The Roboto's Robotic Project Report

Computer Applications in Mechanical Engineering

Group #7

Aaron Klapheck, Shervin Davod, Jacob Scott

20-May-08

Estelle M. Eke

Abstract*

The Project

In this course, ME 175-Computer Applications in Mechanical Engineering, we have been introduced to the Board of education, Basic Stamp 2 or in general (BS2) micro controller and the board of education robot, BOE-BOT. For this project we were asked to demonstrate our skills by using computer programming and apply them to the microcontrollers installed on the board of education to come up with different movements and actions from the two Boe-Bots.

The first thing that we decided to do, was creating the Gantt-chart, so we can manage our time wisely. Our goal is to remove the Lego bricks off of a rotating platform and delivering them to the designated location using the Boe-bots. The area that we decided to perform our project in was 4 feet by 4 feet. Within this area we had five sections, four corners which, each corner's area is 1 foot by 1 foot, and exchange zone which is located in the center of the performing area and has the area of 2 feet by 2 feet.

The rotating platform locates in top right corner and has the height of the 6 feet, which the first Boe-Bot should go straight from its location toward the platform and grabs the Lego brick and comes back to the exchange zone. While the first Boe-Bot comes back to the exchange zone, the second Boe-Bot moves forward and then turns left and travels to the west until it gets to the exchange zone. Now the delivery takes place and the first Boe-Bot is ready to goes back to the rotating platform to grab the second Lego brick and comes back to the exchange zone to deliver the second brick to the second Boe-Bot. At the end after staking all the bricks, the Boe-Bots will com back to their original locations.

* Shervin wrote *The Project*, Jacob wrote *Design*, and Aaron wrote *Programming*.

Design

The original inspiration for bot 1 was shervins. He put together the tower gripper which was later modified to include an elevator for the lego. Originally the elevator was not needed because the design of boebot 2 was to include a chute thru which the Lego would fall. But because of the difficulty in positioning the Lego properly in the Shute to prevent turning and incorrect stacking, it was decided that a simple elevator in combination with extended griper on boebot 2 would be more reliable. Placement of sensors to set the limits for the movement and eliminate the possibility of propagated error was critical to the design of the grippers and elevator.

Coordination of the boebots proved to be the most difficult part of the project. The original idea was to use digital encoder kits to position the bots. However the kit failed to perform to expectations and was abandon in favor of line following. This was preformed using the basic ir object detection circuit adjusted for the specific purpose of floor detection.

Programming

There was an enormous amount of programming involved in the coding of all four Boe-Bot boards. Each Bot holds two Boe-Bot boards; because of this there was a large amount of code dedicated to parallel processing. This involved one board performing a selected action and then triggering the other board to perform another selected action. This was necessary because of the eleven sensors, eight servos, four speakers, ten LED's, and an elevation actuator that were being used to complete this project. The movement of each of the bots was coded using two IR sensor/emitter pairs which followed lines on a board. The Lego retrieval was done using an IR emitter/detector pair which detected the Lego against the background of the black rotating platform, grabbing the Lego with the grippers, and used precise timing to retrieve the Lego from the platform. The exchange of the Lego between Bot 1 and Bot 2 involved programming the grippers of both bots, a ping sensor, the treads (which gradually dropped the logo to a lower position for Bot 2 to grab), and also timing. The exchange itself took over 400 lines of code in total for all for boards to work out precisely. After this exchange Bot 2 moves to the Lego drop off zone to stack the Lego. This stacking process was the most difficult for us to work out because of the lack of time we had to work on the code. If given more time we would have used an IR sensor on a sliding platform to position the second Lego on top of the first. And code the gripper to release the Lego when the bottom Lego was detected.

