

# Color Tracking Turret Project Proposal

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Initial proposal for ME102B project, where we introduce a color tracking missile turret device that can be controlled remotely offsite.

## I. Introduction

Modern day warfare is an increasingly impersonal affair. We seek to investigate the extents to which technology can be applied to weaponry. Specifically, we want to explore the areas of image processing to see exactly how much human intervention we can remove from the control loop.

## II. Goals

Specifically, we propose to prototype a system which provides the following functionality:

1. Tracking of arbitrary color of a target, specified by user input.
2. Ability to control the turret remotely, with a simple user interface.
  - (a) Input of which color to consider as the target.
  - (b) Fire on command.
  - (c) Ability to manually override the turret.

## III. Design

We will seek to design the entire system from the ground up. The components include:

1. Mechanical missile turret armed with electronically controlled gun.
2. Camera mounted to turret for color recognition.
3. Computational server that will be responsible for running the control loops and the color detection algorithms.
4. Interactive server that will interface with the computational server to respond to human commands, in addition to provide a user interface.
5. Networking infrastructure (possibly wireless) for all the components to communicate.

## IV. Algorithm

Here is a high level description of our main control loop algorithm

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### Algorithm 1 ControlLoop( $R_d, G_d, B_d$ )

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Capture  $(R_i, G_i, B_i)$  values for each pixel from camera  
Let  $I :=$  convert image into black/white image based on heuristic function (inputs are  $(R_d, G_d, B_d)$  and  $(R_i, G_i, B_i)$ )  
Let  $(X_I, Y_I) :=$  spatial centroid of  $I$   
Run PID on  $X_I$  and  $Y_I$  such that  $(X_I, Y_I) \rightarrow (X_I^*, Y_I^*)$

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### Algorithm 2 Heuristic( $(R_d, G_d, B_d), (R_i, G_i, B_i)$ )

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Let  $x := \sqrt{(R_d - R_i)^2 + (G_d - G_i)^2 + (B_d - B_i)^2}$   
**return**  $x < threshold$

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## V. Proposed Implementation Details

In our first implementation, we propose the following architecture. The turret will have two degrees of freedom,  $X$  and  $Y$ . There will be two motors controlling both axis. These motors will receive PWM signals from an Arduino microcontroller board mounted on the turret. The Arduino board will, in turn, receive control command data from the computational unit via a serial link (or wireless). We will use a simple serialization format for this communication. The camera mounted on the turret will be connected to the computational unit via USB.

The computational unit will be running the algorithm described previously. We will make use of Intel's Open Computer Vision (OpenCV) API to do our image processing.

## VI. Challenges

Most of the challenges we foresee deal with the accuracy and sensitivity of our color detection algorithm. Because we are using a simple heuristic model, our algorithm is quite susceptible to changes in the background; it will work best when there is an obvious contrast between the color to track, and the background. Also, the color will need to be a solid block. A more complete model would incorporate a combination of heuristics and statistical machine learning models over large data sets.

Another challenge we foresee has to do with the accuracy of the gun. Because we are only detecting color, depth information is not captured very well. Therefore, how we position the gun (how we determine  $(X_I^*, Y_I^*)$ ) might not be as accurate as possible. To deal with this, we might take into consideration how bright the recognized color is, and adjust our reference position accordingly. This would probably be aided by switching to do calculations in the HSV color space (instead of RGB).

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