530.421 Mechatronics

Project 2: ArtBots

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http://www.me.jhu.edu/~allisono/courses/530.421/
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Project demonstration date: December 8, 2006
(Private evaluation session & Public showing, within 10 am – 2 pm)
Project Report due date: December 11, 2006

Goal

To produce an "art machine" that will:

1. Engage the audience by moving with an interesting or pleasing motion, possibly combined with other pleasing visual or auditory stimulus,
2. Be a self-contained mobile device (with the exception of "passive" art-making materials if desired), and
3. Modify a canvas (white poster paper) taped to the ground over which the device travels.

The projects will be viewed and enjoyed not only by your fellow 530.421 students, but also by interested people who may know a little about art *and* the technology involved. Also, the best Artbots that are robust, operable by the layman, and use readily available art-making materials will be saved for a long-term exhibit. You should keep this in mind when designing the project. The machines will be displayed and demonstrated in Room 101 of the Ross-Jones Building of the Mattin Center (also known as the Second Decade Society Room).

The underlying purpose of this project is to give you further experience with designing and building an electromechanical/robotic device. This will involve working with sensors, actuators, circuits, and microprocessor control. You will also submit a report detailing the sensors, actuators and control of your device.

Specifications

- Each team of *two* will design and construct a machine. Your teams *must* be interdisciplinary (you should partner with someone outside your primary department). Your teammate does not need to be a previous lab or project partner.

 Thanks to Joan Freedman (JHU Digital Media Center) for her contributions to the conception of this project.

- The machine's behavior will be initiated by the pressing of a single button/switch. Once triggered, the machine should react by moving over the canvas and generating the art. The process should run for a minimum of 30 seconds and a maximum of 120 seconds. You can trigger the artbot to perform multiple runs on the same canvas to achieve different effects, but each run should also be sufficient to create a piece of art.
- The canvas (white poster paper of size 32" by 48") will be provided. It will be taped to a black background on the floor of the room. Your Artbot should only modify the canvas, not the surrounding environment. Thus, it must detect the presence of the canvas. Different size canvases may be used if desired.
- The robot must not create the same art twice.
- The generation of the art must use at least *two different* sensors and *two different* actuators.
- The mobile ArtBot must have a footprint that falls within a 11" by 17" rectangle.
- The machine should not rely on any power source outside of the operation space (e.g., no power cable connecting your machine to the wall). Your project may include batteries and, if desired, may use the Basic Stamp.
- While it is normally not good practice, the finished circuitry may be constructed on a proto-board. (Wire-wrap is also acceptable, but more difficult to debug.) This has been done to allow you to spend the maximum time on your project, without having to learn electronic prototyping or wait for printed circuit boards to be manufactured.
- Your team may not spend more than $80 on the materials included in the final version of your device. You may use any sensors and actuators already available in the lab (these are not included in the $80 cost), BUT you must return them unbroken at the end of the project.

Note the following safety requirements:
- The machine must be safe for both users and spectators
- No toxic materials.
- No part of the machine may become ballistic outside the canvas
- No pyrotechnics or fire of any kind!
- If the machine contains any liquids, they should not be conductive or corrosive, and *must* be packaged in a safe manner.

Evaluation

Each ArtBot team will receive four grades:

1. **Concept (20%):** This will be based on the technical merit of the design of the machine. Included in this grade will be the appropriateness of the solution, as well as innovative hardware, and use of physical principles in the solution.

2. **Implementation (25%):** This will be based on the prototype displayed at the evaluation session. Included in this grade will be evaluation of the physical appearance of the prototype and quality of construction. We will not presume to judge true aesthetics, but will concentrate on *craftsmanship* and *finished appearance*.

3. **Performance (40%):** Based on the results of the performance testing during the evaluation session. Does it work? Is it reliable?

4. **Report (15%):** Project report requirements are described in a separate document. This report is due to the instructor's office on Monday, December 11, 2006 (the Monday after the demonstration). One report per team. You should also turn in a self and partner evaluation form.

Performance testing procedure: All machines will be tested by the instructor pressing the designated button on the machine, initiating the process and observing the response. Each team should prepare a verbal, 30-second (no more) presentation to introduce the machine. This presentation should highlight the basic functionality and unique features in the design.