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* Also contains file names for presentation and code

Conclusion

The project seemed to come together quickly at first. However, unforeseen problems slowed the actual building and testing time. The ability of the Boe bot to maintain an accurate location estimate was found to be very limited without external reference. Given more time, the project may have had many more sensors the better correlate the movements of the two bots relative to the placement on the board. Timing was also an issue. While the Bot can keep an accurate time within itself, the level of battery charge badly affected its ability to accurately time its movements. Therefore, the amount of independent timing was limited to single tasks. DO NOT RELY ON TIMING FOR MOVING DISTANCES OR TURNING TO ACCURATE ANGLES. Always have an externally verifiable position.

References

Lindsay, Andy. Robotics with the Boe-Bot. Version 2.2. © 2003 Parallax.

Lindsay, Andy. Basic Stamp Manual. Version 2.0. © 2000 Parallax.

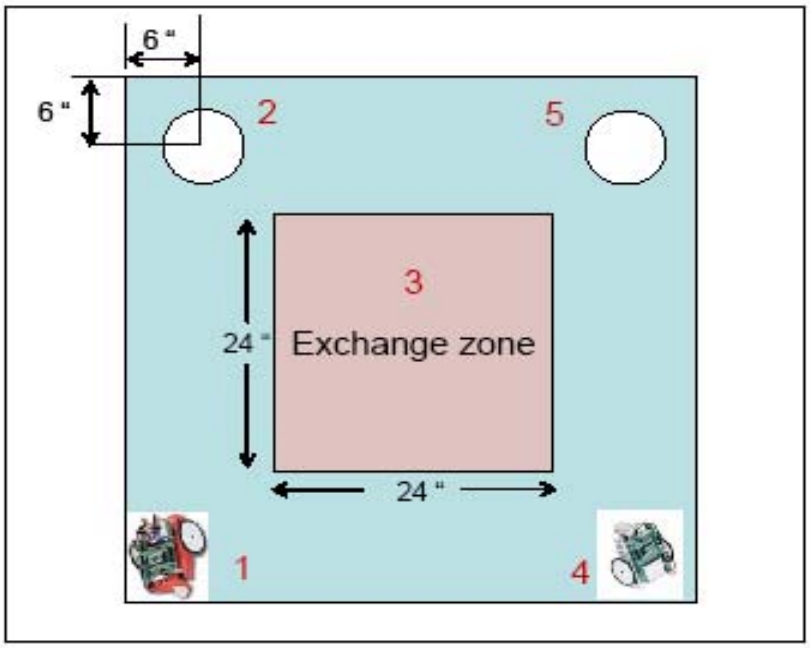
Lindsay, Andy. What's a Microcontroller?. Version 2.2 © 2003 Parallax.

ME 175 Spring 2008 Final Project
Instructor: Professor E. M. Eke
Format for Lab Report

1. Use a report folder or binder
2. Report must be type-written (10 – 12 pitch font); make use of Microsoft tools such as WORD, EXCEL, PROJECT
3. Title Page 1 should contain
   - Title
   - Course Information
   - Group #
   - Group Members
   - Date
   - Instructor's name
4. Abstract
   - Project description (700 – 800 words)
5. Table of Contents
6. List of Figures
7. Accomplishments, comments, conclusions and recommendations (200 – 300 words)
8. References
9. Appendices
   - Project Sheet
   - Project Schedule (Gantt Chart)
   - Schematic etc.
   - Name of program file that contains PowerPoint presentation; file should be in Voyager Drop Box by 2 p.m., Monday, 5/19/08
   - Program Code (Voyager Drop Box, by Tuesday, 10 a.m. 5/20/08)

1. **ROTATING PLATFORM (LEGO BRICKS)**

Area	4 ft x 4 ft
Elevation of platform, h_p	$3 \leq h_p \leq 6$ inches
BoeBotA starts from southwest corner, zone(1) • picks up brick from rotating platform in NW corner, zone (2) • delivers brick to BoeBotB at exchange point located in the center of area, zone(3) • returns to zone (2) and repeats process	
BoeBotB starts from southeast corner (4) • gets brick from BoeBotA at exchange point, zone (3) • takes brick to Drop-off zone (5) • returns to zone (3) and repeats process	

