Run, Edwards, Run!

Shoot First, Ask Questions Later.

Andrew Bui*, Cathy Chen†, Johnny Chin*, Andrew Sabato*, Michael Scott†

*Department of Electrical Engineering
†Department of Computer Engineering
School of Engineering and Applied Science,
Columbia University in the City of New York

Abstract:

The goal of this project is to create a platform that locates and shoots a non-lethal dart at a predetermined target (individual wearing a tracking device/target). This project utilizes both the hardware and software capabilities of the Altera DE2 Board, while also using our knowledge of ballistics, image recognition and robotics.

Introduction:

Computer Vision, Image Processing, and Trajectory Analysis are all interesting projects that can be implemented on an Altera DE2 FPGA Development Platform. This project aims to explore the abilities of all these processes on the DE2, to create an interesting application. Using the processes listed and utilizing the skills learned in CSEE4840 the final application will be a mobile robot that is able to track, chase and attack a target.

Final Deliverable:

The project will involve an object recognition program that is able to locate the position of a stationary target, along with the rocket launcher. The object recognition will drive a tracking and ballistics algorithm on the software layer which will allow the deliverable to fire a foam dart gun at a given target of interest.

Object tracking will be implemented through the use of LEDs in the RGB space. In order to realize consistent ballistics action, the movement of the USB Rocket Launcher will be controlled via the modulation of the elevation and rotation angles.

The ideal realization of this robotic platform will ideally be self-contained, including initial calibration. This self-calibration will be achieved through the use of trial shots in order to gauge the real space distance as a function of pixel distance.

Action Points:

Currently the project naturally presents three separate considerations:

Action 1:

The first major consideration would be target acquisition and image processing. We would like to model our image processing on the concept used in the popular Nintendo Wii system. Given an image that contains LEDs of an unknown distance, the coordinates of the target can be captured with a camera, and the distance from the rocket launcher to the target, as well as the distance off the ground can be calculated. The “Robot Eye View” input from the hardware will be fed to the NIOSII for processing, and will additionally be displayed on the LCD monitor via the VGA output on the DE2 board. When a predetermined distance is reached, the ballistics calculation and firing will be triggered.

Action 2:

Using the distance calculation from the image processing, a ballistics algorithm will be used to fire a projectile at the target. The USB rocket launcher, which is electronically triggered via the USB port, seems to be a viable solution to the ballistics needed. Given

the distance to the target and known behaviors of the trajectory of the foam darts, we will calculate where the target will be upon impact and fire the dart at that point.

Action 3:
Using the USB Rocket Launcher from thinkgeek.com, we can control pitch and pan of the launcher. The Rocket Launcher has been investigated by numerous individuals and has a USB protocol for changing these conditions in the Rocket Launcher. The USB protocol seems to be fairly well documented on a few internet sites.

Hardware and Software:

1. The hardware side of the project consists of some type of IR LED sensing device (which is most likely going to be a camera), a bar that has two groups of IR LEDs separated by some distance, and the peripheral for trigger the USB Rocket Launcher.
2. On the software end, we will implement all the algorithms for ballistics calculation, image processing and motion control using C.
3. In addition to the hardware and software we have to implement, we will use the DE2 board from Altera and the USB Rocket Launcher which are readily available to us for the project.

Milestones:

Milestone 1 (March 29):

- A communication protocol between the peripherals should be set.
- Each interface should be defined and tested.
- USB Rocket Launcher can be controlled from the FPGA.
- Video input and hardware processed image should be completed and the "Robot Eye View" should be displayed on the LCD monitor.

Milestone 2 (April 12):

- USB Rocket Launcher statistics (accuracy distance, height of gun mount, etc...) should be obtained.
- Ballistics calculation should be well underway
- Image processing algorithms should be complete

Milestone 3 (April 28):

- All peripherals should be integrated together, mounted, and the process of testing, debugging and retesting should be under way.

References:

1. CSEE 4840 project from Spring 2008: http://www1.cs.columbia.edu/~sedwards/classes/2009/4840/proposals/POTS.pdf

2. USB Rocket Launcher: http://www.thinkgeek.com/geektoys/warfare/8a0f/