# Contents



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## Revision History

| Name | Date | Reason For Changes | Version |
|---|---|---|---|
| Dawei Geng | 12 Aug 2012 | basic framework of the SRS | 0.1 |
| Dawei Geng | 12 Aug 2012 | Introduction and Overall Description | 0.1 |
| Yufeng Bai | 13 Aug 2012 | User requirements | 0.2 |
| Dawei Geng | 16 Aug 2012 | Add user requirements & layout edit | 0.3 |
| Dawei Geng | 17 Aug 2012 | Minor changes & layout edit | 0.3.1 |
| Yatong Zhou&Shikai Li | 17 Aug 2012 | External Interface Requirements | 0.4 |
| Jun Chen&Yaoyun Yao | 18 Aug 2012 | Other Non-Functional Requirements b | 0.5 |
| Nguyen Quang Khoi | 18 Aug 2012 | System Features | 0.6 |

# Chapter 1

# Introduction

## 1.1 Purpose

This document is set to describe the requirements of the Archeology Robot Project, to be used for survey an archaeological site containing the remnants of an ancient city. This document shall address the user requirements, system features, external interface requirements and other non-functional requirements describing the robot and the control software's function.

## 1.2 Document Conventions

In this document, user requirements will be describe with requirement description, requirement rationale, acceptance criteria, source of the requirement and a priority ranking. However, other requirements such as external interface requirements and non-functional requirements may not have priority ranking.

The requirements will be labeled with ID which contains letter representing the type of the requirement and a reference number. U, S, UC and N will be used in this document corresponded to User Requirement, System Requirement, Use Case, and Non-Functional Requirement.

how does the numbering work? Is it Sequential?

## 1.3 Intended Audience and Reading Suggestions

TThe audience of this document can be project managers, developers and testers of this project.

how about client?

- For project managers, this document gives a overall description to the requirements. A project manager shall read the entire document and pay special attention to User Requirements, External Interface Requirements, and Non-Functional Requirements.
- For developers, this document gives details about the requirement for them to work on. A developer shall reader the entire document and pay special attention to Use Cases and Non-Functional Requirements.
- For testers, every requirement has a acceptance criteria which can be used to help all the test, and testers also should focus on the User Requirements.

## 1.4 Project Scope

This project's aim is to develop a new intelligent Archeology Robot to be used for survey an archaeological site. A graphic user interface shall be developed for navigation and keep track of the burried remnants within the site. The user interface will also shows the details of the robot and its position and conditions. The robot will be connected to a host computer over Bluetooth connection. The robot shall be allowed to automatic scan all the flat surface on the site and be

able to find the hidden walls or remnants under the ground and produce the information of the site and shows on the user interface's map. User can operate robot through operating the host machine. Manual control shall be enabled when required.

## 1.5 References

**Design Brief**

Computer Science Department, The University of Adelaide (2012) *Project Description.* Adelaide : South Australia

Paul is the author

You can and should reference the minutes of your group and client meeting.

# Chapter 2

# Overall Description

## 2.1 Product Perspective

use acronym

The goal of this project is to develop a new archeology robot and its operating software. It will contains the robot itself, a host machine with a graphic user interface connect to the robot over Bluetooth. This robot will be able to survey the archaeological site with safety priority which the robot shall have the ability to avoid walls and obstacles on the surface.

The robot itself will have one light sensor to detect the hidden walls and object, two touch sensor to avoid collision, and ultrasonic sensors to detect walls or obstacles in front of the robot.

The operating software will have a user friendly graphic user interface which contains control panel, map area, and robot detail information such as battery usage, location, and mode.

The database of this project shall contain XML map files of the sites which the robot have surveyed before. Saving and loading of these files is allowed.

## 2.2 Product Features

The project includes the following main features — Saving and loading map

- Robot shall automatic scan the site and giving feedback on to the screen of the host machine in real time.
- A site map shall be produced when a complete survey is done by the robot.
- Manual control over the robot is allowed.
- Since there may have no go zone within the site. The robot shall never enter the no go zone, if ever a robot is in a no go zone by accident, a message will displayed on the host's screen and called for help. — Ability to add/remove no go zones
- As the robot is working on the site, accuracy and safety is important. In order to ensure that, the default speed of the robot will be set in a acceptable level. — not so much a feature as a non-functional requirement. Would not classify it as a major feature

## 2.3 User Classes and Characteristics

The user of this system will be trained archaeologist who have the knowledge to operate and control the robot. These archaeologist have been trained to perform safe operations to the software and the robot under variety of situations.