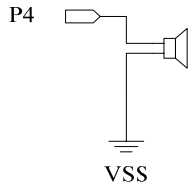


Project Schedule

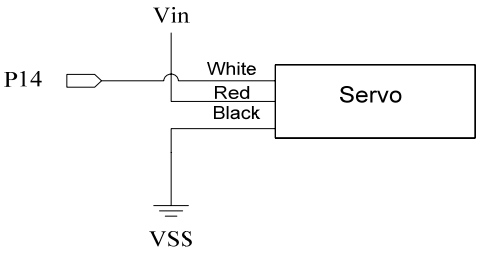
Task Name	Duration	Start	Finish
Aaron assemble gripper for Boe-Bot 2	16 hrs	Tue 4/15/08	Wed 4/16/08
Shervin assemble gripper for Boe-Bot 1	5.6 days	Thu 4/17/08	Fri 4/18/08
Shervin Design gripper movement assembly	9.6 days	Fri 4/18/08	Mon 4/21/08
Shervin make gripper movement assembly	12.8 days	Mon 4/21/08	Thu 4/24/08
Aaron program Gripper/Arm movements	17.6 days	Fri 4/18/08	Wed 4/23/08
Shervin and Aaron program Large body movements	15.2 days	Fri 4/18/08	Tue 4/22/08
Aaron adjust gripper for grabbing Lego for Boe-Bot 1	8 days	Tue 4/22/08	Thu 4/24/08
Aaron assemble base of rotating platform - did not use	1.8 days	Mon 4/28/08	Mon 4/28/08
Aaron and Shervin assembled and programmed digital encoder	39.2 days	Tue 4/29/08	Thu 5/8/08
Jacob redesigned base of rotating platform	3.2 days	Thu 5/1/08	Fri 5/2/08
Aaron Program stepper motor - did not use	3.2 days	Thu 5/1/08	Fri 5/2/08
Shervin repositioning gripper arm	1 day	Thu 5/1/08	Thu 5/1/08
Aaron create base of rotating platform	1 day	Thu 5/1/08	Thu 5/1/08
Jacob design and create an elevation actuator	5.6 days	Sat 5/3/08	Mon 5/5/08
Aaron write program for elevation actuator	3.2 days	Sat 5/3/08	Sun 5/4/08
Aaron program large body movements for Boe-Bot 2	6.6 days	Tue 5/6/08	Wed 5/7/08
Shervin write project section of Abstract	11.4 days	Fri 5/9/08	Mon 5/12/08
Jacob write design section of Abstract	11.4 days	Sat 5/10/08	Tue 5/13/08
Aaron write flowcharts for Boe-Bot 1 and 2	36 days	Sat 5/10/08	Mon 5/19/08
Shervin write program for gripper movements	16.2 days	Fri 5/9/08	Tue 5/13/08
Jacob replaced QTI sensor with bump sensor for elivation actuator	1.8 days	Tue 5/13/08	Tue 5/13/08
Shervin and Aaron installed and programmed the Ping sensor	22.4 days	Tue 5/13/08	Sun 5/18/08
Aaron and Shervin work on PowerPoint presentation	24.8 days	Tue 5/13/08	Mon 5/19/08
Jacob and Aaron designed/build tread elivator, gripper extension, ect.	11.4 days	Fri 5/16/08	Mon 5/19/08
Jacob write conclusion and design section of abstract	1.8 days	Mon 5/19/08	Mon 5/19/08
Jacob, Aaron, and Shervin finish writing code and setting up track	6.6 days	Mon 5/19/08	Tue 5/20/08

