Multi-Vehicles Formation Control Exploring a Scalar Field

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Overview

- Objective
- Specifications
- Functionality and Algorithm
- Hardware
- Circuit Diagram
- Photos of Product
- PBasic Code
- Prototype Cost Analysis
- Product Limitations
- Conclusion and Improvements
- Acknowledgements

Objective

- Exploring a Scalar Field using Multiple – Mobile Agents both In and Out of Formation
  - Light
  - 3 Mobile Agents
  - Equilateral Triangle Formation

Specifications (aimed at)

- Controlled by Basic Stamp 2 microcontroller (succeeded)
- Safety features
  - Instantaneous shutdown safety switch (did not use)
  - Hard/Software features to prevent damage to the BS2 and other components (partially used)
- User Interface/Control (partially used)
  - On/Off RF controller
- Analog Sensor (succeeded)
  - Photo - resistor
- Digital Sensor (succeeded)
  - RF transceiver
- Actuators (succeeded)
  - Full rotation servo motors (6)

Multi-Vehicle Formation Control

- System of controls for multi-vehicles driven in formation
- Each capable of exploring a scalar field
  - Light Intensity field (our choice)
- Basic Stamp powered computing
- Use RF transceivers to communicate
- Battery powered system
  - 9V batteries

Functionality and Algorithm

➢ CASE 1: Stand Alone Operation

- Master is Manually Driven

- Followers Receive command from Master

- Maintenance of Formation

- Triggering Signal for Breaking of Formation

- Vehicle stops at a Safe Distance from Light Source

- If Job finished, then it communicates with the other vehicles and if necessary repeats the above algorithm

Functionality and Algorithm 2

➢ CASE 2: Formation Operation

- When Triggered, Master senses the Scalar Field (Light Intensity) and comes up with the Trajectory
- Master Guides the Followers through RF transceivers
- Stoppage at Safe Distance from Light Source
- Once Job is finished, the above algorithm is repeated

Hardware

➢ Boe-Bot Robot Kit
- Basic Stamp 2 (1)
- Board of Education (1)
- Robot chassis (1)
- Servos (2)
- Resistors (2 , 1, 1)
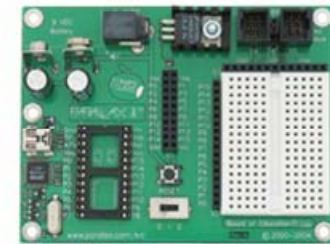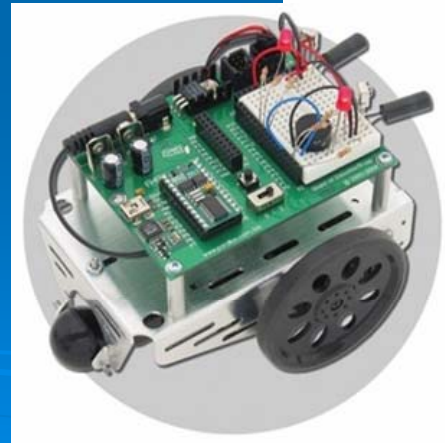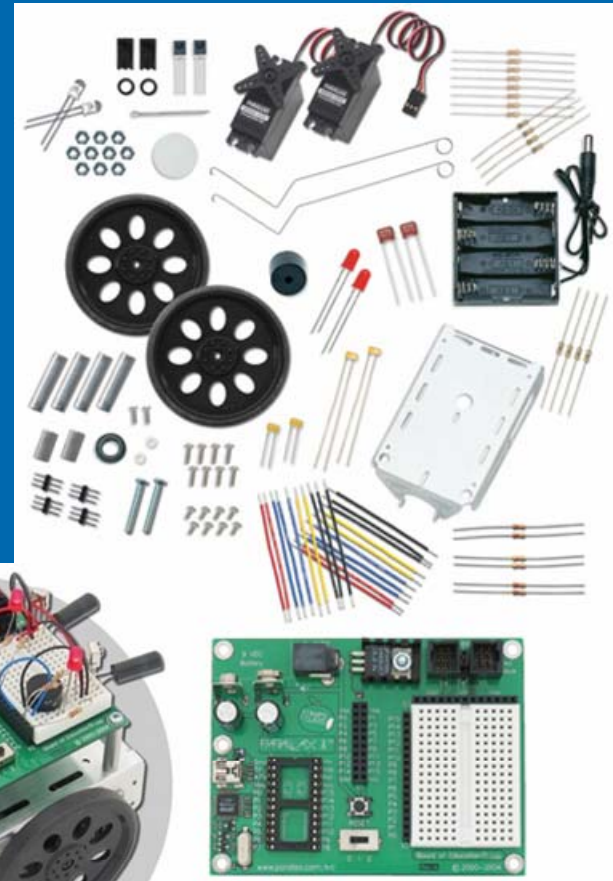
Hardware 2