Checkpoints

Your project should meet a series of minimum levels of design/functionality by the end of the following lab sections:

Thursday 11/2 or Friday 11/3: Project partner chosen, evidence of brainstorming
Thursday 11/9 or Friday 11/10: Response to button press/switch, fairly complete mechanical design ideas, and essential materials purchased
Thursday 11/16 or Friday 11/17: Mobile chassis prototype complete, all final materials purchased
Thursday 11/23 or Friday 11/24: Thanksgiving, no lab
Thursday 11/30 or Friday 12/1: Preliminary ArtBot complete

You should continue to attend the lab sections throughout the project period. The instructor and TAs will be on hand to check the progress of your machine. In addition, this is one time when you can be guaranteed to receive help from the TAs in the lab.

Suggestions

We understand that the project definition is probably a bit more open than you might be used to. To help you get your creative juices flowing, we offer some reflections that you might want to consider:

- Art can be geometric.
- Art can be abstract.
- Art can be interactive.
- A sculpture is also art.

We encourage, and hope to foster, a wide range of solutions to this problem. This will make for the most enjoyable presentation for your audience. The tasks of being triggered, modifying the canvas, and creating new art each run represent the basic functions that all machines *must* provide.

While the emphasis in this class and *Robot Sensors and Actuators* has been on the use of sensors, actuators, electronics, programming, and control, don't forget the mechanical aspect. Make use of techniques demonstrated in the rapid prototyping lecture (e.g., foam core, laser cutter). Do not attempt to make an unnecessarily complex device. Get something simple working first, and then *carefully* add bells and whistles as time permits. Your machine must be rugged enough to survive your testing as well as "testing" by the audience. Functionality is judged on the day of the demonstration, not the night before.

Materials

You are limited to an expenditure of $80 per team of two ($40/person) for purchased materials and parts used in the construction of your final project. You may use any item already available in the lab (these are not included in the $80 cost), BUT you must return then unbroken at the end of the project. Examples of available items include: A breadboard, a Pittman motor with optical encoder, an LCD display, a ultrasonic transducer with circuit board, a stepper motor with control circuit, wire kit, amplifiers (low-power and power). If these items are damaged or destroyed, you will be charged their cost for replacement. If you wish to keep your device at the end of the project, it is *highly* recommended that you purchase all your own hardware and circuitry. That way all you would need to purchase in order to keep it running is your own microcontroller.

Some suggestions for purchasing items online:

- Digikey is an online electronics store (http://www.digikey.com/)
- Mouser is an online electronics store (http://www.mouser.com/)
- Tower Hobbies sells RC Models and parts (http://www.towerhobbies.com/)
- Parallax makes the Basic Stamp and thus sells many easy-to-integrate components, including sensors and servo motors (http://www.parallax.com/)
- You can also get free samples shipped (often overnight) from companies like National Semiconductor, Texas Instruments and Analog Devices.
- Jameco Electronics sells electronic and mechatronic components (http://www.jameco.com/)
- McMaster-Carr sells mechanical parts (http://www.mcmaster.com/)
- When ordering chips, note that you usually want to order them in DIP (Dual Inline Packaging) configuration. If you purchase surface mount, you will curse yourself as you try to solder it onto reasonable wire.

Some suggestions for local electronics:

- Radioshack is located in the Rotunda (http://tandy.know-where.com/RadioShack/cgi/site?01-2903)
- Baynesville Electronics is located in Towson (http://www.baynesvilleelectronics.com/)

Mechanical construction should be done as *simply as possible*. I particularly encourage the use of foamcore, glue guns, acrylic, and acrylic "cement". Foamcore can be cut using an X-acto knife or similar. Glue guns and glue are available in Wyman 140. To cut

acrylic, you can use the laser cutter in Wyman Park Building. If you need help with simple machining tasks, such as tapping a hole or cutting a shaft, see the TAs.

Don't Forget

- The specifications listed in the project description. Meeting these specifications is more important than flashiness. Start conservatively.
- Design your subsystems on paper first, before constructing any circuitry or hardware.
- The TAs, Brian and Bob, will be in the lab during the normal section times. Allison will also stop in frequently, especially during the last week of the project.
- When debugging, first make sure that you know what each part of your circuit/program *should* do. Then test each subpart separately to determine if it is doing the right thing.
- You must leave the lab in *pristine condition*. Mike Johnson and Bob Blakely have worked extremely hard to provide us with this resource. You should carefully package and store your project materials in a box underneath the supply bench or in a corner of the lab, or take it home with you. We will have a record of who was in the lab at any given time. Poor lab maintenance will affect the participation portion of your grade (10% of your total course grade). If the lab is already in bad shape when you walk in, use the phone in the room next door to notify the instructor or lab managers immediately (Allison Okamura is at 6-7266, Mike Johnson is at 6-6752, and Bob Blakely is at 6-8660).