Boe-Bot 1 Top Board Schematics

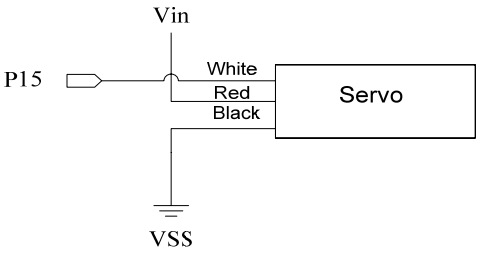
Piezospeaker



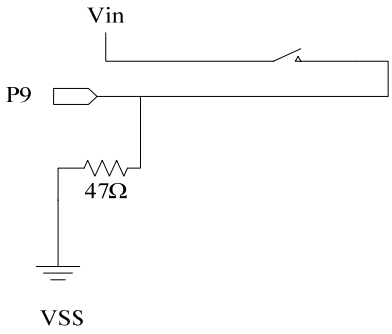
Gripper Rotator



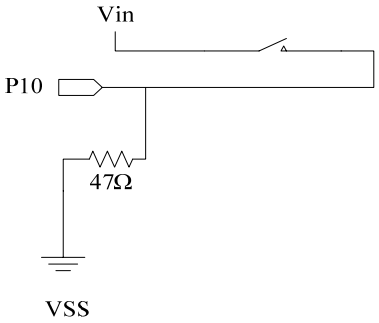
Gripper



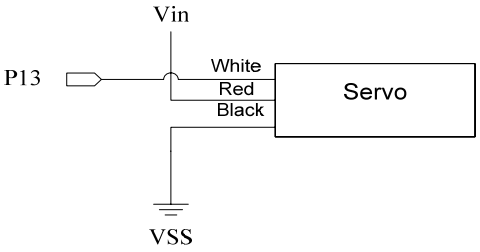
Bottom Micro Switch

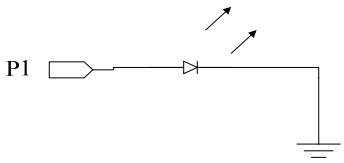


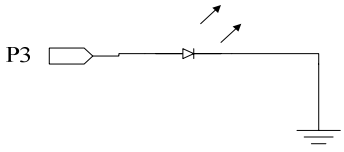
Top Micro Switch

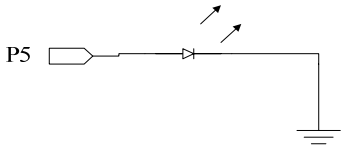


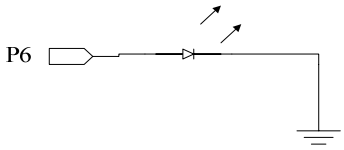
Tread Elevator











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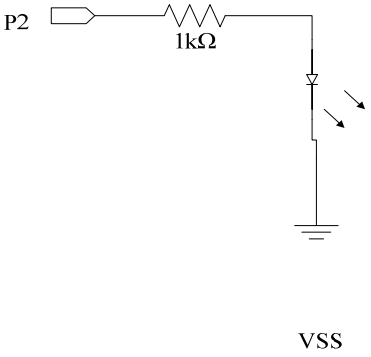

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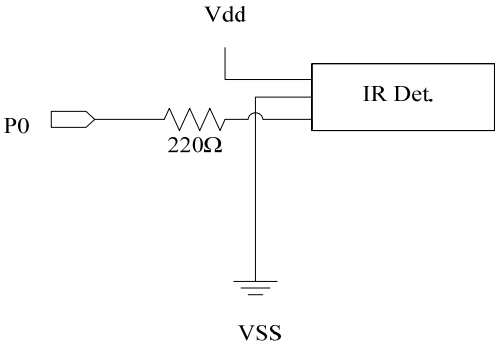

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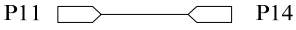

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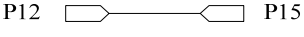
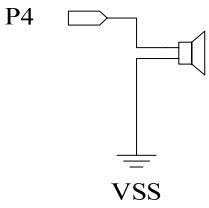


Boe-Bot 1 Bottom Board Schematics

Piezospeaker



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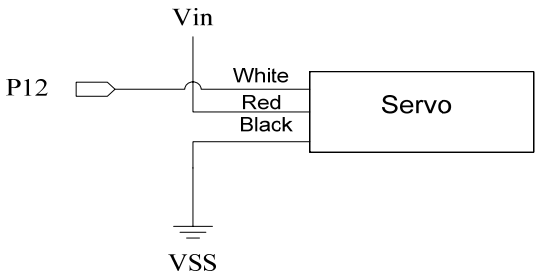