## 2.4 Operating Environment

The host software can be run on any system which has installed, Java, NXJ and also have Bluetooth implementations. The client software shall be installed on a LEGO® Mindstorm® robot running NXJ 0.9.1.

## 2.5 Design and Implementation Constraints

The client machine which is the robot shall have its own program can accept and run commands from the host machine. The client software shall be stored in the robot's memory which has limited capacity. Therefore the software on the client end needs to be as minimal as possible. The software shall be written in JAVA using the LeJOS API to interact with the robot. The client and host shall use Bluetooth® for communications.

## 2.6 User Documentation

A user manual shall be produced, outlining the basic operation of the robot and also going into detail about the full capabilities of the package.

## 2.7 Assumptions and Dependencies

In the project the following list will be assumed.

- The terminal used is capable of running JAVA
- The terminal used is capable of running NXJ
- The terminal used is capable of Bluetooth connection
- The archaeological sites will be a single enclosed polygon
- The archaeological sites will have grind lines ever 50mm both vertically and horizontally
- The archaeological sites will be a flat ground
- Hidden walls will be showed as thick gray shape
- The smallest hidden which a robot can detect will be at size of 25mm*25mm

# Chapter 3

# User Requirements

## 3.1 Manual Controls

### 3.1.1 R0001: Robot movements

**Description:** Robot is able to move forward, backward, rotate left and rotate right according to the manual operation.

**Rationale:** If user choose the manual mode, the robot will not be permitted to move by himself. The user is required to use the GUI to control the robot by pressing the button. The GUI has different buttons which represent the different functionality.

**Acceptance criteria:** In manual control mode, when user press direction button(forward, backward, left, right) on the GUI, the robot will move according to the command which is given by GUI. The robot is able to move correctly.

**Source:** Based on third week's milestone plan.

**Priority:** High

### 3.1.2 R0002: Hidden wall detection

**Description:** The robot is required to search the map and to find all hidden walls. In manual control mode, the user need to control the robot to detect by himself/herself.

**Rationale:** The robot will not be allowed to detect the hidden walls automatically. User have to use GUI to control the robot. If the users do not give the command to the robot. The robot will stop and wait for the further command. The switch of light sensor is still controlling by users. If users do not turn the light sensor on, the robot will not be able to find the hidden walls.

**Acceptance criteria:** When the users control the robot by GUI, the users need to turn the light sensor on. The light sensor will detect the hidden walls according to the colours of the shape on the map. If the shape is gray, this shape will be detected as a hidden wall. When robot traverse the map(light sensor is on), if the robot find a hidden wall(gray shape), it will remind the users and let the users give it the further command.

**Source:** Based on introduction of Project Description

**Priority:** High

### 3.1.3 R0003: Avoid danger

**Description:** The robot must be sure to work safely. The robot is not permitted to collide against any external block. The robot is also not allowed to enter the no go zone.

**Rationale:** ~~The robot is not permitted to bump to any external object.~~ The user need to turn the bump sensor and ultrasonic sensor on to detect the block and protect the robot. The robot also have to walk inside the map and not go into the no go zone.

**Acceptance criteria:** Users need to turn the light sensor and bump sensor on. In this situation, if the robot detect the external block, the robot will remind the user, at the same time it will slow down automatically and stop in front of the block(the colliding is forbidden, so we have to set it stop automatically.) Then the robot will not allow to move until the users give it move command. The robot will deal with "out of bound" problem and no go zone problem in the same way as colliding problem.

**Source:** Based on the Project Description 2.4 safety.

**Priority:** High

## 3.2 Automatic Survey

### 3.2.1 R0003: Automatic robot movements

**Description:** The robot is able to move forward, backward, rotate left and rotate right automatically. The users do not need to control robot and robot can traverse the whole map according to the requirement.

**Rationale:** The movement is the fundamental requirement for the robot. Robot must walk and traverse the whole map by itself. In this mode, user do not need to use the GUI to control the robot, the robot will move automatically.

**Acceptance criteria:** The robot can move automatically. It can determine to move forward or rotate according to the actual situation of map by itself. The automatic mode also can be switched by users' operation.

**Source:** Based on week 3 of the milestone plan.

**Priority:** High

### 3.2.2 R0004: Automatic exploration

**Description:** The robot is required to search the map and to find all hidden walls. In automatic mode, the robot is required to traverse and find hidden walls automatically. When the robot discover one hidden wall, it will record the position of the hidden wall and choose another direction.

**Rationale:** The main task of this robot is to find the hidden wall on an archaeological site. The robot must have the ability to detect all areas and find all hidden walls without the controlling.



