1 Project Logistics

1.1 Team Size and Topics

The nominal team size is 3 people. The instructor reserves the right to, at his discretion:

- Adjust the size of a team, based on his assessment of the difficulty of that particular task,
- Swap group members as dictated by logistics and/or team management factors,
- Assign additional deliverables for larger teams doing a simpler project.
- Limit the number of Project Choices based on logistics and/or laboratory inventories.

1.2 Standards and Styles

All written proposals & reports must comply with the Written Document Style Guide [2]. All source code must comply with the Embedded Programming Style Guide [1] for this course.

1.3 Deliverables and Deadlines

1. **9:55 AM, Wed March 27**: (10%) A short written Project Proposal, submitted to the instructor. It should clearly list: (1) the objectives and scope of your project; (2) all hardware needed from MTU lab inventories; (3) all hardware being provided by you; (4) questions or ambiguities regarding the specification of the project.

2. **9:55 AM, Fri April 5**: (10%) A short written Progress Report submitted to the instructor. It should emphasize (1) A short review of the goals and objectives, (2) What tasks have been accomplished, (3) What tasks remain to be accomplished, (4) Any open questions, ambiguities, problems, or roadblocks that you anticipate may hinder completion of the project.

3. **No later than 10:00 AM, Wed, May 1**: (40%) Complete a live demonstration of your working project. You may be asked to repeat the demonstrated functions up-to three times to establish the reliability of your design.

   Warning: do not wait until the last minute to schedule a demonstration time with the instructor.

4. **No later than 10:00 AM, Wed, May 1**: (40%) A formal, written Final Project Report, to be submitted in lieu of a final exam. The Final Report shall define your objectives, design, and results in sufficient detail that another student who has taken this course could understand your project, replicate it, and take it forward to the next generation.

   Grading will depend on the completeness, clarity, readability, and style-guide compliance of your report, as well as on the quality of your design decisions and the final design itself.

5. **Peer evaluation forms (± Δ%)** will be made available, and the results thereof may be used to adjust the grades of individual team members. These will not be used for minor tweaks, but rather to detect major differences in performance, and identify “heroes” and/or “hitchhikers” on the teams. However, if you feel that a team member is slacking off or hitchhiking, do not wait to tell me.
2 Project Choices

These projects are decidedly low-tech. They are achievable using eZ430 target cards, and emphasize reaching an engineering objective at minimal cost and complexity (i.e. doing the most with the least).

2.1 Line Mapper Bot

Given a contiguous curved line with up to 8 intersections (or cross points), a mobile robot will:

1. Traverse the taped line on the floor, from beginning to end
2. Measure the linear distances between each of the cross points
3. Wirelessly report these distances to a PC for human-friendly real-time display on a terminal.

Conditions of the test:

• The line and cross points will be laid out in black electrical tape on EERC floor tiles.
• Each cross point will be a right angle cross that extends at least 2 inches in each direction.
• The minimum radius of curvature for the path is 6 inches.
• The line sensor suite will be designed by the team, using up-to 4 IR Reflection Detectors.

2.2 Light Seeker Bot

A lamp with a bare bulb (equivalent to 40-60 W incandescent) will be placed at an arbitrary location in a straight section of an EERC hallway with no obstacles in the hall. A mobile robot shall:

1. Traverse the hallway and, using up-to 4 CdS photoresistor cells, detect & localize the light source.
2. Approach to within 6 inches of the lamp and stop, without moving or tipping the lamp.

Conditions of the test:

• No part of the robot chassis, wheels, or attachments may touch any wall or the lamp at any time.
• The base of the lamp will be located with at least 1 foot clearance from the nearest wall.
• The team may decide:
  ◦ Which sensors & means to use to avoid hitting a wall and/or the lamp.
  ◦ If and how to aim or steer the photoresistor sensors.

