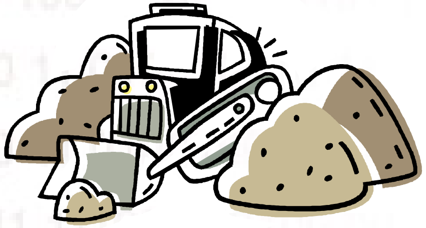
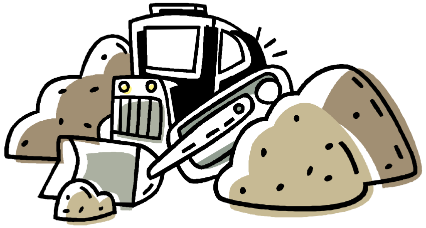
University of Houston
College of Technology
Department of Engineering Technology
Computer Engineering Technology Program



ELET 4308/4108
Senior Project Presentation

# Robotic Bulldozer

Spring 2006
April 27, 2006



**Team 12**


*Team Members:*
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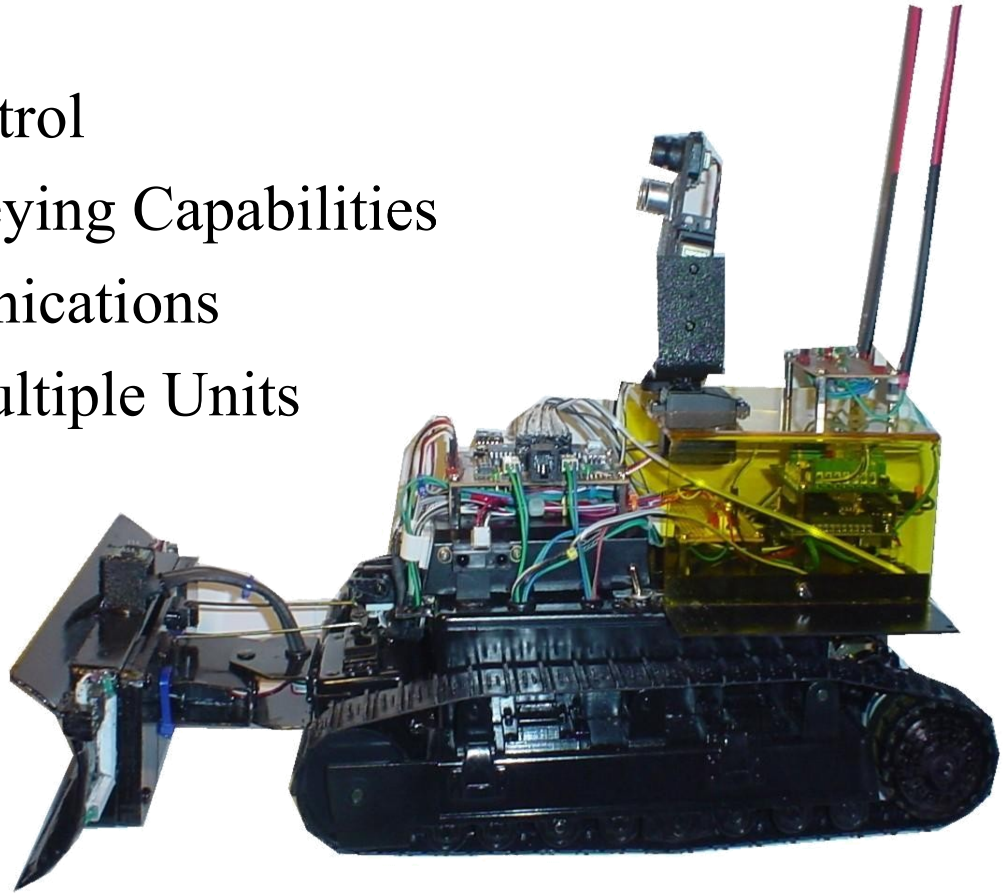
*Project Advisor:*
Dr. Farrokh Attarzadeh

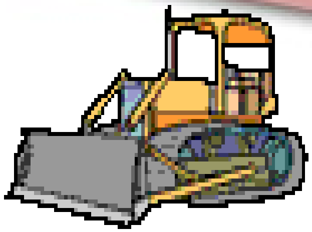
# Introduction

❖ Create A Microcontroller-Based Robotic Bulldozer

- Autonomous Control
- Leveling & Surveying Capabilities
- Wireless Communications
- One Operator, Multiple Units
- Universal System
- User-Friendly
- More Efficient
- Safe