**Acceptance criteria:** The robot need to traverse the site(except the no-go zone). The light sensor will take responsibility to detect the hidden wall. The light sensor will find hidden walls according the colour of the them(gray shape). Users do not need to control the sensor. The sensor will keep switching on for the whole process. When the robot find one hidden wall, it will record the position of this wall and send the message to users, at the same time , the robot will choose another direction and keep detecting.

**Source:** Based on introduction of Project Description

**Priority:** High

### 3.2.3 R0005: Avoid danger

**Description:** The robot must be sure to work safely. The robot is not permitted to collide against any external block. The robot is also not allowed to enter the no go zone.

**Rationale:** The robot is not permitted to bump to any external object. The user need to turn the bump sensor and ultrasonic sensor on to detect the block and protect the robot. The robot also have to walk inside the map and not go into the no go zone.

**Acceptance criteria:** The bump sensor and ultrasonic sensor will keep switching on for the whole process. In this situation, if the robot detect the external block, the robot will remind the user, at the same time it will slow down automatically and stop in front of the block(the colliding is forbidden, so we have to set it stop automatically) Then the robot will choose another direction and travel another way. The robot will deal with "out of bound" problem and no go zone problem in the same way as colliding problem.

**Source:** Based on the Project Description 2.4 safety.

**Priority:** High

### 3.2.4 R0006: Finding path

**Description:** The client hopes the robot is able to find the path between two given position. In the automatic mode, the robot need to calculate the path(the shortest and safest path are better).

**Rationale:** This is the additional requirement from client, the client hopes we can implement this task. According to the client's requirement, we should find the shortest way or the safest way(safe is priority) to reach to a given position.

**Acceptance criteria:** The user can set the position by GUI, then the robot will calculate the path automatically and move on the map according to client's requirement. In our design, safe is priority. So we always choose the safe way first.

**Source:** Based on the week 2 of the client meeting.

**Priority:** Low

## 3.3 Graphical User Interface

### 3.3.1 R0007: Map representation

**Description:** The GUI contains a window for drawing the map. The map is synchronous with the robot. Before the robot starts, the initial colour of map window is black. When the robot moves, the map will be drawing gradually. After the robot finishes the detection, the map will be finished at the same time. The the GUI will remind users that the map is complete.

**Rationale:** The map window is used for users to show the process of detection. From the map window, the users can check the position of each hidden walls, block and the no go zone. Map is necessary and convenient for checking.

**Acceptance criteria:** When the robot moves, the map will be drawn gradually. The map will mark all hidden walls, blocks and "no-go zones". The map also demonstrates the location of the robot, which is convenient for users to understand whole process of searching.

**Source:** Based on the Project Description 2.1

**Priority:** High

### 3.3.2 R0008: Robot representation

**Description:** The status of robot need to be represented to users. The status includes the power of battery, the location, the bluetooth connection and the speed of the robot. Users are able to understand the robot's situation and make some adjustment.

**Rationale:** When the power of battery is almost running out, the robot need to return to where it begins. So it is necessary to monitor the status of battery. The location and the speed demonstrate the immediate situations for robot. The bluetooth connection is the signal to represent the signal of bluetooth to make sure the robot is connecting correctly.

**Acceptance criteria:** The battery is demonstrated by GUI using a bar. We will use percentage to show how much power left. The location is demonstrated by coordinate to show where the robot is. The speed is demonstrated by GUI using a bar and a number. The bluetooth connection is a light, when the bluetooth works properly, the colour of light will be green. If the bluetooth lose the signal, the colour will become red.

**Source:** Based on the Project Description 2.1

**Priority:** Low

### 3.3.3 R0009: Robot mode change

**Description:** There are two modes can be switched by users: Manual mode and Automatic mode. These two modes can be switched between each other in GUI.

**Rationale:** The client requires us to have these two modes, which is convenient for the client to control the robot at any time. If we do not have the functionality of mode change, the client will hard to control the robot by client. The mode change will be built as a button.



**Acceptance criteria:** When the users press the button of mode change, there is a window jumping out and write like "Do you want to change to the manual mode?" If the users press "yes", the robot will execute as manual mode. The same situation is also suitable for manual mode to automatic mode.

**Source:** Based on the client meeting of week 3rd.

**Priority:** High

### 3.3.4 R0010: User mode change

**Description:** There are two modes can be switched: Client mode and Developer mode. In Client mode, this system allow client to control the robot by GUI, the client can use the robot to search the archeological site and to find the hidden walls, blocks and the no-go zones. The client is not permitted to edit the setting of the robot, for example, the client is not allowed to change the speed setting and the bluetooth setting. If developers want to use Developer mode, they must log in by password(developer only). In Developer mode, the developer can change the speed and the some other system setting.

