Robot Competition

Mechatronics Microcontroller Project MXEN2002

A catastrophic accident has caused the ACME laboratory to become flooded with radiation. A human rescue team is on standby, but radiation exposure must be limited by a carefully targeted rescue.

You must design and build a semi-autonomous robot, which will enter the laboratory and map (by hand) the location of the victims to inform the subsequent rescue operation. The victims are represented by tags consisting of a red number at least two centimetres in height, and a symbol of variable size which must be recorded.

There are two zones in the laboratory. The first zone has restricted communication, meaning robot operation must be autonomous except for a “pause” function, allowing victims to be identified. The autonomous zone is a flat-floor single path maze with no dead-ends. The second zone permits full remote operation, and may include various obstacles and mobility challenges, including inclined floors (up to 10°) and small steps and obstacles (up to 3cm).

For this task, you will have the following components available:

- One preconfigured Arduino Mega Board, with LCD display, two analog joysticks and an XBee communication module already attached (a remote controller)
- A second Arduino Mega board, which you will configure for low level robot control.
- A second XBee module for wireless communications.
- A selection of position and velocity servomotors.
- Three or more Sharp range sensors (a mix of 30cm range and 80cm range subject to availability)
- One or more wireless cameras which will relay images to the remote operator
- H-Bridge motor drivers
- A LM7805 5V power regulator

An 11-12V power source (a power supply during testing and a battery for the competition) will be supplied. This power source can directly power the Arduino board and the motors, but a 5V regulator circuit will required for the Servomotors (the Arduino 5V supply is not sufficient).

The XBee wireless modules will be configured to communicate directly using an Arduino Serial channel. You will be able to read and write wirelessly in exactly the same way as you would read and write over a wired serial connection.

The preconfigured Arduino board will need to be programmed, but should not be rewired without permission (it needs to be reused by other groups). This board is the “remote controller” board, and should be used to drive the robot, and also to relay information from the range sensors.

The robot will commence operation at the entrance of the “autonomous zone”. When autonomous mode is activated, the controls may not be touched except to pause the robot until the robot emerges from the autonomous zone (otherwise penalties will apply). The robot is then operated under remote control for the remainder of the operation.

Competition rules:

The **winner of the competition** is the team which records the highest score within a five minute time-limit according to the following metric:

- Victim identified (number recognised): **2 point per victim**
- Symbol correctly recorded: **2 point per victim**
- Victim identified while in autonomous mode: **2 points per victim**
- Successful navigation of autonomous zone: **4 points total bonus**
- Demonstrated real-time display of sensor readings **4 points total bonus**

It is expected that there will be two victims in the autonomous zone (12 points total), eight victims in the remote-operation zone (32 points total), with a maximum score possible of 52 points. Note that autonomous operation is not strictly required, except that autonomous points cannot be scored if autonomous operation is not successfully achieved. Part marks may be awarded for autonomous navigation. The maximum score with no autonomy is 44 out of 52.

Each team will have **one** opportunity only to complete the rescue operation. If a team experiences a major failure during their run, they may request a second run with a penalty of 20% of their final score.

Each team has one designated driver. The designated driver is permitted to view the playing area prior to the driving attempt, but may not view the field (except via the camera and sensors) during the run. Non-driving team members may support the control and power cables, but may not interfere with the robot in any other way (interference or repairs incur penalties as below).

The robot may be returned to the start position and repaired or reset at any time without penalty.

The following penalties apply to other interference with the robot during the competition run:

- A 'nudge' of the robot position or angle: **-1 point**
- A reset of the robot microcontroller: **-2 points**
- Other 'minor' interference: **-1 point**
- Other 'major' interference: **-2 points**

Project Marking: **(total 30 marks)**

Marks for functionality and design are awarded in addition to marks for performance in the competition. Three one-page submissions are required on competition day, and will be used to guide the judging of the robots: a circuit schematic (for the robot), a flow chart or state diagram (for the autonomy), and a description or diagram of the robot user interface (controls and display). These submissions will also be submitted as appendices to the robot design report.

Functionality and Design: **(20 marks)**

1. Control of robot drive, judged for smoothness and lack of latency **(4 marks)**
2. Pan control of wireless camera, judged for smoothness and usability **(4 marks)**
3. Real-time display of calibrated sensor measurements **(4 marks)**
4. Neatness and quality of electronic layout (schematic required) **(4 marks)**
5. Autonomous performance (flow chart or state diagram required) **(4 marks)**

Competition Performance: **(10 marks)**

The competition winner (highest score) will receive 10 marks for performance. The other groups will receive marks in proportion to their score, and scaled according to the winners:

$$M=10*S/S_w$$

where M=marks, S=competition score, and S_w = winning team's score

Example arena layout: