Smart Material Museum Exhibit Conceptual Design Review

Senior Design Group 13

Glen Ashworth

Daniel Roque

Isaac Piersall

Laura Wainikainen

Presentation Overview

- Problem Statement
- Constraints
- Existing Technology
- Design Concepts
- Decision Matrix
- Conclusion
- References

The Challenger Learning Center in Tallahassee, FL

Problem Statement

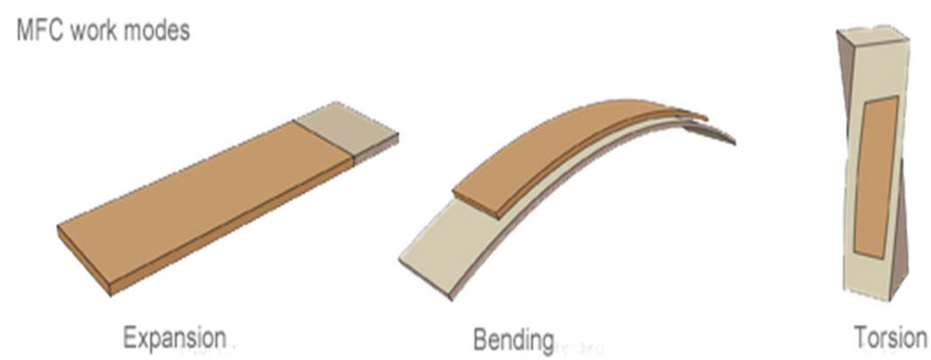
- The goal of this senior design project is to design, build, and test a museum exhibit
- Exhibit must utilize and demonstrate the behavior of a smart material and its applications
- Smart material chosen for this project is the piezoelectric type
- Exhibit must be interactive and entertaining for students
- Final product should be delivered to the museum ready for display

Constraints

- Safe for use for school aged children
- Must be space themed
- Sized appropriately to fit in the Challenger Learning Center
- Budget of $1500

Existing Technology

- Piezoelectric
  - electricity (voltage) to mechanical force
- Smart Material Corp.
  - Macro Fiber Composite (MFC)
    - Elongate or contract



Amplifiers

- used to increase the power of signal without otherwise altering it
- **EMCO High Voltage**
  - C series
    - Small regulated power amplifiers
    - Run off 11.5-16 VDC

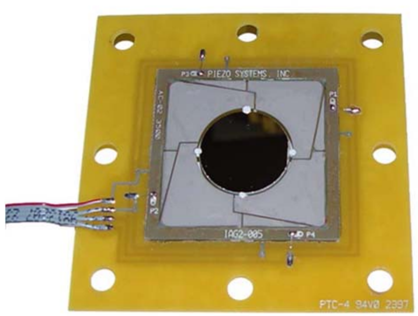
PRODUCT SELECTION TABLE

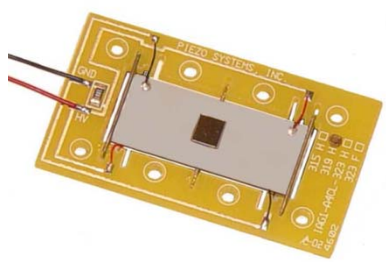
MODEL	OUTPUT VOLTAGE	MAXIMUM OUTPUT CURRENT*1
C01	0 to 100 V	0 to 10 mA
C02	0 to 200 V	0 to 5 mA
C03	0 to 300 V	0 to 3.3 mA
C05	0 to 500 V	0 to 2 mA
C06	0 to 600 V	0 to 1.67 mA
C10	0 to 1,000 V	0 to 1 mA
C12	0 to 1,250 V	0 to 1 mA
C15	0 to 1,500 V	0 to 0.67 mA
C20	0 to 2,000V	0 to 0.5 mA
C25	0 to 2,500 V	0 to 0.4 mA
C30	0 to 3,000 V	0 to 0.33 mA
C40	0 to 4,000 V	0 to 0.25 mA
C50	0 to 5,000 V	0 to 0.2 mA
C60	0 to 6,000V	0 to 0.166 mA
C80	0 to 8,000V	0 to 0.125 mA

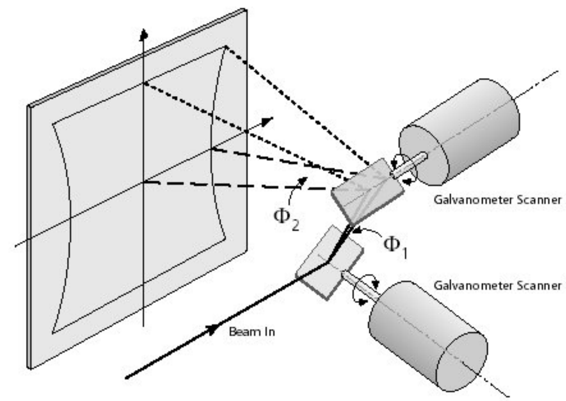
Complete List of Models on page 2

Laser and Motion

- Any Class 2 or Class 3A
  - <5 mW beam power
    - Most laser pointers
      - offers wide variety of colors
- Direct and Indirect motion
  - Direct: physically move laser
  - Indirect: move one or more mirrors

