ECSE 211 - Design Principles and Methods

CONSTRAINTS DOCUMENT

GROUP 11
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Abstract

This document is intended to list all the constraints on the design solution. These can involve the environmental constraints that might be specified in the original design description or by the client in meetings, e.g. the operating environment of the device. Note, again, that the information here is only given if it does not already exist in one of the other documents. The document might also point to time constraints for the project and due to the resources. There are also constraints due to the systems available and these come out of the Systems Document. Finally, the budget provides a major constraint on the solution.

Contents

1 EDIT HISTORY

- February 19th 2017:
  - **Ian Smith:** Initial set up of document sections (including table of contents)
- February 20th 2017:
  - **Alex Lam:** First draft of section 7
  - **John Wu:** First draft of section 4 (including 4.1, 4.2 and 4.3)
  - **Ethan Lague:** First draft of section 3 (including 3.1 and 3.2)
  - **Ian Smith:** First draft of section 2 (including 2.1, 2.2, 2.3 and 2.4)
  - **Durham Abric:** First draft of sections 5 and 6
- Wednesday March 29th:
  - **Ethan Lague:** Update on constraints
- Saturday April 8th:
  - **Alex Lam:** General formating and final review of the document

2 ENVIRONMENTAL ISSUES

2.1 Floor

The robot will be required to operate on nine 4' x 4' hardwood covered metal panels. The issues presented by the floor were covered in the Requirements document under "2.5 Operating Environment - 2.5.1 Floor".

2.2 Field

Within the floor, the robot must operate in a field with fixed and variable parameters. The constraints posed by the competition field are covered in the Requirements document under "2.5 Operating Environment - 2.5.2 Field".

2.3 Lighting

The demo for the competition will take place on the second floor of Trottier building. The possible issues associated with the competition room's lighting were covered in section 2.5.3 of the Requirements Document

2.4 Obstacles

The robot's movement will be restricted by obstacles and the competition rules. The possible obstacles were covered in the Requirements document under "2.5 Operating Environment - 2.5.4 Ultrasonic Noise"

3 HARDWARE CONSTRAINTS

The hardware made available by the client is listed in section 3 of the Systems document. Any other hardware will need to be approved by the client before being used.

3.1 Battery

One of the biggest limitation in terms of hardware is brought on by the battery life. If the battery voltage is not high enough at any given point during the round, problems may arise. Examples of such problems include the possibility of the sensors giving inaccurate readings, or the motor for the catapult being unable to reach a high enough rpm. If the sensors produce inaccurate readings, that could be detrimental to the robots localization and its object avoidance which both would lead to the robot not being successful. If the motor for the catapult cant produce a high enough rpm, the ball launcher then may become inaccurate. Therefore the only parts we are planning to use outside of the 3 Mindstorm EV3 kits are 6 fresh AA batteries, which we plan to only use on competition day to ensure maximum voltage.

3.2 EV3 Parameters

Another constraint in the hardware is the limited number of ports in the EV3 brick. We are limited to 4 output ports and 4 input ports meaning that we can have no more than 4 motors and no more than 4 sensors. This will have an effect on our final design and it is something we will have to consider moving forward with the design process.

3.3 Motors

The constraints on the motors present a huge constraint on the robot because of the necessity for their precision while launching the ball. They have a maximum running torque of 20 Ncm and will stall at 40 Ncm. We should never get to the point of stalling but the 20 Ncm torque limit is too low to shoot the ball 8 tiles using only one motor.

3.4 Ultrasonic Sensors

The constraints of the ultrasonic sensors are not very pressing since the range is 1-250 cm and the error margin is 1 cm which will be fine for what we are asking of the sensors.

3.5 Color Sensors

The color sensors poll at a maximum rate of 1 KHz which will suffice as long as wee keep that in mind when determining the travel velocity of the robot. We also have to be conscious of the calibration of the color sensors to minimize the amount of times a sensor misses a line.

4 SOFTWARE CONSTRAINTS

4.1 Java

Our code is written using the Java LeJOS API which is a layer built on top of the hardware. For this reason, we are not able to directly access the hardware and lower level memory itself in order to do more custom manipulations. Although this allows us to use a higher level object-oriented approach, it also limits us to the classes that are provided by the LeJOS API. This approach, however, allows us to model and and easily manipulate hardware using objects and take advantage of more advanced data structures such as hash mapping.

4.2 Noise

Our design will require the data coming in from our ultrasonic sensors to be as accurate as possible. However, our sensors our prone to a lot of noise which alters the true result of our readings. A method to filter out this noise is essential in order to make the localization and navigation of our robot as accurate as possible.

4.3 Threads

Java allows us to run multiple threads at the same time, but this advantage also requires careful management of each of the threads. As some threads will be using the same variables, it is important to ensure that values that need to be updated asynchronously are done so accordingly. In addition, we must ensure that constants are only declared once and kept consistent throughout all threads.

5 AVAILABILITY OF RESOURCES

The availability of resources shouldn't be a major challenge in the management of this project. The team's primary resource and asset is the members' knowledge and capabilities. As outlined in the Capabilities document (section 5, Availability), our team has prepared for any potential scheduling conflicts. We've also agreed upon a weekly meeting time and place to discuss large-scale design challenges and decisions.

In addition, our team has decided to utilize Slack, a cloud-based collaboration tool, in order to improve our communication. Slack allows us to organize our online discussions by topic (e.g. Software), search past messages, and upload and share documents with each other. It also integrates with GitHub, Google Drive, Dropbox and time management tools; this saves us valuable, budgeted time by making our communication centralized and efficient.

Our team will be using GitHub to manage, organize, and share our code among us. GitHub will allow us to collaborate on our source code remotely while remaining organized and documenting past versions of our code.

This utilization of technology, coupled with our team members' ability to access the internet remotely, means that we will have near constant and immediate access to each others' knowledge, thoughts and ideas. As such, we don't expect the availability of resources to interrupt the critical path.

6 BUDGET

Our budget is 270 hours (plus any overtime) divided up between our 5 team members (or 54 hours per person). The largest consumption of our budget will be used to design, build and test the robot. However, budget will also be allocated for documentation and management. It is the duty of management (Durham/Alex), to ensure that the budget is being used in an efficient manner so that the robot is fully functional by the competition date (April 5th 2017). In addition, as a smaller team with a smaller budget (less 54 hours), we will maximize our budget by automating any processes that may save us time (e.g. recording data, calculations, etc.). An initial breakdown of our budget is as follows:

- **Project Management:** 35 hours
- **Documentation:** 65 hours
- **Software Design:** 90 hours
- **Hardware Design:** 40 hours
- **Testing:** 40 hours

We have set ourselves a goal for the robot to be ready by **March 31, 2017** in order to allow our team to thoroughly test the robot in its final form previous to the competition. The final documentation for this project is due **April 10th, 2017** as specified by the client.

7 GLOSSARY OF TERMS

- Requirements document: Separate document in which the requirements of the project are outlined and discussed in detail.
- Mindstorm EV3 kit: This is the hardware kit containing the majority of the hardware components to be used in this project.
- API: The Application program interface is a set of routines, protocols, and tools for building software applications
- Java Lejos API: The firmware used in order to allow Java code to be executed on the Mindstorm EV3 device.
- Noise: unwanted data reported by devices that causes error in performance
- "The client" in this document refers to Professors Lowther and Giannacopoulos giving this course.