2.3 Hallway Shuttle Bot

Using only an accelerometer chip for input, a mobile robot shall traverse the distance between two lines across a straight hallway. Given lines that are exactly 12 meters apart:

1. Starting at a Start line, drive to a Finish line and stop within ±0.5 meter of the Finish line,
2. Pause for a few seconds,
3. Back up to the Start line and stop within ±1 meter of the Start line.
2.4 **Hallway Navi Bot**

Given up-to 3 active ultrasonic sensors (pingers), a mobile robot shall autonomously:

1. Complete at least one circuit through an EERC hallway (e.g. the 8th floor "U")
2. Avoid bumping into the walls or any other static obstacles.
3. Stop within one meter of the wall at the far end of the circuit, but before hitting the wall.
4. All obstacles will be at least 1 foot in diameter, and may be placed anywhere in a straight section of hallway (not at corners). Only one obstacle will be placed in any given location.

2.5 **Ultrasonic Radar Line**

Using two “radar towers”, each comprising an active ultrasonic sensor (pinger) mounted on a servo, and wired to an MSP430:

1. Detect and track a single target as it moves through the radar’s range of view.
2. Determine the target's (X,Y) position & velocity, and point the pingers toward the target.

**Conditions of the test:**

- The area to be covered shall be a 1 m x 1 m square.
- The pingers have a wide field of view, so azimuth is useless; you have only range to work with.
- You may **not** use any Floating Point values or operations (yes, it can be & has been done).
- The target to be tracked will be cylindrical or spherical, and at least 6 inches in diameter.
- The speed of the target will be limited to no more than 15 cm/sec. However, the target may wobble or vibrate, so those motions must be filtered out, esp. from velocity.

2.6 **WSN and Guard Bot**

Create an eZ430-based Wireless Sensor Network (WSN) to detect and locate an intruder in a straight section of EERC hallway, and forward the data wirelessly to a base station mounted on a mobile robot.

1. There must be 4 free-standing sensor nodes and 1 base node mounted on the robot.
2. The fixed sensors employed shall be simple Passive Infrared (PIR) motion detectors.
3. If the intruder comes “too close” to the robot's end of the hallway, then dispatch the robot to approach and challenge the intruder.

**Conditions of the test:**

- The robot shall approach to within 2 feet of the intruder and point at the intruder.
- No part of the robot chassis, wheels, or attachments may touch any wall or the intruder at any time.
- The robot should be able to tell the difference between the intruder and a wall.
- The designers may decide what robot-mounted sensors & methods to use for localizing the intruder.
2.7 Wireless Remote Oscilloscope Probe

Use two eZ430 Target cards to create a wireless link between an analog signal source and an oscilloscope, as follows:

1. The Sensor card will receive the input signal to be measured via its ADC10 port, and transmit the digital value to the Receiver card.
2. The Receiver card will receive the digital signal, and use a DAC to reconstruct the original analog input signal as accurately as possible.

Conditions of the test:

- The input analog voltage shall range from 0 to 3 V (so as not to exceed the ADC10 range)
- Input test signals shall include both sinusoidal and square waveforms.
- On the oscilloscope:
  - the original signal shall be displayed on one channel, and
  - the reconstructed signal shall be displayed on the other channel.
- The report shall include an evaluation of the wireless system performance, including:
  - The lag time between the original and reconstructed signals,
  - The fidelity of the reconstructed signal vs. the signal frequency.

2.8 Custom Project Options

You are welcome to propose your own final project ideas, but they must meet the following criteria and they must be approved by the instructor.

1. Proposals need to be much more detailed than for the “canned” projects above, in order for us to evaluate the level of difficulty & feasibility. Consult the instructor early in proposal drafting.
2. The project must be academically rigorous enough to be a final project, but not too difficult. The most common error is proposing a project that is too big or complex for the time available.
3. The project should be relevant to the topics of this class.
4. You are not restricted to the MSP430 or I/O devices discussed in lecture. However, we may not be able to provide much advice or tech support for other microcontroller platforms or devices.

3 References


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1 Based on a project idea originated by Sam Smit.