Project Proposal

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1 Principal Investigator

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2 Project Title

Auto-Pilot: Autonomous control of a remote controlled helicopter

3 Problem Statement

Autonomous vehicles have become a very popular subject and a lot of research and effort has gone into their development . Autonomous air vehicles (or drones) are of particular interest, as they can be used for military purposes such as battlefield environments and also for security and surveillance. [6]. One way to implement this autonomy is to first investigate small, remote controlled helicopters and attempt to make them autonomous. The aim of this project is to create a system that simulates an autopilot for a Syma S107 mini helicopter. This helicopter must be tracked using a Kinect camera and sent messages in real time, using an Arduino board, in order to make it autonomous. Even though a mini helicopter's performance will be quite different to that of a full size one, it is a feasible starting point.

4 Objective of Research

The main objectives of this research are stated as follows:

- Send commands to the mini helicopter from an infrared transmitter on an Arduino board which can control it's movements
- Identify and track the LEDs attached to the mini helicopter to monitor its movement. This will be done using a Kinect.
- Use this tracking information to control the helicopter autonomously.

The helicopter should be able to perform certain predefined movements. These will first be simple, like hovering in one place, and will then increase in complexity until it can do movements such as fly in a figure of 8 or fly around an obstacle, such as a pole.

5 History and Background

5.1 Autonomous helicopters

Helicopters are fairly difficult to control due to their complexity [5]. They are, however, very useful vehicles and have a lot of real-world applications. Making an automated helicopter would be very useful as they have many advantages and uses. They could be used for security, such as helping the pilot if they cannot control the vehicle, or provide surveillance of aerial space. They can also be used for monitoring things like volcanoes, air pollution and other environmental factors. Another very pertinent use could be to help in dangerous situations, such as removing mines and going into radioactive atmospheres [5, pp. 1–2].

5.2 Syma S107 RC helicopter

The Syma S107 remote controlled helicopter will be used to make a small-scale autonomous vehicle. This is the first step into the world of autonomy. The Syma S107 has three basic movements. These are the throttle, the yaw (rotation) and the elevator (forward or backward movement). The main advantage of using this helicopter is that it is very stable. This stability is a result of the helicopter having two propellers and a stabilizer bar. The

helicopter has 3-channels and uses infrared for control, which means it has to be used indoors due to interference from sunlight [1].

5.3 Arduino platform

The Arduino Uno board will be used to send commands to the helicopter. Arduino is an inexpensive platform for making interactive applications. The Arduino board has an ATmega328 micro controller and can be powered by USB. The Arduino programming language is based on the Processing programming environment and is quite simple to learn [3] [4] [8, pp. 1–3].

5.4 Tracking

In order to make an auto-pilot system, the mini helicopter needs to be tracked. This will be done using a Kinect which is a motion sensor for XBox 360 and gives 2D information as well as depth information. The Kinect will be used to identify LEDs on the front and back of the mini helicopter and track these as it moves. Calculations can then be performed on the position of these LEDs, which can determine where the helicopter is, how far away it is and what its next movement should be.

5.5 Previous work

A lot of work has been done using the Kinect to track different objects such as a head, a person or gestures. The 3D tracking of human hands was done using a Kinect [7]. The Kinect is a very useful tool to have when trying to track objects because it can give 3D information. The tracking of mini helicopters has also been done in a number of different ways using different tools. One approach, done by [9], used a Bonita camera manufactured by Vicon Motion Systems to track the helicopter. The helicopter used in this project has been used before, together with the Arduino board, to allow it to be controlled from a computer [2]. Results from this previous experiment showed that the IR LED used was not as strong as it should be. For this reason, a max power LED kit will be experimented with in this project.

6 Approach

The approach for this project can be divided into four phases. The time line, shown in Section 8, gives estimated times for each of these phases.

- The first phase of the project will involve getting to know the Syma S107 helicopter being used. This includes understanding the different movements of the helicopter. This first phase also involves gaining familiarity with the Arduino environment and learning the programming language. There will also be a lot of research done in order to gain familiarity with object tracking and the various ways to implement this by using the Kinect.

- The second phase involves decoding the infrared protocol used by the helicopter and understanding how this protocol works. Once this information is found, a program must be made to send commands to the helicopter via an infrared emitter on the Arduino board. This must be worked on extensively until the helicopter is moving quite steadily.

- The third phase of this project involves making a tracking system to track the helicopter from the Kinect. This system must be able to extract the helicopter's 2D position and calculate the distance of the helicopter from the camera, which will give it a 3D position. These positions will be used to determine which commands must be sent to the helicopter, in order for it to move in some predetermined way.

- The fourth and last phase of this project involves testing. Automation of a helicopter can be very unreliable and tricky, therefore a lot of testing needs to be done to ensure that the helicopter moves in the right way at the right time. Any unsolvable problems will be recorded and recommended for future research.

7 Requirements and Resources

The hardware requirements of this project are:

- A Syma S107 R/C helicopter
- An Arduino Uno board
- A Max Power IR LED Kit or any IR LED
- A Kinect camera

The software requirements of this project are:

- Arduino software
- Kinect software

8 Time line

The following table shows the estimated time line for the project:

Table 1: Estimated time line of auto-pilot project

Dates	**Activities**
28 February - 5 March	Prepare Project proposal and presentation
6 March - 20 March	Research and gain familiarity with the Arduino environment and the controls of the helicopter. Research object tracking. Start project website
21 March - 10 April	Learn about the infrared protocol used and attempt to create a system that can control the helicopter
11 April - 17 April	Gain familiarity with the Kinect and its software
18 April - 15 May	Apply knowledge of object tracking and Kinect to attempt to track the helicopter
16 May - 1 June	Build initial prototype system to control the helicopter and make it fly in a straight line and turn around. Complete Literature survey
15 June - 13 July	Improve system to track and control helicopter to do more advanced movements
14 July - 16 September	Testing and improvement of system
2 November	Project Completed
5 November	Complete website
19 November	Short paper submitted

References

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