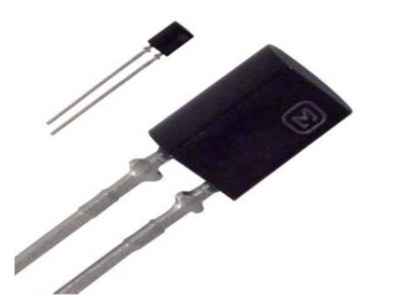






Misc. Parts

- Light sensors
  - Photodiode, phototransistor, photo-resistors
- User interface
  - Joystick
    - Digital
    - Analog



All design concepts utilize….

- Two bending piezoelectric ceramics
- Two amplifiers
- Joystick
- Laser

- Final output of the laser is controlled via user input from joystick
- Each amplifier and ceramic control one degree of freedom
- Each design concept also requires additional supplies unique to the design.

Design Concept 1: Controlling Curiosity

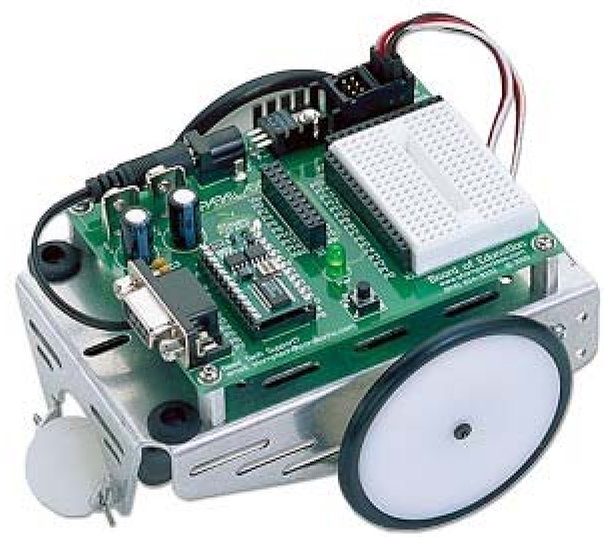
- Use direct/indirect laser control to manipulate the movement of a robot.
- Theme: Curiosity Mars Rover
- Operator guides the rover through a maze set up in the display
- Three different concepts:
  - Light sensor eyes
  - Webcam eyes
  - Light sensor array “remote”

Light Sensor Eyes

- Commercially available robots with photo resistors eyes that are programmed to travel toward or away from the light
- Parallax Scribbler
  - Light would need to be shined directly at the robots eyes or above the robot
  - Essentially push or pull the robot in the direction of the light

Light Sensor Eyes cont.

- Parallax Boe-Bot
  - Can be programmed to steer on its own and follow light shined in front of it
  - Operator would shine laser on the ground in front of the robot and guide its path
  - Direct and Indirect control of the laser could be used



Webcam Eyes

- Mount a webcam on top of the robot
- Have the webcam image travel back to a computer
- Programmed in such a way to follow a laser light dot on the ground
- Would require programming experience

Light Sensor Array

- Create a light sensor array that would guide the movement of the robot
- 4 light sensors, each controlling movement in a different direction (left, right, forward, backward)
- The array can be placed on the robot or somewhere else in the display and wirelessly control the robot movement
- If placed on the robot it may be difficult to aim at each sensor if the robot moves a large distance

Design Concept 2 : Satellite Transmission Game

- Piezoelectric materials used in satellites for micropositioning
- Multiple miniature satellite dishes, each equipped with an LED and phototransistor positioned downstream from laser
- LEDs and phototransistors wired to a microcontroller
- Microcontroller lights up an LED on a satellite
- User must aim laser at corresponding phototransistor on the satellite

Design Concept 2 Continued

- After hitting photodiode, the LED light goes out and another lights up, process continues
- Must move laser to hit photodiode
- Simulates sending data to various satellites
- Similar to proven, popular "point and shoot" type arcade games
- Can be competitive, either timed or scoring system

Design Concept 3

- Laser is controlled via joystick by user
- A mock satellite dish is positioned down range from the laser
- The movement (pan left/right, tilt up/down) of the dish is controlled by four different photodiodes
- Each respective photodiode induces specific movement in satellite when laser is pointed at it
- Satellite dish is positioned by the user so that the laser can be redirected by the reflective dish to a map

Interaction

- Students apply voltage to piezoceramic, giving laser beam a range of movement
- Controls what side the satellite "adjusts" to
- Student selects by projection of laser which country to "communicate" with