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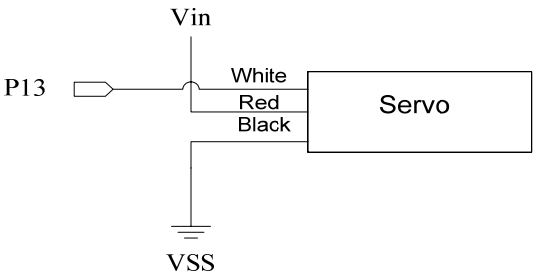

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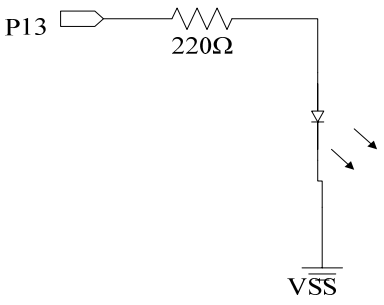

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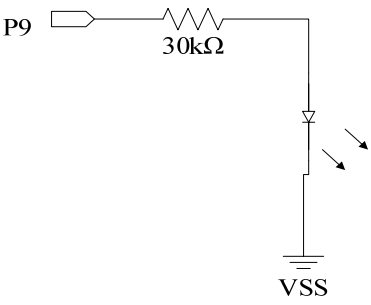

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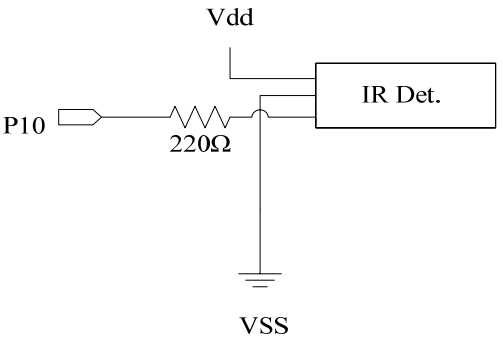

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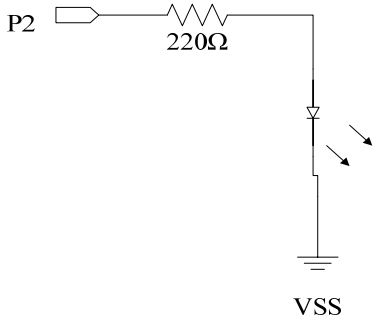

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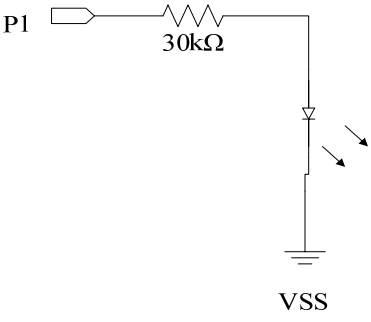

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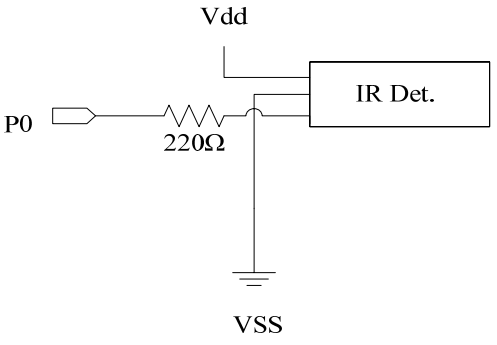
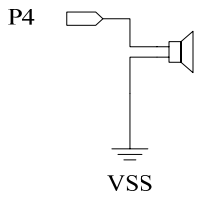