**Rationale:** The Client mode is used by client, they do not need to understand the internal setting of the whole system. The robot is just a tool to finish its task. They are not permitted to change the internal setting, because sometimes clients do not understand the principle of this system, they may break the system due to some wrong operations for internal setting. The developers are allowed to change the system, because this is our responsibility to make the system better.

**Acceptance criteria:** The default mode of the GUI is Client mode. If the developer want to change to Developer mode, they have to input the ID and the password in the window on the top right side of the GUI window. Then the developers can change the internal setting here.

**Source:** Based on the client meeting of week 3rd.

**Priority:** Low

### 3.3.5 R0011: Load/Save XML map file

**Description:** The map need to be loaded and saved from GUI. The GUI has the two buttons to implement the load and save operations.

**Rationale:** The robot is required to walk on any kind of map, so we need to save more maps in computer and these maps are also convenient and easy to be loaded by client. So we need to add the buttons to control the loading and saving by users.

**Acceptance criteria:** Wen users press the loading button, there is a window jumping out and you can choose the map from here. On the other hand, if the robot finish the searching and users want to save the map, the users can press the saving button. Then this finished map will be saved in computer.

**Source** Based on the Project Description 2.1

**Priority:** High

## 3.4 Emergency handle

### 3.4.1 R0012: Handle entering the no go zone by accident

**Description:** For preventing some unanticipated situation, we set the Emergency Handle operation. When some accidents happen, users need to press Emergency Handle button.

**Rationale:** We must set some operation to deal with some unexpected situation, which is a necessary method to protect the whole robot system.

**Acceptance criteria:** When the users press the Emergency Handle button, the robot will stop immediately and wait for the further command. For example, the robot has to stop at the boundary of the no go zone.

**Source:** Based on the client meeting of the week 3rd

**Priority:** High

### 3.4.2 R0013: Handle bluetooth connection loss

**Description:** This system shall have the ability to handle a connection loss situation by trying to reconnect to the robot or send a error message to host machine.

Limited order will it do these

**Rationale:** A connection loss could cause operation fail or even broken the robot. In order to improve the entire operation's safety and efficiency, we add this requirement into our emergency handling procedures.

**Acceptance criteria:** When a connection loss happen, the robot should stop operation immediately and the host machine shall trying to reconnect the robot. if the reconnection failed, a error dialog box shall appeared on the host machine waiting for further operation.

**Source:** First client meeting.

**Priority:** Medium

### 3.4.3 R0014: Handle battery failure

what emergency?

**Description:** This system shall be able to handle a emergency when the robot's battery is running out and can not return to the start point.

More detail

this should not happen. Need prevention Strategy as well

**Rationale:** The robot should operate under sufficient energy at anytime. However, There may be some cause to a battery failure such as faulty batteries and external damage to the battery. Such failure could cause connection loss and inaccurate information.

**Acceptance criteria:** When the system detects the battery level is not enough for the robot to return to the start point, the robot should stop operation immediately and the host machine shall trying to reconnect the robot. if the reconnection failed, a error dialog box shall appeared on the host machine waiting for further operation.

**Source:** First client meeting.

requirements for
- loss of communication?
- Setting boundaries of map?
- mini map

**Priority:** Medium

description of requirements needs to use correct language
See the lecture slides
rationale should explain why we need the requirement instead of adding more detail to the description
source should be documents for meetings or project specification
many of your requirements don't follow this!
Need to break down requirements into more fine grain requirements

# Chapter 4

Your acceptance criteria tends to explain what the user should expect if they do something. We want you to explain how you could verify that what it is doing is correct

└ the software or a robot

# System Features

## 4.1 Manual Control

the priority is? Is this actually necessary?

### 4.1.1 Description and Priority Not stated

The operator can control movement and speed over the robot. The operator needs to hold a directional button on the interface to move and release it to stop. To change speed, the operator can select the appropriate speed on the slider bar. It is essential that the functions are implemented in the system to move the robot to the starting point safely.

The manual control implements requirement R0001, R0002, R0003, R0010

these should be here

### 4.1.2 Stimulus/Response Sequences

The operator has to select manual mode to enter manual control. The buttons in the 'Control' tab is then highlighted and is ready to use. The operator selects the appropriate speed by moving the slider bar before holding on a directional button. The host software will send a PC packet with the latest speed setting and the direction to the robot, moving the robot in the indicated direction.

