Unmanned Aerial Vehicle

THE XR-82 PROJECT

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Abstract

In many circumstances it is desirable to have a versatile, inexpensive, autonomous robot available to complete a task. This is most often advantageous when a circumstance presents a danger to human life or when a human is not possible due to size or maneuverability issues. Our goal will be to create an aerial platform that will be the core for mission specific uses. These uses range from surveillance, mapping, search and rescue, security and more. Military applications are also possible and advantageous due to the low cost of the platform and the life saving possibilities of robotic warfare.

Project Description

Goal:

To design and fabricate an aerial vehicle capable of autonomous flight to maneuver down a hallway, retrieve a digital data sequence and report it.

Functionality:

- Take off from a specified location
- Navigate through a hallway without contacting the walls.
- Sense an infrared LED emitting a data sequence and capture the data.
- Return to the take off location without contacting the walls
- Land
- Perform all functions autonomously without user input
- Vehicle will have a master kill switch to limit potential damage

Conceptual Design:

The microcontroller will be programmed with a main algorithm that will control the vehicle using inputs from various sensors. A three axis accelerometer will provide the microcontroller with tilt information to stabilize the vehicle. An array of infrared sensors will provide the microcontroller with the information to control its position relative to the hallway. These electronics will be mounted on a main control board using stand offs.
Background Research:

To accomplish the given tasks, there are many aerial designs to choose from. A fixed wing airplane was considered, but due to the restrictive nature of an indoor flight and the speed required for a functional craft, it was omitted. An airship was also considered, however it was deemed too bulky, slow, and fragile. This left us with rotor based designs of a helicopter or a quadrotor. Our team will design and build based on the concept of a quadrotor. This choice was made for many reasons which are as follows:

- Simplicity of design leading to less mechanical failure and lower cost
- Smaller rotor size due to having four rotors which would cause less damage in the event of a collision
- Higher payload capacity ensuring that our design would be capable of performing different tasks with different load requirements

System Design:

Sensors will obviously be necessary for autonomous flight. In order to control the six degrees of freedom needed for three dimensional movements, accelerometers will be required to gather tilt information relative to the axis. The output from the accelerometers will then be read and interpreted by the microcontroller to maintain stability. Movement through the hallway will be monitored by an array of Sharp infrared sensors mounted in an ‘X’ configuration; each one mounted 45 degrees from the axis. By comparing the values given by the IR sensors, the relative position in the hallway can be obtained. These will allow us to use the two relative locations on each side to monitor the rotation around the Z-axis and avoid the use of a gyroscope. A gyroscope could be used but will try to be avoided due to their relatively high cost. Another IR sensor will be aimed downwards to monitor our altitude.
These values will be continuously checked and correspondingly corrected by the microcontroller/motors, enabling our vehicle to maintain its flight without any input from the user. A reference point for all sensor values will be established before take off for the main stability routine. A new set of reference points will then be used for movement.

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![Diagram of the XR-82 project](image)

**Figure 2: Top View**

**Figure 3: Hardware Block Diagram**
Constraints:

Due to the end goal of the project being competition with another team, the main restrictions are defined by the rules of the game and the size of the hallway. The hallway is approximately 7 feet across and 100 feet long.

The rules of the game are as follows:

a) Robots will take off from a specified location

b) Robots will have to fly to the end of the hallway

c) At the end of the hallway will be an infrared beacon emitting an 8-bit sequence the robots will have to capture

d) Crafts will have to return to the original take off location and land

e) Teams will be judged by time of completion, absence of collisions, and data capture

Maintenance for the craft is very simple due to the vehicles modular nature. Each of the major functions will be placed on an independent circuit board with headers
so as to be easily replaced. The motors and propellers also lack the servo motors typically used to control tilt, also minimizing maintenance issues. Manufacturing will also be quite simple once again due to the modular nature. The carbon fiber frame and brackets can be drilled with a CNC machine and the boards are also installed easily using headers.

**Project Plan:**
*See attached Gantt chart.

**Cost Analysis:**

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<th>Manufacturer</th>
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<th>Description</th>
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* Tax and shipping not included

**Total** $339.86 $343.88

Updated: 10/12/08
References


**The XR-82 Project** will be a quadrotor craft designed to be a universal aerial platform that can be configured for various mission specific tasks. This particular unit will be designed to take off from a specified location, maneuver down a hallway and retrieve an infrared data package. The vehicle will then return to its take off position, land and report the data.