Parallel
Processing Nodes

Parallel
Processing Nodes

Boe-Bot 2 Top Board Schematics

Piezospeaker



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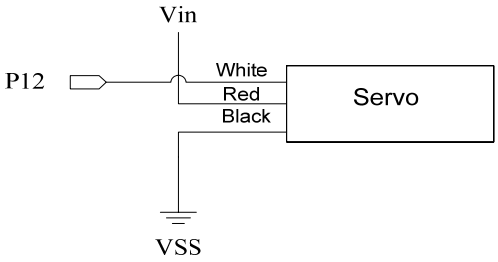

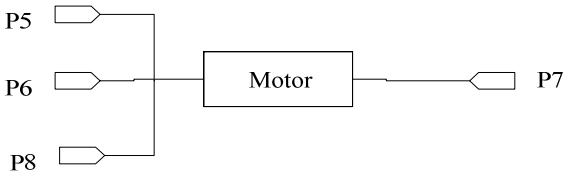

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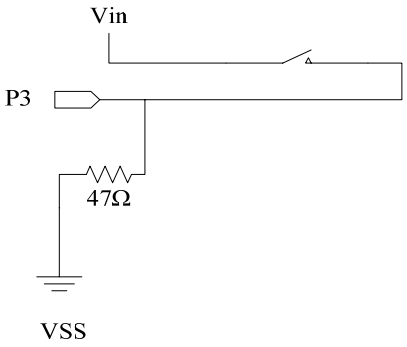

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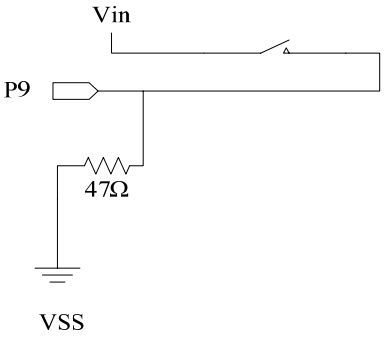

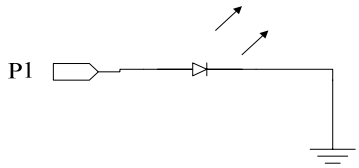

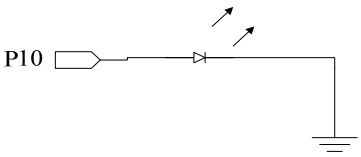

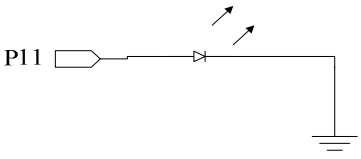

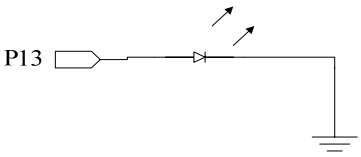

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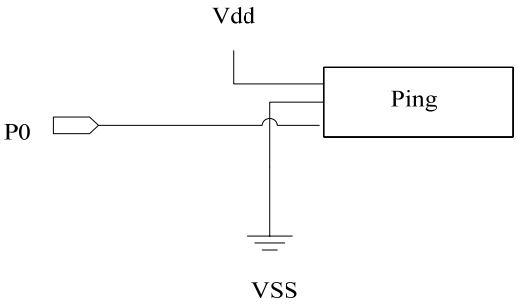
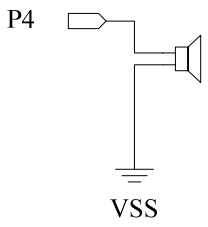


Parallel
Processing Nodes

Parallel
Processing Nodes

Boe-Bot 2 Bottom Board Schematics

Piezospeaker



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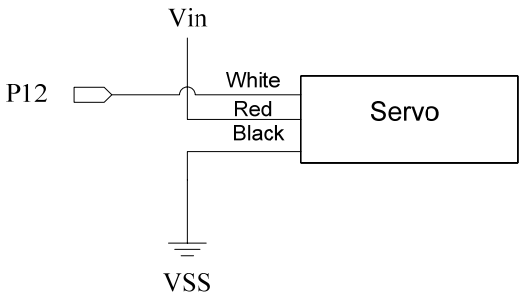