### 4.1.3 (

Functional Requirements)

The functional requirements of the manual control are as follows:

- The GUI includes a 'Control' tab that has directional buttons of moving forward, moving backwards, rotating left and rotating right.
- The 'Control' tab also has a sliding bar that toggles the speed setting of 0,1,2,3 and 4. A speed setting of 0 halts the movement of the robot while the speed setting of 4 set the fastest possible speed for the robot.
- If the robot enters a no-go zone , an emergency mechanism is triggered.

## 4.2 Automatic Control

### 4.2.1 Description and Priority

The host software comes with an automatic navigation algorithm. The robot has a light sensor to detect a mine object and an ultrasonic sensor for detecting an obstacle object. Each time a wall is encountered by the robot, the robot sends a request to the host software controller to record the position and decide on the best possible path to take. The new generated path is

then reflected on the GUI while the controller sends back the new path in a PC packet to the robot.

The navigation system may start with either a new, partial or completed map. In any case, the map will contain information for the starting position of the robot,above-ground walls and buried walls

The automatic path Finding navigation implements requirements R0003, R0004, R0005, R0006, R0007, R0009, R0011.

### 4.2.2 Stimulus/Response Sequences

When the robot set on the starting position of the survey area , the operator has the option to switch to auto mode. This function disables manual controls while enabling the usage of the start and stop buttons. At this point, the operator can press the start the button which causes the host software to initialize the robot with the starting position coordinates and an intial generated path. The robot then follows this path till it encounters an object, making change to map and requesting a new path.

### 4.2.3 Functional Requirements

The GUI contains a start and a stop button for auto mode. If the user push a start button, a map is to be generated and be displayed on screen.

## 4.3 Graphical User Interface

### 4.3.1 Description and Priority

The GUI serves as an interaction platform between the operator, the robot and the survey area. . All controls are made available to the operator through the GUI. The GUI also includes executing either automatic or manual robot control. In addition, the GUI provides a visual interpreta- tion of the area to the operator in the form of a writable XML map. As the robot makes its exploration, any objects encountered by the robot is displayed on the GUI. Lastly, the robot's status such as oordinates, mode, etc is shown at the bottom of the GUI.

The graphical user interface implements requirements R0007, R0008, R0009, R0010, R0011

### 4.3.2 Stimulus & Response Sequences

There are various components of the GUI that the operator can access:

- The tool bar on top of the GUI - The operator has the ability to load map, save map and save as map through the 'File' header. If the 'Robot' header is accessed, the operator could connect and disconnect the robot. Under the 'View' header, the grid and path taken by the robot can be toggled on and off. As for the last header named 'System', the operator has the option to exit the system.
- The map interface and map editor - The map interface displays a loaded XML map illustrates the survey area. A map editor is provided for the operator to add no-go zones and remove no-go zones.
- Manual mode - When the operator selects manual mode, he has access to the manual controls of the robot under the 'Control' tab. Manual controls include moving the robot and altering the speed settings.
- Auto mode - Auto mode is used when the robot is placed at a designated start position in the survey area. When the operator selects auto mode, the manual functions are disabled.



If the start button is pressed, the robot will commence autonomous mapping. At any time the operator can click on the stop button to halt the operation.

- Robot status -The status displays the robot's coordinates, the current mode, the speed of movement, connection and battery strength.

### 4.3.3 Functional Requirements

- Directional buttons and speed toggle are needed for the manual mode.
- A start and a stop button are required for the auto mode.
- A mode switch is required.
- The GUI must support the functions of loading and saving a map.
- No-Go zones can be edited.
- The map must display the wall if the robot discovers one.
- The robot status must be displayed.

## 4.4 Use Cases

### 4.4.1 Frequent Use Case

**UC001: Operating the robot in manual mode** UC001 is associated with section 4.1 - Manual control as well as R0001.

1. Use Case Name: Operating the robot in manual mode.
   - Description: The use case shows the operation of the robot under complete manipulation of the operator.
   - Goal: The objective of this use case is to ensure that the robot under the control of the
2. Flow of Events:The robot is placed in an arbitrary position outside of the survey area while the operator is controlling the robot through Bluetooth.
   - The operator switched the robot on and run the program. He then executes the GUI, connecting the robot. Next, he selects the manual mode.
   - The control buttons are highlighted to imply that it is ready for use. The operator selects the appropriate speed by using the slider bar.
   - The operator then holds down the directional key to move the robot till it reaches the destination
3. Preconditions:
   - The robot batteries are charged and the robot is working properly.
   - The GUI must be working
   - The Bluetooth connection operates normally.
   - An appropriate XML formatted map must be loaded. This map may be a new, partial or completed map.
4. Postconditions:
   - The robot reaches the destination safely.

