# Designing an Autonomous Quadcopter

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## Quadcopter Characteristics

- Uses 6 directional sonar sensors to navigate indoors
- Will run a version of SLAM called orthoslam that locates planes(walls indoors) and navigates based on a map of the surrounding planes
- Has four brushless motors that can lift 290 grams so it can lift a total of 775 grams counting the frame and electronics
- Has a flight time of 12 minutes on a 1300mah battery

## Motivation

- Improvements in hardware and battery technology make it feasible for the first time to fly for extended periods of time in small spaces.
- The algorithms and software needed to fly indoors largely doesn't exist as most autonomous flight is guided by a human or guided by satellites which do not work indoors
- We are on the cutting edge of research into autonomous indoor flight and it will be largely done in approximately 5 years.

## Build

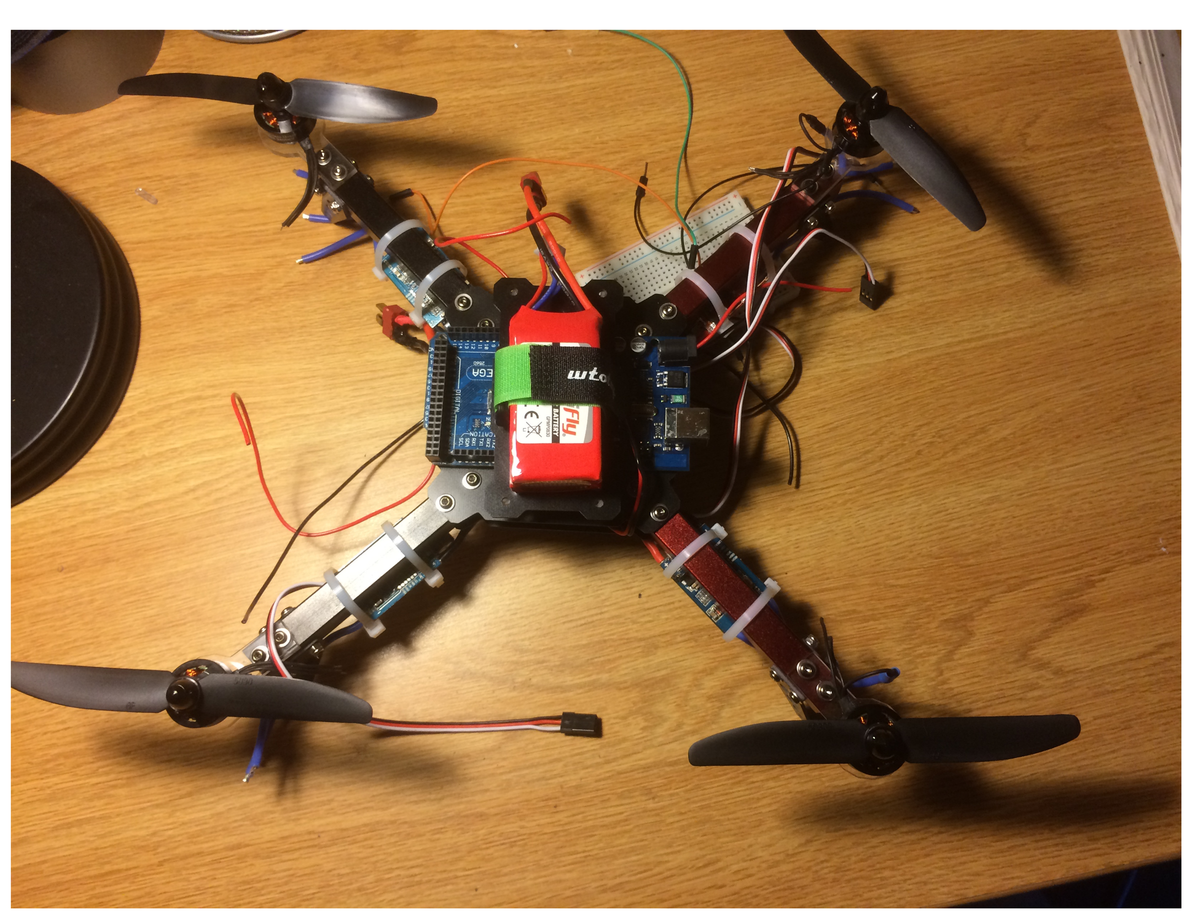

**Figure 1:** Completed Quadcopter

- Built out of Aluminum and Glass Fiber. The light materials contribute to a low overall weight of 385 grams.
- Custom designed motor mounts made out of PMMA plastic
- The quadcopter is 10″x10″ and fills a space of 15″x15″ when the spinning propellors are factored in. Its small size makes in maneuverable in doorways and hallways.