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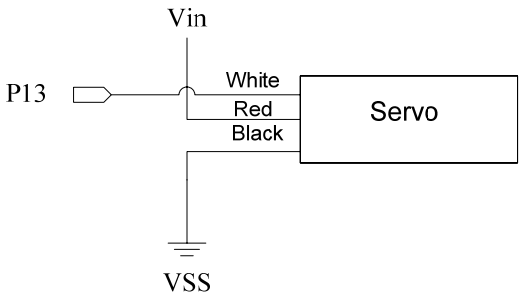

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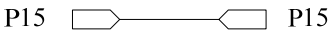

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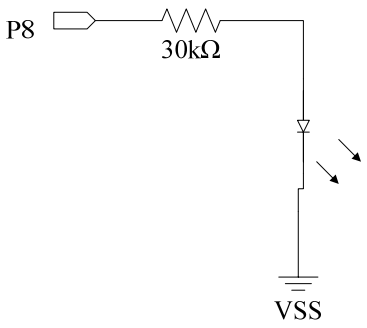

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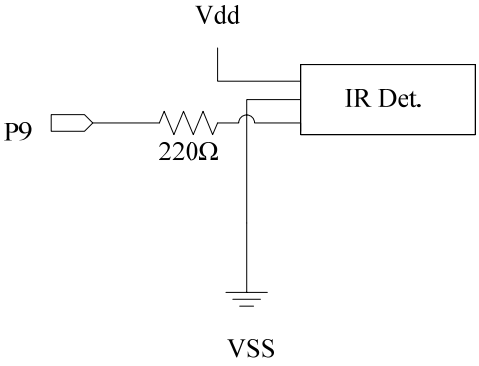

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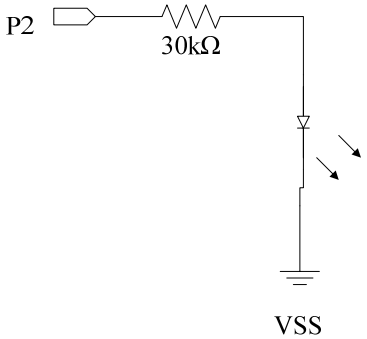
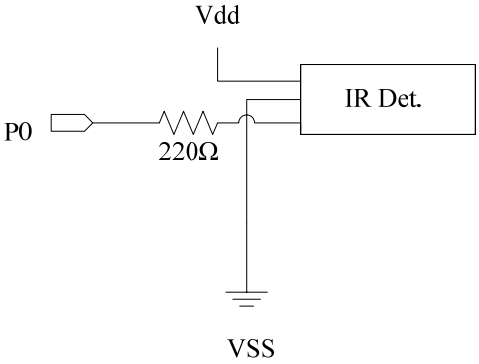