**UC002: Operating the robot in auto mode** UC002 is associated with section 4.2 - Automatic control as well as R0003.

1. Use Case Name: Operating the robot in automatic mode.
   - Description: Under the supervision of the operator, the robot commences autonomous mapping from a given starting point of the suvery area.
   - Goal: The end result of this use case is achieved when the robot has successfully mapped all the points in the area.
2. Flow of Events: Using manual controls, the robot is moved onto the starting position of the survey area. Like UC001, the operator supervises the robot through the host machine.
   - The operator ensures switched on the robot,executing the program. He then opens the host machine to run the GUI. The operator connects the robot through Bluetooth, selecting the automatic mode.
   - The start and stop buttons are then ready to use.
   - The operator then presses the start button to initiate autonomous search.
   - Without being interupted, the robot moves on its own till it finishes mapping. The actions are now determinied by the controller in the host machine.
   - If the operator wishes to halt the progress of the autonomous search, he has to press the stop button. At any point, the map is written into an XML File and can be loaded again for later use.
3. Preconditions:
   - The robot batteries are charged and the robot is working properly.
   - The GUI on the host machine must be running.
   - The connection between robot and host machine is stable
   - An appropriate XML formatted map can be loaded. This map may be a new, partial or completed map.
4. Postconditions:
   - The robot finished mapping completely and safely.

### 4.4.2 Exceptional Use Cases

**UC003: Loss of communication signal**

1. Use Case Name:Loss of communication signal.
   - Descripton: The process details on the steps taken by the robot in the event if the Bluetooth communication link is broken between the host software and the robot.
   - Goal: The robot tries to re-establish communication link.
2. Flow of Events:
   - During manual or autonomous mode, communication between host software and robot is lost.
   - The robot stops at its current position.
   - At the same time, it tries to re-establish communication by prompting the host software at a regular interval.
   - If communication is established, the robot will request the next instruction.



   - Otherwise, it will remain at its current position. — warning Sent to operator

3. Preconditions:
   - The robot is having a connection with the host software.
4. Postconditions:
   - The robot should stop immediately
   - The connection should be resumed after a short time.

Overall these are good ~~need~~ but should follow a complete pass through the System.
So flow of events might start with loading an existing map or starting a new map.
Might run until entire area is mapped.