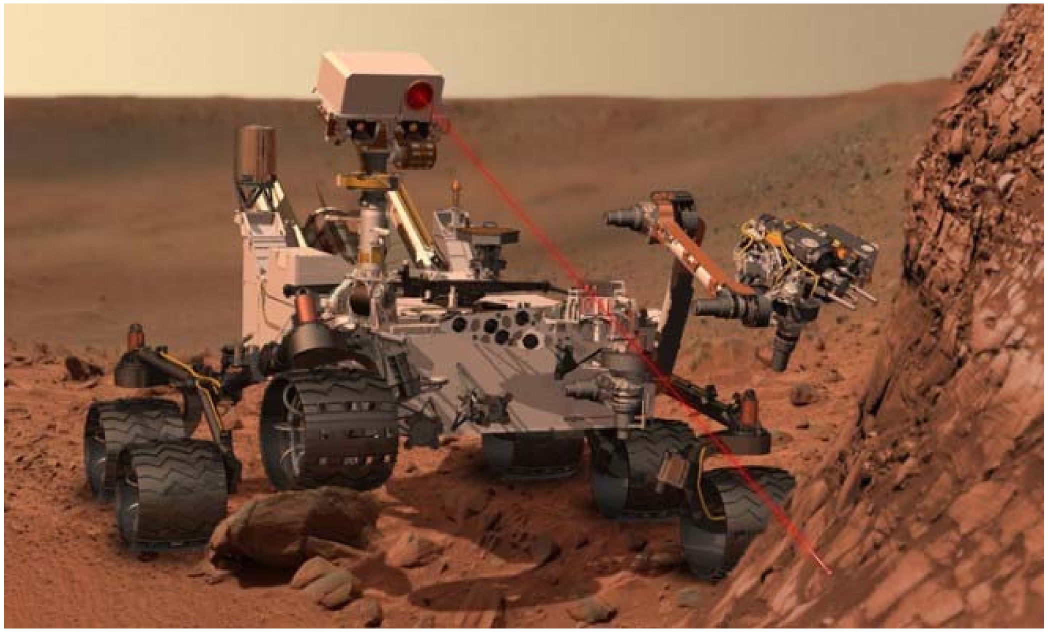
Additional Components

- Pan/tilt motor kit
- 4 Photodiodes
- Mock satellite
- Map/Globe

Figure: Pan/Tilt Motor Kit

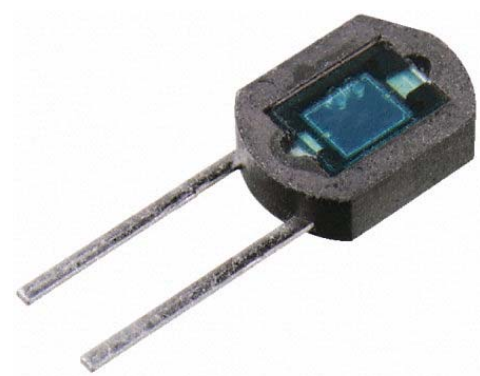
Concept 4

- Reflective of the Mars rover Curiosity
- Curiosity has a ChemCam laser which fires in brief pulses at rocks on Mars
- This idea is somewhat represented in this design



Components

- Laser
- 6 photodiodes
- Small immobile robot "Curiosity"
- 2 piezoceramics



Description

- Fixed laser turned on and aimed towards top of case
- It hits mirror and beam sent downward
- Laser beam then hits Curiosity's "ChemCam" which is composed of 2 piezoceramics covered in reflective material
- Beam then projected onto a Mars wall with photodoides (or Mars rocks)
- When a photodiode is hit by the laser, a corresponding screen with information comes on

Interaction

- Students apply voltage to piezoceramics on "ChemCam" allowing the laser to be projected onto wall
- Control the laser's aim in hitting the different rocks (photodiodes)
- Can include information about smart materials or Mars exploration on activated screens

Decision Matrix

		Concept 1: Laser Manipulated Robot		Concept 2: Satellite Transmission Game		Concept 3: Laser Activated Satellite Control		Concept 4: Mars Curiosity Rover Chem-cam	
Specifications	Weight	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Estimated Cost	25%	3	0.75	4	1	4	1	2	0.5
Applicability to the Learning Center's educational program	40%	3	1.2	4	1.6	5	2	3	1.2
Educational Value	20%	3	0.6	3	0.6	3	0.6	4	0.8
Entertaining	15%	4	0.6	4	0.6	4	0.6	3	0.45
Total	100%		3.15		3.8		4.2		2.95

Conclusion

- After getting your input on a design, we will work on finalizing each part of the selected design
- We will then form a comprehensive part list and costs, then get started on purchasing components
- After obtaining components, building and testing will commence

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