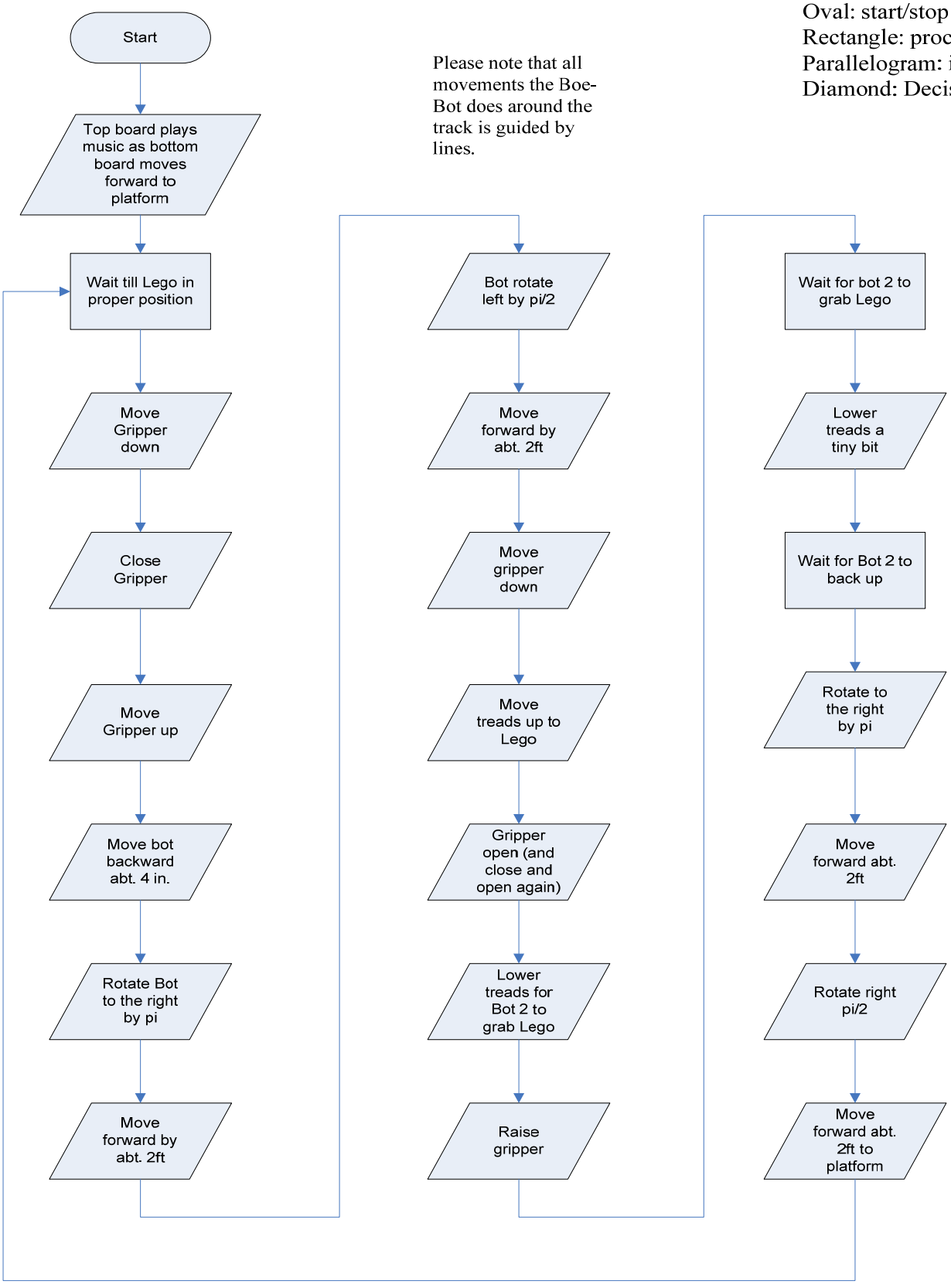
IR Detector Right



Boe-Bot 1

Symbols
Oval: start/stop
Rectangle: process
Parallelogram: input/output
Diamond: Decision

Please note that all movements the Boe-Bot does around the track is guided by lines.



Boe-Bot 2

Please note that all movements the Boe-Bot does around the track is guided by lines.

Symbols
Oval: start/stop
Rectangle: process
Parallelogram: input/output
Diamond: Decision

Cost Analysis

Table 1 **Roboto's Cost Analysis**

Part	**Number of parts**	**Cost per part**	**Total cost**
Boe-Bot kit	4	$160	$640
Gripper kit	2	$55	$110
Extra nuts and bolts	1 set of 200	$18	$18
What's a Microcontroller? text	1	$20	$20
Basic Stamp Manuel version 2.0 text	1	$20	$20
CD player	1	$20	$20
Extra parts (metal strips, etc)	1	$20	$20
HFE supplies (switches, wires, etc.)	1	$30	$30
Ping Sensor	2	$30	$60
Micro Switch, and LCD's	1	$20	$20
Cables and Soldering iron	1	$40	$40
Spacers and screws	1	$11	$11
Board and tape	1	$15	$15

Complete cost of Roboto's project: $1,024

File Names

File name that contains PowerPoint presentation: *Roboto_PowerPoint* (in folder *group 7 Roboto_PowerPoint*)

File name that contains Basic programming code: Roboto_code