Autonomous Quadrotor Combatants in Simulated Combat Environment

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Narrative

The goal of this project is to create a team of four quadrotors that work together autonomously to play laser tag against human opponents competitively. A quadrotor is an aerial vehicle, similar to a helicopter, that has 4 rotors to create a stable platform. It is desired for the quadrotors to present a significant challenge to the human opponents, even to the point of being able to defeat them. This means that the quadrotors must be agile and able to fire with high accuracy. They must also be able to make decisions quickly and dynamically, so as not to be predictable. The quadrotors will be operating in a known environment, as the aspect of autonomously creating a virtual map of an environment is outside the scope of our expertise and resources. The quadrotors will receive commands from a remote tactical control system, and send information back about their current position, orientation, and whether they see an opponent or not. The control system will implement artificial intelligence techniques running on a reasonably powerful computer to make rapid, tactical decisions in order to achieve victory. The position and orientation of each quadrotor will be calculated by inertial measurement and dead reckoning. Each quadrotor will have a camera attached to see its surroundings; if an opponent is detected when the camera image is processed, the tactical control system will decide whether to fire on the opponent or evade fire and send appropriate instructions to the quadrtotor. When a quadrotor is "killed" or the end of game conditions have been met, the control system will guide the quadrotor(s) back to a charge station and power them off to charge for the next round. To avoid damage, each quadrotor will also monitor its battery level and send this information to the control system. If the battery level falls too low, the control system will guide the quadrotor back to the charge station and power it off.

The applications of this project range from entertainment to military use. In the entertainment industry, a team of autonomous airborne combatants creates an exciting new challenge for laser tag players. If the quadrotors are equipped with non-lethal weaponry, such as a TASER, they could be used in law enforcement and military applications. This would allow the disabling of an armed suspect or combatant without risking human life. This application would require expansion on our project by allowing for the quadrotors to either create a virtual map of the environment in real-time, or operate on less information about the environment, such as a blueprint.

Specifications

How many: 4 quadrotors
Operating Altitude: 1 – 8 feet
Diameter: 8 – 18 inches
Battery: 11.1 v
    44 amps
Motor: 11 amps
    Kv rating: 1100 – 1600 RPMs/volt
How close each gets to walls: 6 inches
How close each gets to other quadrotors: 8 inches
Propeller: 8" diameter, 3.8" pitch
Web cam: 2 megapixel resolution
Velocity:
    Vertical: ~1m/s
    Horizontal: ~2m/s

Cost Analysis

The optimum goals of the project will cost $2500. This is broken down to approximately $375 per quadrotor and $1000 for a tactical control system. The quadrotors at this price point will be able to navigate around various obstacles with great speed and agility. Having a remote tactical computing system will allow for a more advanced artificial intelligence component, yielding faster and more intelligent decision making. This would also allow use of the Soar architecture for the AI component or the project. Should we be unable to attain our ideal budget, the project will still be able to proceed, but its overall performance will be greatly impeded.

Basic Level ~ $1000

- Swarm computing, minimum requirements for speed and agility

Intermediate ~ $1500

- Swarm computing, ideal speed and agility

Advanced ~ $2000

- Remote tactical computing, basic speed and agility

Optimum ~ $2500

- Remote tactical computing, ideal speed and agility

Design Plan

With the volume of research and design required for this project, we have split it into four main components and each member has taken responsibility for the success of one:

Artificial Intelligence – Shane Parker
Image Processing – Yousef Al-Khalaf
Flight Control – Chris Culver
Power Management – Bianca Wood

Each component is heavily integrated with all of the others, so we will be working closely together on all aspects of the project, but will each be taking the lead on a different part.