➢ 912MHz RF transceiver (1)

- 800 ft range
- 9600 baud serial
- 16-bit CRC Error Checking
- FIFO Buffer
- +3V to +5V Operation
- Built-In Antenna

➢ Photoresistor (1)

Hardware 3

IR Sensor
(Used only on
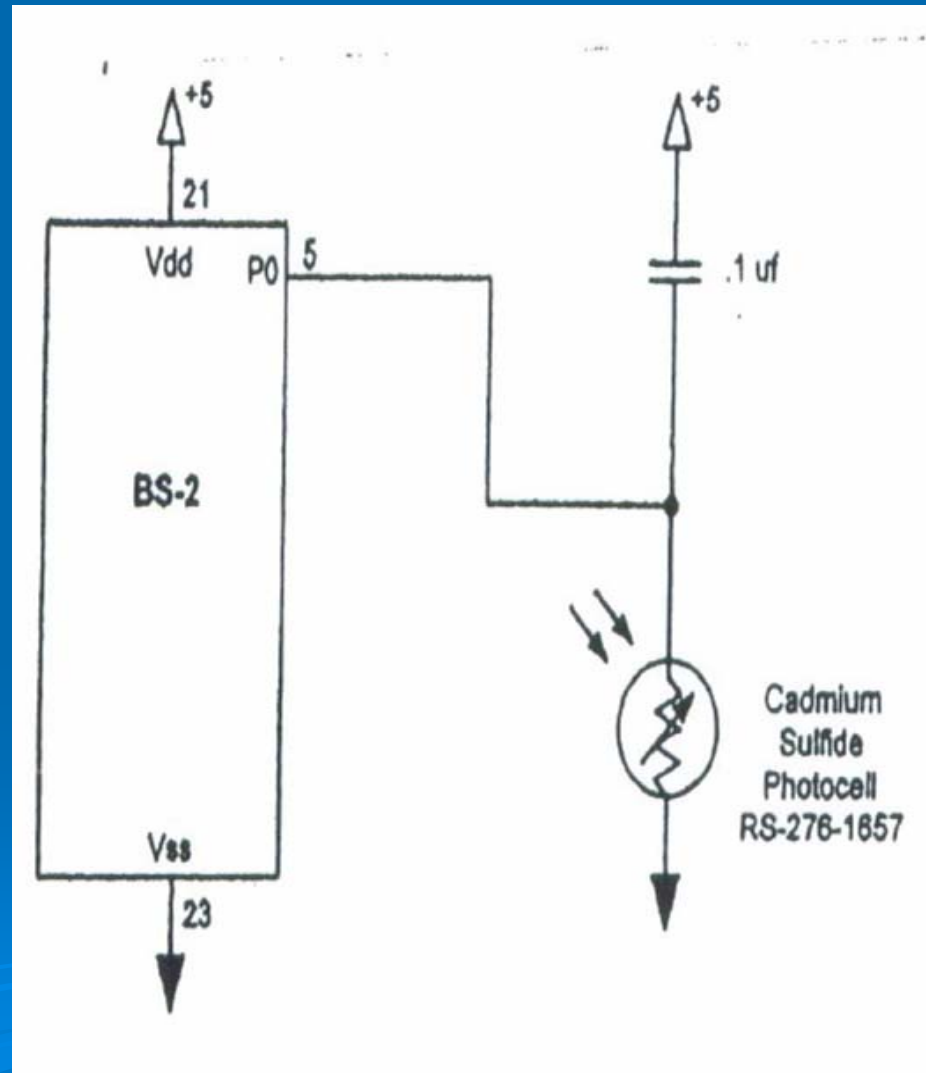the Master)