# Chapter 5

# External Interface Requirements

## 5.1 User Interface

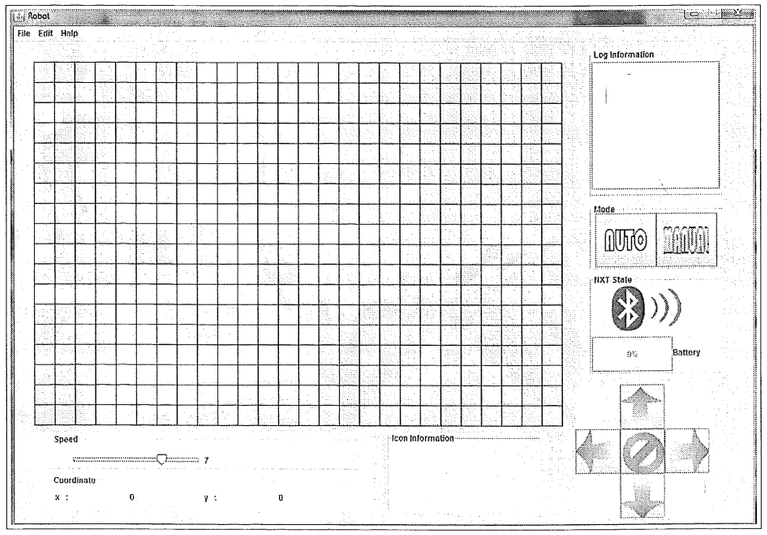


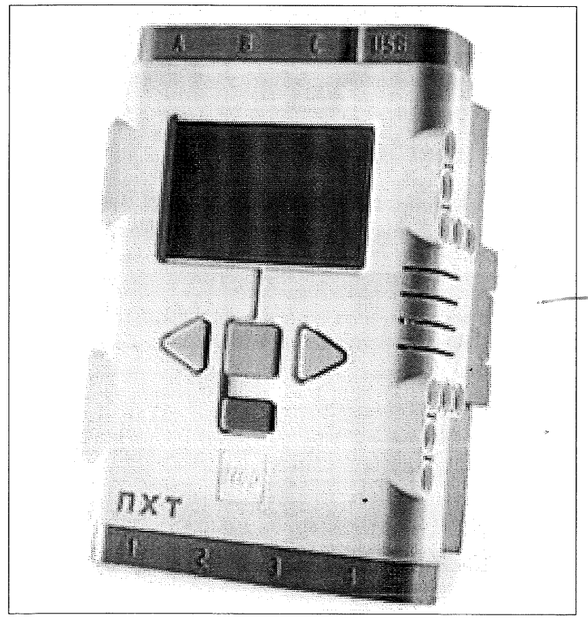

Figure 5.1: Overview of the graphic user interface

The Graphic User Interface is a Java-Based Program, which is used to control robot from the host computer. The UI Window has a menu bar on the top, and a display panel under it. The menu bar contains three menus: File, Edit and Help. Under the File menu contains options to open and save map, it can control the window as well. Edit menu has some functions to control the robot, User/developer mode switch and connection settings. Help menu contain an about item which shows the information of the software. The main desk panel contains the map display area. Right side panel contains log information, auto/manual mode switch button, battery and Bluetooth connection state, and direction control buttons. Bottom panel contains current coordinate of robot in map and speed slider bar.





## 5.2 Hardware Interfaces




not required

Figure 5.2: Hardware interfaces contains robot body (brick)

The brick has these four main interfaces:

- Bluetooth connection:
  This part is the wireless communication device and data transfer device between user and robot.
- Light sensor:
  Light sensor can detect the different stuffs on the map according their color depth.
- Ultrasonic sensor:
  Ultrasonic sensor is the device on the robot which looks like two eyes, it has the function like eyes as well. This device can sense the barrier in front of the robot, and it will warn the user if the bot is too close to the barrier. It can also let the bot stop through software when danger located in front of the bot.
- USB interface:
  USB interface has the same function as the Bluetooth. The difference is the data transfer and communications are both via a USB cable.

## 5.3 Software Interfaces

Any machine (Mac/Windows/Linux) installed Java virtual machine(JVM) can run the software. GUI supports the LeJOS Java API and can be operated by the user, to implements this, the machine are required capable at either Bluetooth or USB connection. Real maps can be created, load and save map file through the GUI.

## 5.4 Communications Interfaces

Bluetooth (wireless) or USB (cable) connection can be connected to the robot. Files manipulation and other communication can be made through LeJOS NXJ Control Centre like this:

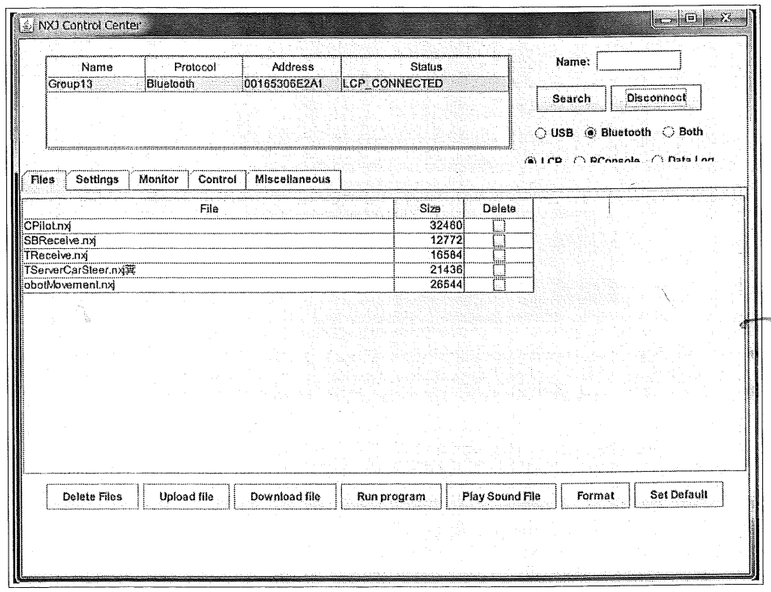



Figure 5.3: NXJ Control Center

With this program, basic connection can be made easily between host computer and brick. We can delete and upload testing source codes via either Bluetooth or USB cable.

# Chapter 6

# Other Non-functional Requirements

## 6.1 Robot Performance

### 6.1.1 N0001: Time Performance

**Description:** The robot must be able to scan the whole map and detect all the elements on that map, within a adequate amount of time.

**Rational:** Normally the robot should complete any tasks in 20 minutes, including scan the map and find all hidden walls and remnants.

**Priority:** Low

### 6.1.2 N0002: Accuracy Performance

**Description:** The robot must be able to mark the position of elements correctly and accurately. It must be able to tell the difference between hidden walls and remnants which distinguished by different colors.

