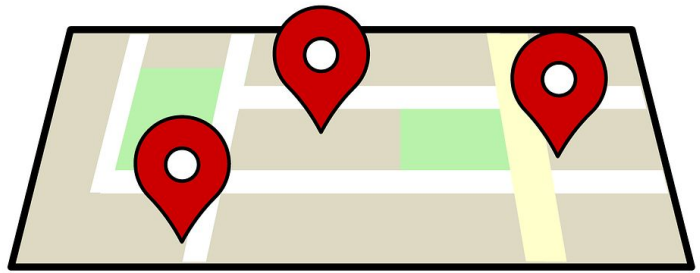
A general understanding of positioning and technologies that are available

Why positioning?

- Quadcopters and other robots
  - A robot does not know where it is
  - Want autonomous flight or motion
  - Accelerometers / gyros (IMU) are not good enough
- Other use cases
  - Warehouse management
  - Machines in a hospital
  - Customers in a shop
  - Tracking body motion
  - Gaming
  - ...

What is positioning?

- A system that can calculate the position of a robot using internal or external sensors and devices
- GPS is an example



Relative VS absolute positioning

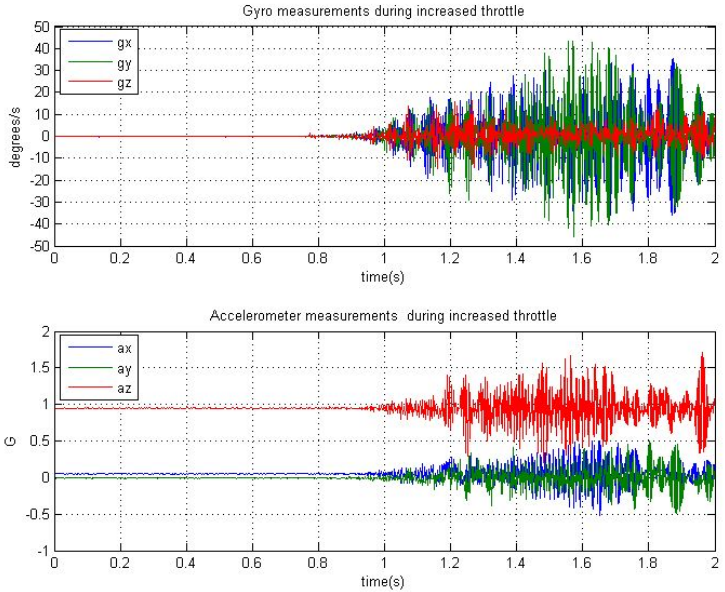
- Relative positioning
  - Only using on-board sensors - optical flow (camera) and ranging sensors
  - Can only determine position relative to start position
  - Compare with an optical mouse
- Absolute positioning
  - Requires external references or devices such as radio anchors, base stations or cameras
  - Provides absolute position in space
  - Compare with GPS

Position estimation inside or outside the Crazyflie

- The computations that gives the position of the Crazyflie can be done in the Crazyflie CPU or on a PC
- On a PC
  - Supports heavy computations
  - Data available on in the PC (large data sets)
  - Position must be transferred to the Crazyflie, bandwidth limitation ⇒ limited number of devices
  - Higher latency
- In the Crazyflie CPU
  - Limited CPU power
  - Data available from internal sensors (small data sets)
  - Scales to many devices
  - Low latency

Position estimation

- We never know exactly where we are - we only have an estimate
  - Errors
  - Uncertainty
  - Noise
- Sensor fusion
  - Accelerometers
  - Gyros
  - Other sensors
- Kalman filter

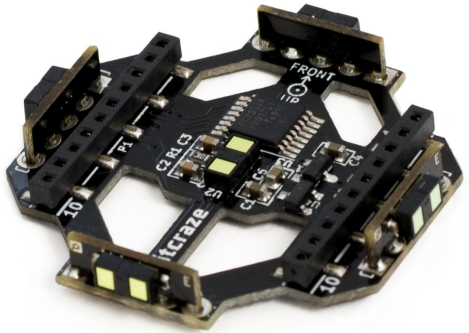


Ultra Wide Band (UWB) Radio

- Radio based
- Time of Flight
- More details in other session

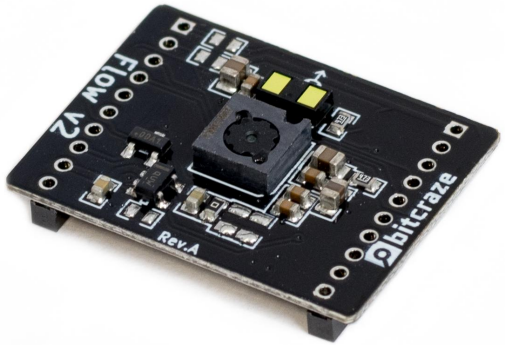
Ranging sensors

- Laser ranging sensor
- Time of Flight
- Outputs distance to closest obstacle, processing done in chip
- Up to 3 meters



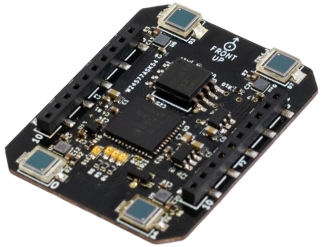
Optical flow sensor

- Small low resolution camera that tracks motion
- Similar to sensor in an optical mouse
- Outputs relative motion in X and Y, image processing in chip
- Must be combined with distance to be useful



The Lighthouse

- Base stations that sweep horizontal and vertical light planes through space
- Light sensors on the Crazyflie detect when they are hit by the sweeps
- Base station position and orientation is known and from this the position of the Crazyflie can be calculated
- More details in other session



Motion capture systems

- Use external cameras to track markers on a robot
- With multiple cameras, the position of each marker can be calculated
- With multiple markers on the robot, the full pose can be calculated
- Very high precision - “ground truth”
- Calculations done in a PC and position is sent to the robot

Other technologies

- Ultrasound
- On-board camera - SLAM, markers on objects
- External cameras - AR markers on drone, reflective markers
- Radio based - angle, receive power
- More...

Conclusions

- Many technologies
- Different properties
- Position calculation in Crazyflie VS PC