IR Remote

* figures are not to

Circuit Diagram

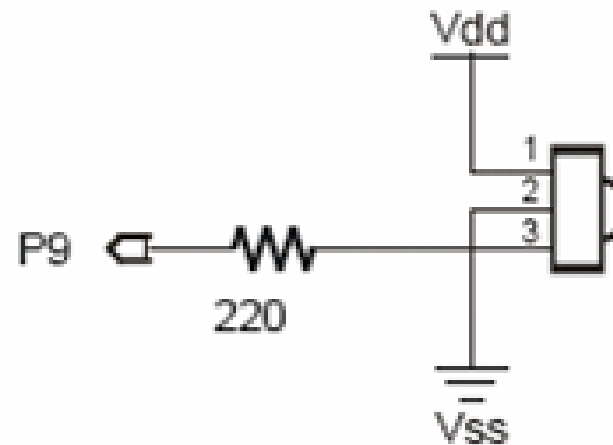The Picture beside is a Simple Circuit Diagram for the Usage of RC time command.

This is Used indirectly to obtain determine the Relative Intensity of Light
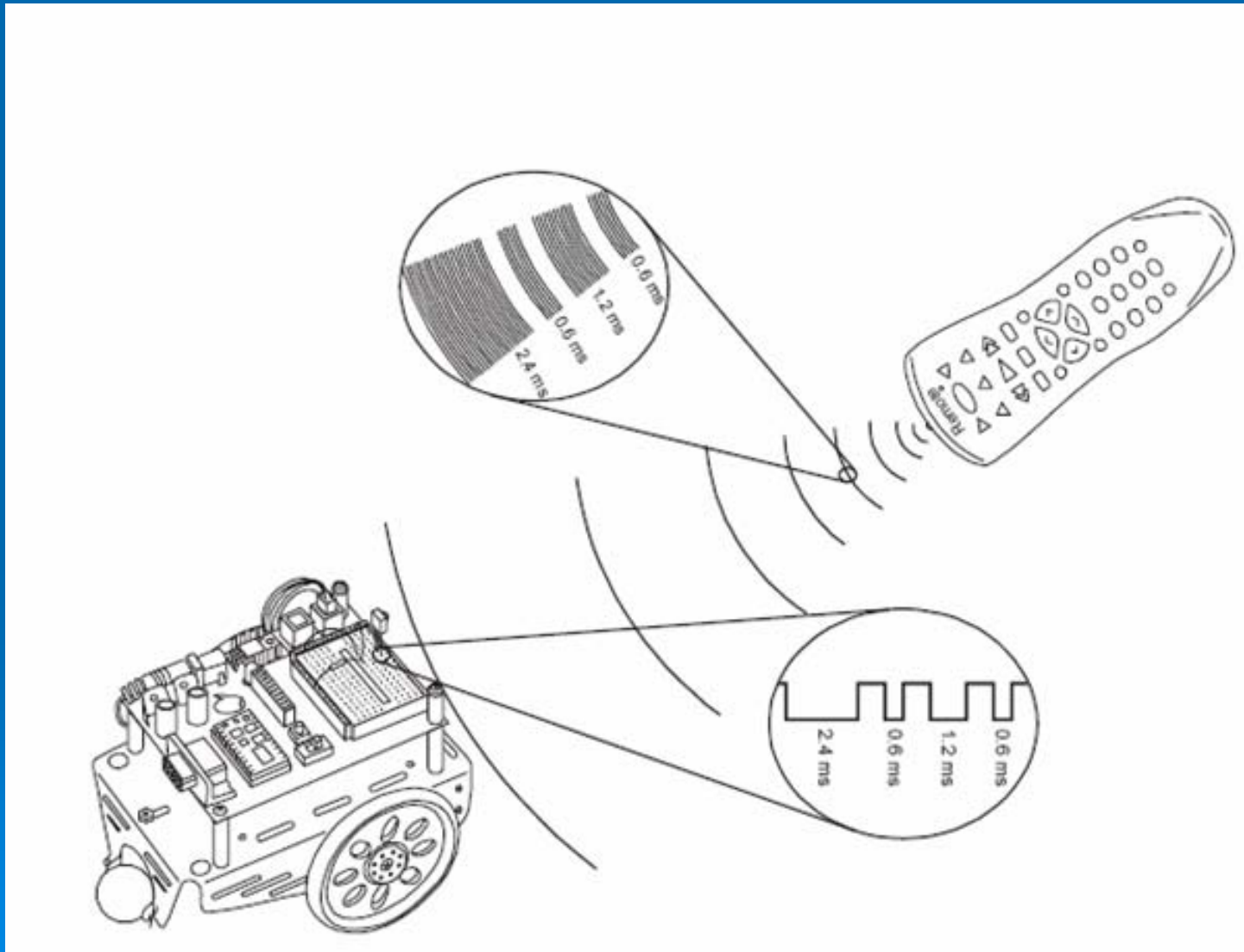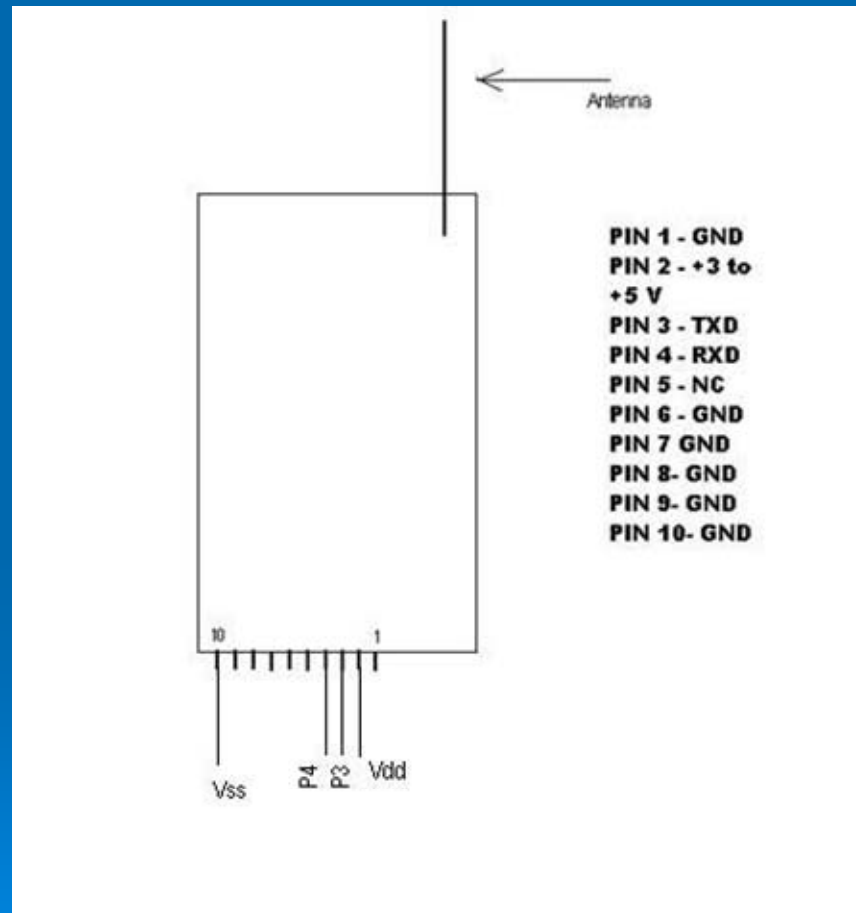
Circuit Diagram 2