## Control Sequence

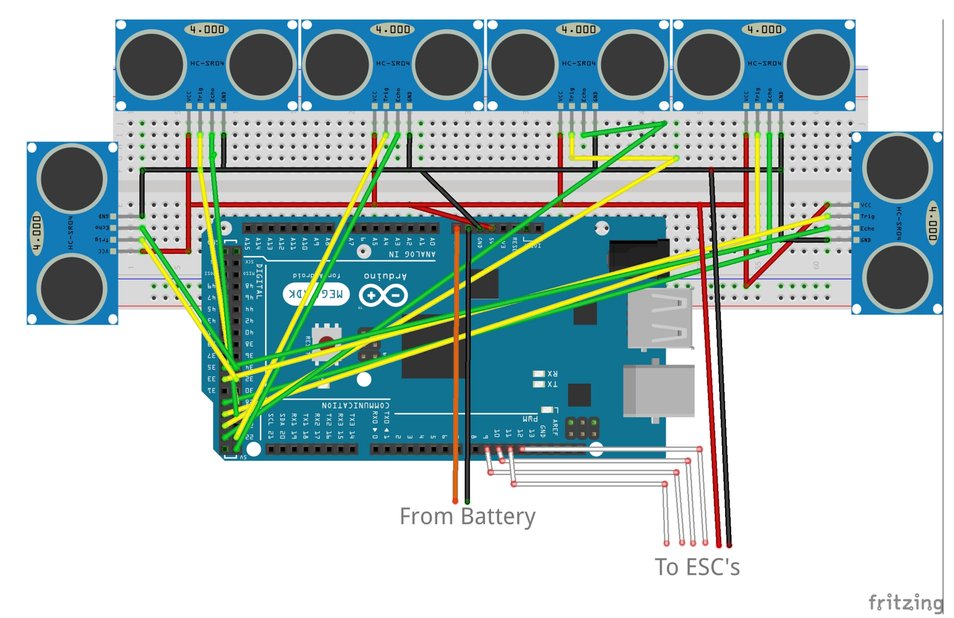


**Figure 2:** Wiring Schematic

- A KK2 Board runs through the PID loop while an Arduino Mega does the Sonar calculations
- Abstracting the control loop out onto its own board mitigates the overhead causes by running a PID loop as well as checking six sonar inputs
- The sonar loop is very simple, it first gets to a stable hover at ≈ 5cm. Then it enters into the navigation loop.
- The navigation loop runs the difference algorithm and sends it the KK2 board.
  - Takes the path array $h$
  - $i$ is the waypoint counter (initialized to zero)
  - Find the current waypoint $h[i]$
  - $w$ is the current sonar input
  - $r$ is the range of the controller (0-90 for most controllers)
  - Sets $o$ to the square of the difference between $h[i]$ and $w$ divided by $r$

$$o = \frac{(w - h[i])^2}{r}$$

**function** MAIN($h$)
  $stableHover()$
  $flying \leftarrow true$
  $i \leftarrow 0$
  **while** $flying$ **do**
    $w \leftarrow getSonarInput()$
    $o \leftarrow \frac{(w-h[i])^2}{r}$
    $flying \leftarrow sendDifference(o)$
  **end while**
**end function**

