University of Illinois at Urbana-Champaign

ECE 445 Spring 2013

Senior Design

Project Proposal

Aggressive Chasing Car

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I. Introduction

1.1 Statement of Purpose

Senior design is a class where we make our dreams come true. The dream might not be an ambitious one such as becoming a billionaire, but this is a critical start of everything before our successful careers. Through the project we develop and improve our social and technical skills, which are both very important to our future. For this project, when we were bouncing the ideas of the project, we found out both of us have a keen on chasing running target. It seems that both of us want to be the "good guys" and love classic movie scenes such as chasing the bad guys. Luckily we have our idea approved, and now it's the chance for us to direct a mini chasing scene ourselves!

1.2 Objectives

- **Scenario:**

Our goal is to design a linkage system between a running car (the bad guys) remotely controlled by us, a chasing car (the good guys) driven by a microcontroller with an image processing and trajectory calculation algorithm, and the camera on the ceiling (the satellite, or the chopper).

At first, the chasing cars hides itself in some shady dark corners and monitors the cars passing in front of it. Once it detects the target, the running car, it starts to chase behind it with a relatively higher speed. It's highly possible that the chasing car loses the running car in site, possibly due to the running car has gone out of range, or blocked by some obstacles. In such situation, the chasing car will call for help from a satellite or a helicopter. The latter will provide the coordinates of the running car from the view above, and thus the chasing car can estimate the trajectory of the running car and calculate a best path, cutting some corners and driving towards it. Once it spots the running car, the chasing car should switch back to its own view.

- **Features:**

  For the running car:

  - basic movement functionalities
  - wireless signal and manually control

  For the chasing car:

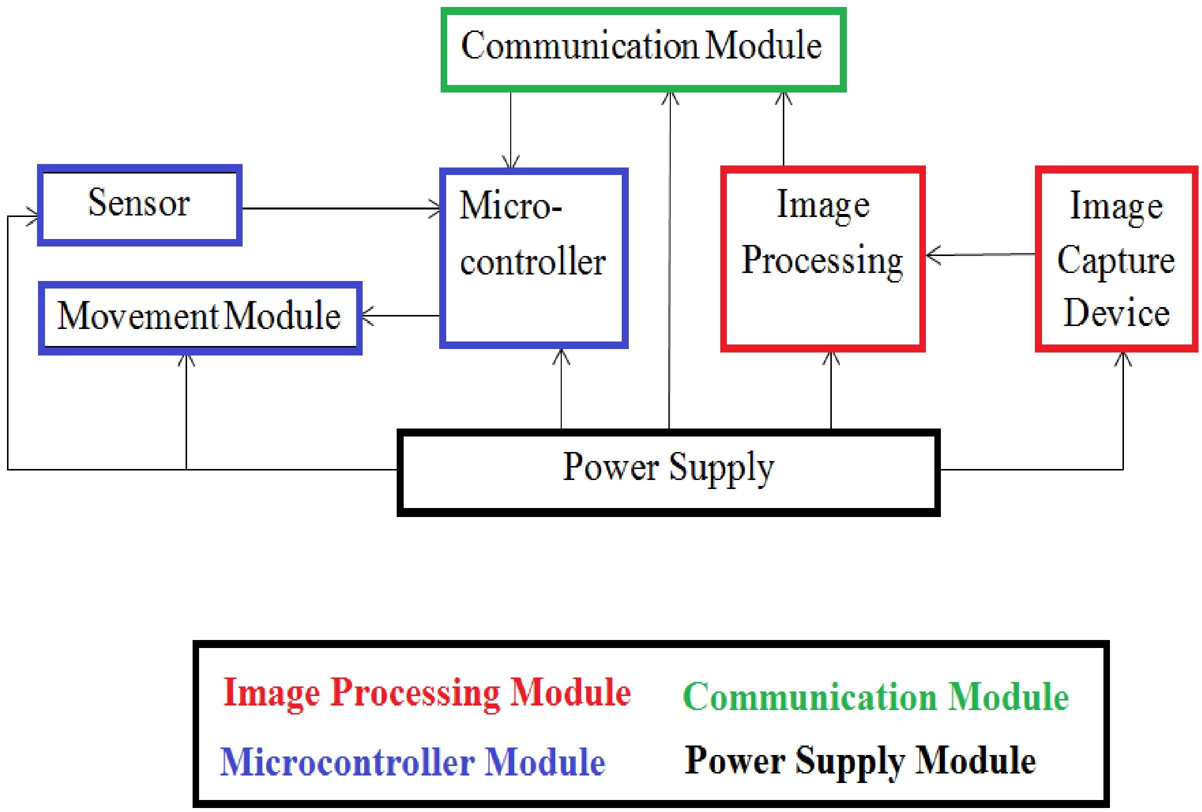
  - trajectory estimation and calculation
  - wireless signal receiving and sending
  - microcontroller-driven movement

  For the camera:

  - image recognition and image processing
  - wireless signal receiving and sending

II. Design

2.1 Block Diagram



2.2 Block Descriptions

- **Power Supply:**

  The power supply for toy cars is provided by rechargeable batteries. It drills electricity to motor, sensor and onboard controllers.