Circuit for the IR Receiver

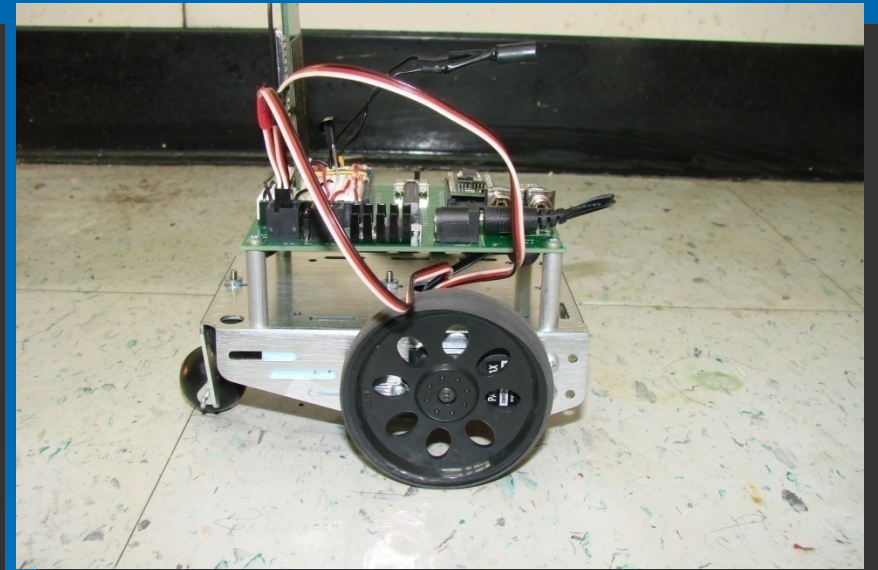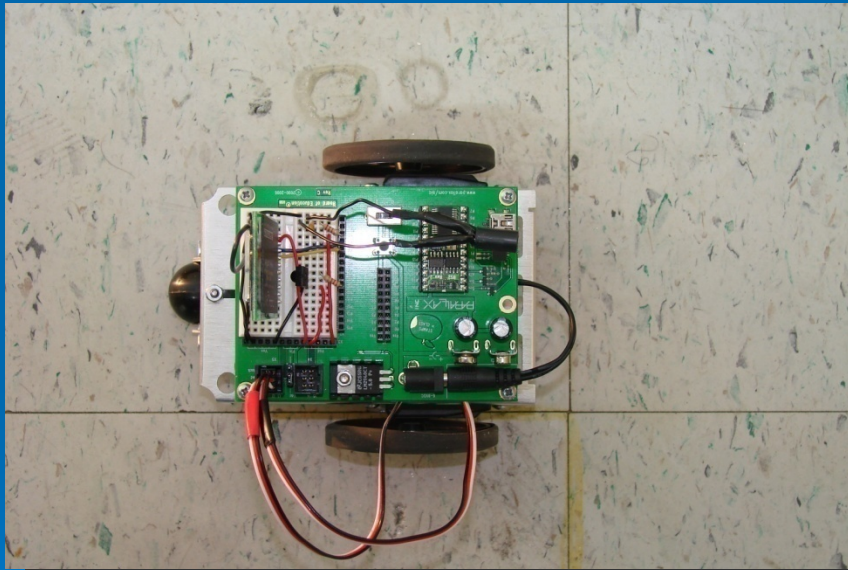Reading at PIN 9 depends on the key which is pressed on the IR Remote (our TV remote)
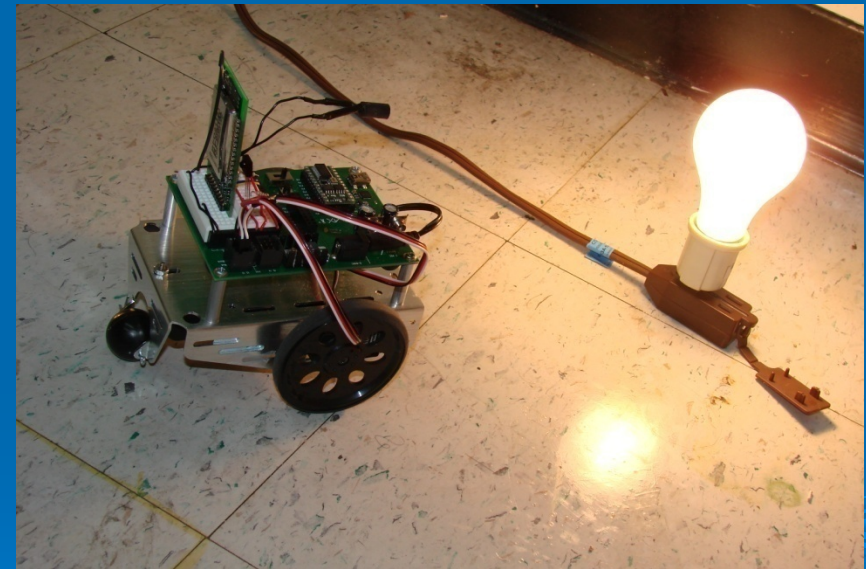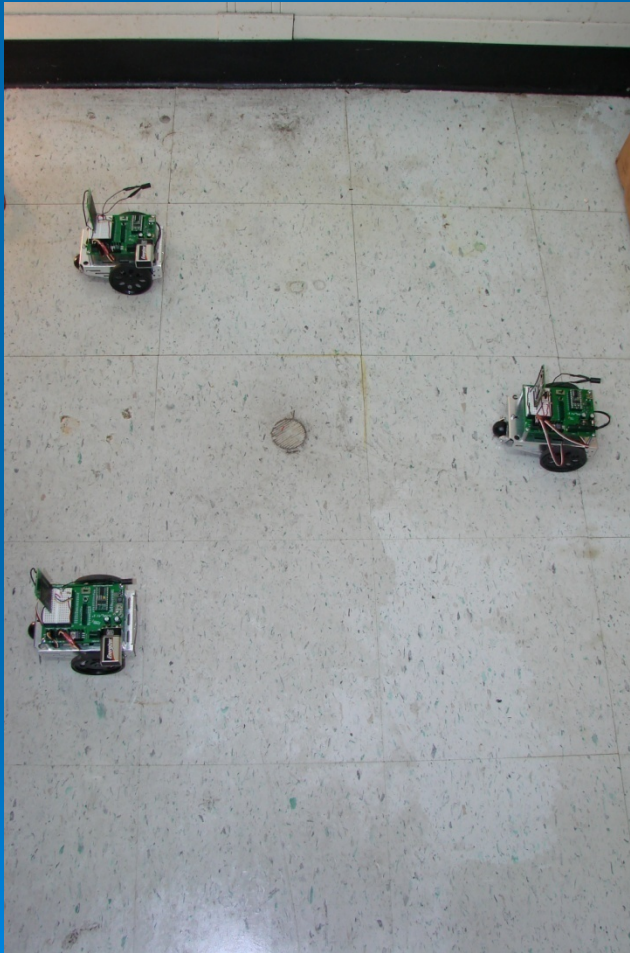
IR Waves