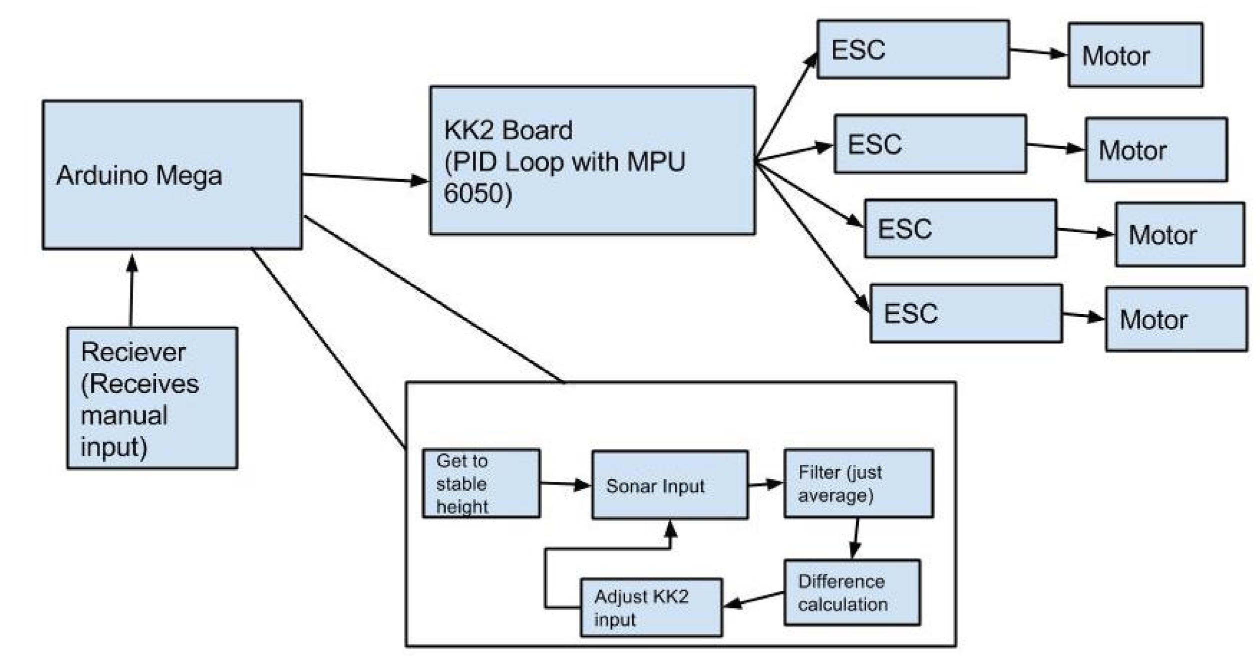


**Figure 3:** System Architecture

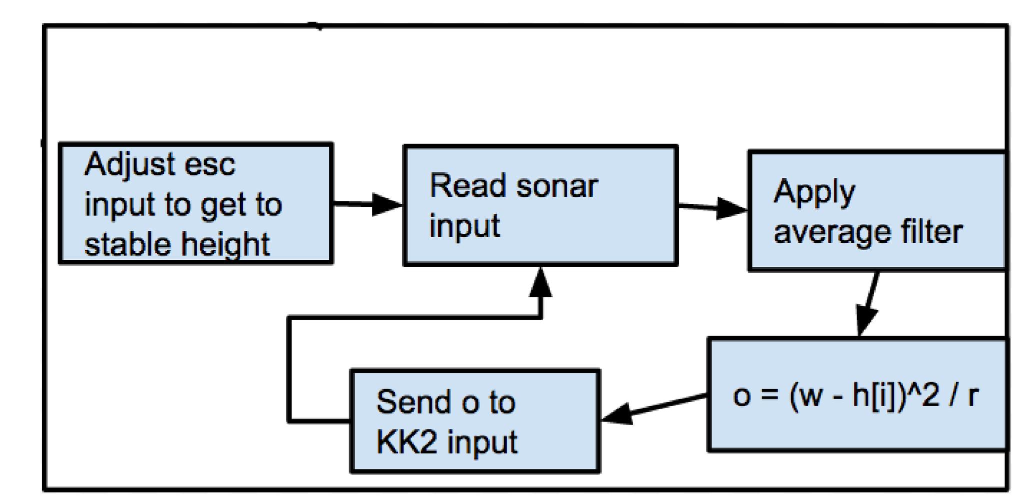


**Figure 4:** Code Architecture

## Significance

- Since the drone can fly in tight spaces with no outside input it makes sense as a mapping tool or data collection platform for situations that put humans at risk
- This can be used in situations that put humans at risk.
- In the future this will run on Rich West's Quest operating system.

**Project Website:** *http://cs-people.bu.edu/swsmith/iap15.pdf*
**Quest Website:** *http://www.questos.org*

**Advisor:** Richard West