THE REQUIREMENTS DOCUMENT

The goal of this document is to try to make sure that the requirements of the client are fully understood. It is composed of several sections, each of which tries to address one aspect of the specification and to try to identify all the related issues. The sections are detailed below and are reasonably generic. These can be modified in your version but only by adding extra sections. The sections given MUST be completed. Once this document is completed, you should know everything about the problem to be solved and the end device to be created. However, as the design process progresses, questions will arise which lead to answers or decisions which might contradict this document. In this case, you need to go back to the document and the client and clarify the issue and update the document appropriately. This is a living document.

Requirements Document

Project: ECSE 211 Final Project (Team 08)

Task: To construct an autonomous robot capable of locating, grasping, carrying and placing an optical beacon, while navigating within an enclosed area populated with known obstacles placed at restricted locations within the enclosure.

Document Version Number: 03

Date: 18/11/2012

Author: Ammad Usman

1. TABLE OF CONTENTS

* Capabilities:
* Purpose - Brief description of the robot’s objectives
* Scope - Summary of the capabilities and limitations of the project
* Constraints - List of client imposed restrictions
* User Functions - Description of user-operating system communications
* Operating Environment - Account of the physical surroundings in which the robot will operate
* Performance - Summary of the minimum performance requirements for the project
* Compatibility:
* Component Re-Use - Account of apparatus(new and previous) which may be used during the project
* Compatibility with Third Party Products – Description of the robot’s ability to interconnect with products other than Legos platform.

2.0 CAPABILITIES

2.1 PURPOSE

The basic purpose of this project is to construct an autonomous robot capable of locating, grasping, carrying and placing an optical beacon, while navigating within an enclosed area populated with known obstacles placed at restricted locations within the enclosure. The task of the robot is to play a version of “Capture the Flag” with a single opponent where the beacon serves as the flag. Upon receiving instructions on Bluetooth radio, the robot will assume the role of either defender or attacker and proceed according to its role. If the role assigned is attacker, the robot proceeds to search for the flag, capture it, and place it at a location specified in the instructions received. Otherwise, if the defender role is assigned, then the robot proceeds to the flag location specified in the instructions received, captures the flag, and places it in an arbitrary location within the enclosure (usually chosen to make it difficult for the attacker to find).

2.2 SCOPE

Range of Capabilities

* Robot will operate on a 12x12 field comprising of nine 4 x 4 hardwood-covered metal panels that lock together. The surface of each panel is marked with a ‘4 x 4’ grid that aligns precisely with adjacent panels. These are intended for navigational purposes, covered in the previous labs.
* The robot will be placed in one of the 4 corners shown, at a random position and orientation within the corresponding tiles.
* This will be a onetime operation.
* The robot will be programmed to operate in a 3D environment, whereby it can successfully place and retrieve the object, regardless of its position inside the field.

Limitations

* Budget issues: Large proportions of the budget were taken up by the initial mechanical design as well as the considerable changes which were made as the project moved ahead. High cost of disposable batteries led to the purchase of rechargeable batteries.
* Time Limitations: Each team will be restricted to 5 minutes to complete the specified tasks either as a defender or an attacker.

2.3 CONSTRAINTS

The main hardware constraint is the availability of 3 Legos NXT kits comprising of 3 NXT bricks, 9 servo motors, 3 light sensors, 3 sound sensors, 3 ultrasonic sensors, 3 touch sensors, 21 connecting cables as well as related Legos accessories. Additional materials may only be obtained upon the client’s permission. The scope of the machine’s design has limitations. The wheel speed is limited by motor strength. The robot requires approximately 3V to 3.6V power supply through 12 AA rechargeable batteries, which need to be recharged after 4 hour intervals.

Some of the major software constraints include limitations imposed by processor speed of the NXT brick, such as the ability to run threads simultaneously. A total of 256 kb of integrated high speed flash memory is available to the device.

Further information on component limitations can be found in the Constraints document. Additional information on hardware and software limitations can be found in the Systems document.