- **Image Capture Device:**

  A camera will be placed on the ceiling and can collect images of the whole area. The data will be passed to the image processing unit.

- **Image Processing:**

It inputs the data from Image Capture Device. The processor will analyze the vision data by first separating the image into background, obstacles, running car, chasing car, consisting of everything else. It can calculate the two coordinates of cars. The image processor has yet to be determined but will most likely to be a Pandaboard or NI CVS 1456.

- **Communication:**

  It is used by the Image Processing Module to send coordinate data to the microcontroller, and the microcontroller to send signal to the Image Processing Module to switch to mode on/off. As the data is little, most of the communication units are qualified.

- **Microcontroller:**

  It is the component that runs all the algorithms. It needs to calculate the trajectory for the chasing car based on the digital input from either the sensor in the front of chasing car or the camera on the ceiling. It also estimates the next likely location of the running car. The pursuit-evasion algorithm needs huge calculation with numerical analysis. We are considering using MSP430.

- **Movement Module:**

  This module is simple. It takes the signal from Microcontroller and turns it into mechanical movement.

- **Sensor Module:**

  The sensor is placed in the front of the chasing car and is used to detect the running car. We are now considering to use another camera to replace the original directional sensors since image processing is much more powerful and more suitable for the situation.

III. Verification

3.1 Performance Requirements and Testing Procedures

- Image Processing:

  Make a scenario where the running car, chasing car and the background with obstacles are all on the ground, and make sure all objects are within the scope of the camera. The camera should be able to recognize and output the coordinates of the running car and the chasing car.

- Communication Module:

  The camera will try to send multiple coordinates and the chasing car should be able to receive the dots in series. Conversely, the chasing car should be able to send signal to enable/disable the camera on the ceiling.

- Microcontroller:

  The microcontroller should drive the chasing car towards the running car. When camera is off, the chasing car should use the most recent coordinates when it spotted and recorded from the running car, and it will estimate the current location of the running car. After sensor has lost the running car for a certain period of time (depend on the actual speed), the microcontroller should send a signal to enable the camera on the ceiling, and at the same time, it should disable the sensor built on itself. When camera is on, given multiple coordinates of the running car, micro-controller should be able to calculate the trajectory of the running car. When the sensor can detect the running car again,the microcontroller should switch the camera back to sensor mode.

- Power Supply:

  Three kind of power supplies should drive the camera, the cars, and the sensor individually. The power supplies should be able to provide stable DC voltage to each component. We will test the voltage when connecting each block.

3.2 Tolerance Analysis

The most important part of the analysis is the recognition of the running car by both the sensor and the camera on the ceiling. The coordinates of the running car might be off for a few samples. As long as the 90% of the points are lining a reasonable direction, the algorithm can filter out the extreme ones and will still be able to figure out the right track. The tolerances from other components do not affect the chasing too much.

IV. Cost and Schedule

4.1.1 Labor Costs

Name	Rate	Hours	Hours * 2.5	Total ($)
Hai Chi	30/hr	200	500	15000
Zhe Ji	30/hr	200	500	15000
Total				30000

4.1.2 Parts

Item Name	Unit Cost ($)	Quantity	Total Cost ($)
Motor Coupling	20	2	40
PCB’s	0	2	0
Camera	100	1	100
Image Processing Board	300	1	300
Toy Cars	40	2	80
Microcontroller	35	1	35
Battery	5	10	50
Wireless Unit	25	2	50
Proximity Sensor	2	4	8
Resistors,	0.1	35	3.5
Capacitors	0.15	15	2.25
LEDs	2	2	4
Total			672.75

4.1.3 Grant total

Labor Costs	30000
Parts	672.75
Total	30672.75

4.2 Schedule

Week	Tasks	Members
2/5	Write Proposal	Hai, Zhe
2/12	Micro-controller	Hai, Zhe
2/19	Prepare Design Review	Hai, Zhe
2/26	Sensor and Power	Hai, Zhe
3/5	Movement Module	Hai, Zhe
3/12	Prepare for Individual Progress Report	Hai, Zhe
	Image Processing	Hai, Zhe
3/19	SPRING BREAK	Hai, Zhe
3/26	Communication Module	Hai, Zhe
4/2	Testing and Debugging: Image Processing	Hai, Zhe
	Testing and Debugging: Pursuit-evasion Module	Hai, Zhe
4/9	Build Mechanical Chassis and Integrate Systems Togethe Ensure Completion	Hai, Zhe
4/16	Prepare Demo Presentation and Paper	Hai, Zhe
4/23	Final Demo	Hai, Zhe
4/30	Final Presentation and Final Paper	Hai, Zhe