**Rational:** The map must be generated correctly to allow the robot to avoid obstacles, even entering the no-go zones.

**Priority:** Medium

## 6.2 Safety Requirements

### 6.2.1 N0003: latency

**Description:** Robot is able to give a response to the command in a response time. Normally,this time is as short as possible.

**Rational:** Response time could be extremely important when the robot is in a dangerous situation and emergency stop needs to be carried out.

**Priority:** High

### 6.2.2 N0004: Manual Mode Security

**Description:** When the robot is in manual mode, the sensors must keep functioning to avoid collision or entering no-go zones. A warming message should also appears on GUI when the user is trying to do something dangerous.

**Rational:** Accident may happened in manual mode by misoperations. Even the user try to enter no-go zones or hit the walls intentionally, the robot should be able to stop by itself.

**Priority:** High

## 6.3 Safety Requirements

### 6.3.1 N0005: Mapping Safety

The robot must not leave the map or enter the "no-go" zone. However, when the robot found itself in a "no-go" zone by accident or condition change of the site, it will send an error message to the host machine, stop the opreation and wait fot rescue.

### 6.3.2 N0006: Action Safety

The robot should not bump any blocks(walls etc.). Also the robot can not move against the user's will. The robot is not allowed to be damaged at all the time.

### 6.3.3 N0007: System Safety

The system of the robot should have a encryption so that no one can hack it. Also the information robot gets will only send to the user, so no one can steal the information.

### 6.3.4 N0008: System Update

The system of the robot should be able to update or maintain in order to upgrade its security level. It can be updated by the user.

### 6.3.5 N0009: Robot Design

The robot should be designed sensibly and stably so that it will not be effected by the change of environment. Also a good design can help the robot move smoothly.

### 6.3.6 N0010: Battery(Optinal)

It is better if the robot has a power saving module. Also the robot should be fully charged before it is put to work. If the robot run out of power, it will go back to the initial point.

## 6.4 Other Requirements

### 6.4.1 N0011: Speed

The robot walks in normal speed, when the sensor detect the wall, robot will slow down. Moreover, the user can change the speed of the robot if he wants to.

### 6.4.2 N0012: Sensors

The default state of manual mode will be all sensors are set to on in order to countinue survey. However, if the user wishes to switch off the light sensor, they can do that. Under any circumstances, all the safety sensor such as ultrasonic sensor and touch sensor will stay on.



### 6.4.3 N0013: Accuracy

The robot must map the archeological site accurately. It must has the ability to identify accurately what it detect. (Above ground walls, buried walls, foundations) With the accurate action, the robot can detect all the things in the site.

### 6.4.4 N0014: Optimised Performance(Optional)

It is better if the robot can Optimise the path after the survey(find the shortest way to reach the destination). This performance can save power and times.

## 6.5 The GUI layout

The GUI is desired to ensure that it is comfortable to used by our client. So we put directional control on the right-hand side same with keyboard as these buttons may be used most commonly. We also let the map occupies a lot of space to make sure users can see it clearly.

The GUI is fit into a 1100x768 fixed sized window with a 800x600 map display area. Speed control,icon information and Coordinate panels are located below the map.Log information, mode switching,NXT state and manual control buttons are on the right part.

# Appendix A

# Glossary

should be made clear in requirement

**Automatic Mode**: Mode of operation, completely controlled by robot and host machine, without human input of movements.
**Bluetooth**: Wireless connection used to communicate between robot and host machine.
**Explored Area**: The area that robot have inspected, which allows robot to travel safely.
**Gird**: A size of 50mm*50mm area in map, which contains 4 pixels. Each gird can be labeled as explored, unexplored, or "no go".
**GUI**: Graphical User Interface. Displays the map panel, control panel and status panel.
**Light Sensor**: Sensor used to detect hidden walls within the site, located at the front of the robot. The sensor returns the distance of the object.
**Manual Mode**: Mode of operation. Movements controlled directly through operator.
**"no go" zone**: A zone predefined is forbidden for the robot to enter.
**Pixel**: A size of 25mm*25mm area in map, defined as the smallest resolution, which is also the smallest area of hidden walls that robot can detect.
**SDD**: Software Design Document.
**SEP**: Software Engineering and Project.
**SPMP**: Software Project Management Plan.
**Ultrasonic Sensor**: Sensor used to detect walls and obstacles within the site, located at the front of the robot. The sensor returns the distance of the object.
**Unexplored Area**: The area that robot have not inspected, which can be considered dangerous.
**XML**: Extensible Markup Language. ~~The map is saved as an XML file.~~ the last part should be mentioned in requirements

user/developer mode is not required
- should consider zooming in/out
- should consider beacons to handle dead reackoning