2.4 USER FUNCTIONS

The NXT brick interface is simple for a user to interact with. The user can select the operating mode of the machine before beginning of the demonstration. Various variables can be predefined by the user at the start of the demonstration. The user can communicate with the device via the device panel or Bluetooth.

The device will not accept external input during the demonstration as it is autonomous by design. However, it will display output data through its screen for the user to evaluate and observe its performance

2.5 OPERATING ENVIRONMENT

**The Field**

The floor of the field consists of nine ‘4 x 4’ metal panels connected together to form a ‘12 x 12’ section field. Each panel is divided into16 square grids, such that the total play area is made up of 144 total square grids. The grids are bounded by black lines, but under the varnish such that there is no bump in the play surface. Each line is roughly 0.5 cm wide. The wood texture on the surface of the tiles is a light wood grain which contrasts very well with the black lines.

The grid on this wood surface, while serving as a useful coordinate system for our machine, is not without its issues, however. There is no guarantee that the field surface will be entirely free from surface irregularities like scratches or scuff marks, which the light sensors must also be calibrated to handle. Perhaps the greatest concern is posed by the gaps which are formed between the metal panels when they are locked together. The surface at the boundaries of the interlocking panels is not level at times, with small cracks appearing between the panels. This impedes the robot’s navigation, as observed during testing. Subsequently, such factors must be taken into consideration when developing the solution.

**Boundary Walls**

The field described above will be enclosed on all sides by wooden walls. These walls are approximately 25 cm high, with each wall covering the length of one panel, or 4 tiles. The wooden surface of the walls is similar in texture and colour to the wood of the field’s surface, but without the black gridlines.

The foremost purpose of the walls is to define the boundaries of the field. In addition, they will be used when localizing the robot during the first stage of the procedure. However, there are certain issues which need to be considered. The existence of small gaps in between each wall panel has to be taken into account when calibrating the ultrasonic sensor, such that it is not thrown off by spurious readings near these gaps.

**Obstacles**

The obstacles that surrounding the arena will be standard sized cinder blocks. They are approximately 8" high, 16" long and 5" high. Their texture is similar to cement, grey, rough and porous. They can be positioned anywhere on the course, including adjacent to walls, or other cinder blocks. The minimum gap size between obstacles (cinder blocks and/or walls) is 30cm, if they are not touching.

**Lighting**

The lighting environment of the play area will consist mainly of fluorescent lighting, but may also be some ambient lighting due to sunlight, if the sun comes out on competition day. The machine must therefore be able to perform optimally in all environments of reasonable lighting if it is to succeed. Therefore a filter must be used in order to filter out the light from the surrounding.

**Sound**

Noise levels will be potentially high, due to the presence of a large audience. This should be taken into consideration if a sound sensor is to be used.

2.6 PERFORMANCE

The Robot must be able to fulfill the objectives laid out by the client, as discussed in the ‘Purpose’ section of this document. Of crucial importance are the hardware and software aspects, which must be achieved, for the demonstration to be considered successful. An example is the Bluetooth communications, which must work, in order for the task to be successfully accomplished.

3.0 COMPATIBILITY

3.1 COMPONENT RE-USE

The team is permitted to reuse the software created for preliminary laboratories (Lab 1 to Lab 5). This saves budget and resources, providing a useful jump off point to initiate the project rather than starting from scratch. Same applies to the hardware used in the above mentioned labs.

3.2 COMPATIBILITY WITH THIRD PART PRODUCTS

As of present, the hardware is not required to interface with components belonging third party manufacturers, although, as previously mentioned, non-Lego materials may be used with the client’s permission.

The software being used is eclipse, which is used to develop and compile code. Eclipse is a JVM based industrial software used to develop and compile code. It is used in synchronization with the Legos kit and software to develop an autonomous robot.

The Legos software is not currently required to interface with any other products.

4.0 GLOSSARY OF TERMS

NA: not applicable since all terms are self-explanatory.