RF Transceiver

Photos of Product

Photos of the Product 2

PBasic Code

Prototype Cost Analysis

Parts Name	Unit Cost	Quantity	Sum Total
Boe-Bot Robot Kit (Servos, Microcontroller, sensors included)	$ 159.95	3	$ 479.85
912MHz RF Transceivers	$ 49.95	3	$ 149.85
3 Function Universal Remote	$ 10.00	1	$ 10.00
Miscellaneous (shipping, taxes, etc.)			$ 100.00
		Total Prototype Cost:	$ 739.70

➢ Prototype Unit Cost = $209.90

➢ Mass Production Unit Cost = $146.25 -- $120.22

Applications

➢ Semi – Autonomous Fire Fighting System

➢ Semi – Autonomous Radiation and/or Gas leak detection system

➢ Remote mapping of any Scalar Field

Product Limitations

- ➢ Open – Loop Control
  - Velocity of the vehicles is not monitored, trouble with variable terrain
  - No distance measurement between the vehicles, chance of formation degradation
  - Once disturbed, the initial formation cannot be reformed
- ➢ Unable to Avoid Obstacle
  - Lack of obstacle avoidance algorithm
    - Greatly increase complexity to avoid obstacles and keep formation

Conclusion and Improvements

➢ Conclusions
- Coarsely Stable
- System is Delicate
- Sensitive to Terrain

Conclusion and Improvements

- Improvements
  - Closed – Loop System for Velocity and Distance
  - Active search to relocate and reform in group formation
  - Add other sensors to increase application use
  - Multiple formation selections

Acknowledgements

➢ Mechatronics Lab: For lending extra Boe - Bots for use

➢ Groups that helped with tools and materials

- Group 3: Vito Guardi & Joseph Ferrari
  - Providing extra Basic Stamps 2

➢ Graphics: Parallax Incorporated (http://www.parallax.com/)

Questions?