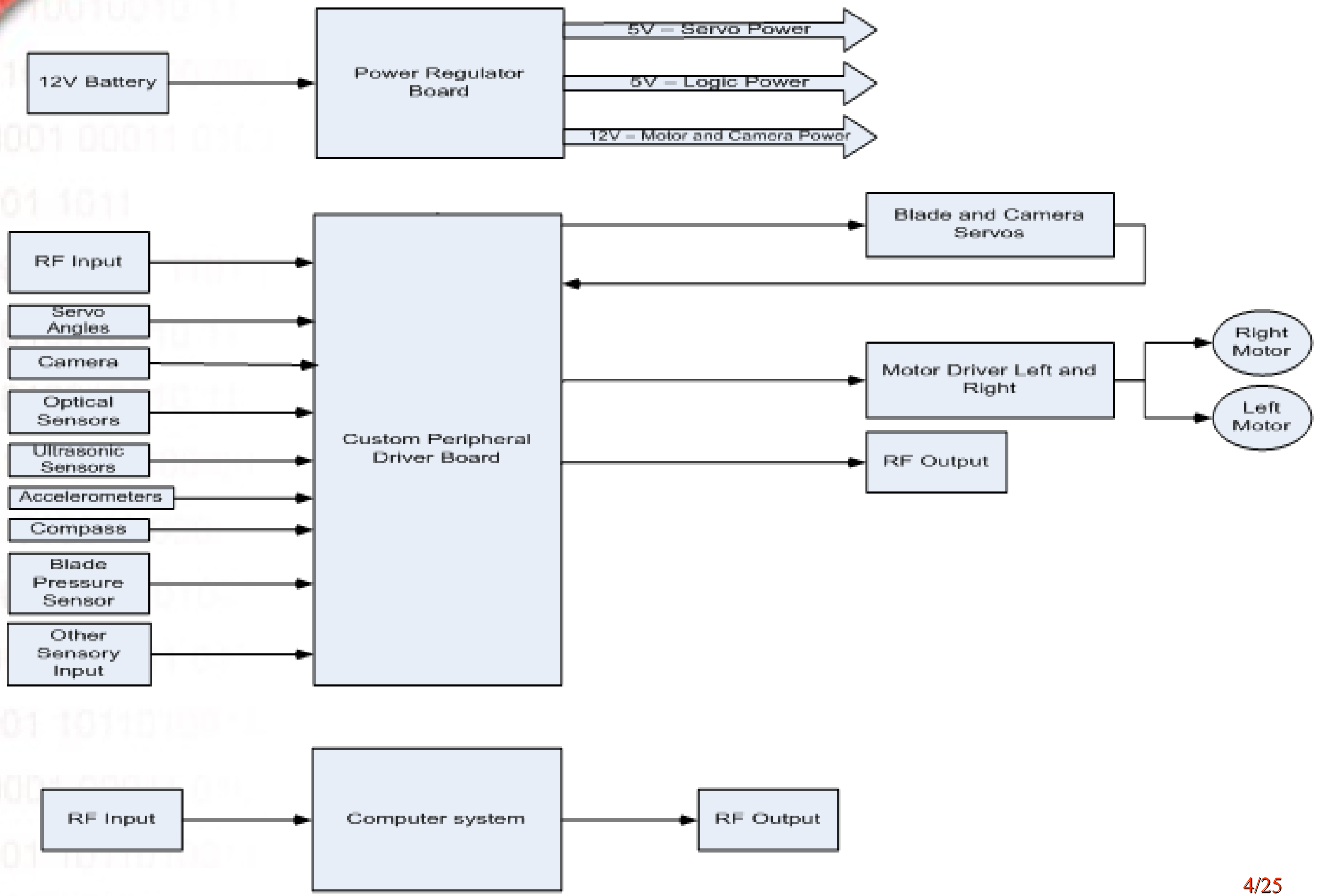


# Technical Features



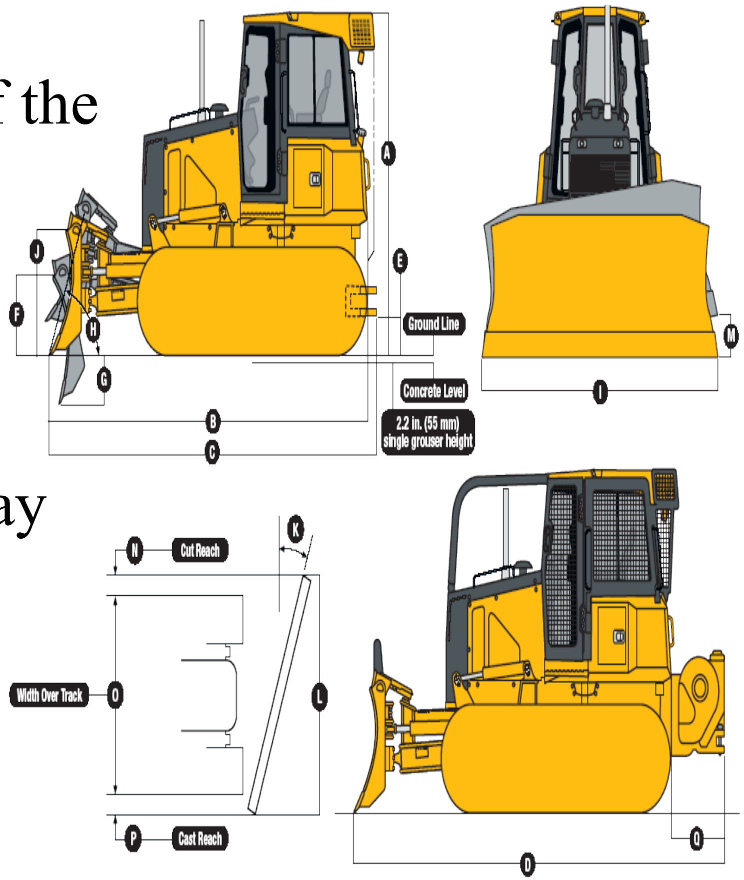
- Main System:
  - System performs a set of specified tasks
  - Uses Artificial Intelligence (AI)
  - Distance Elevation Modules (DEM)
  - Preprogrammed instructions to accomplish tasks

# Block Schematic Diagram



# Blade System

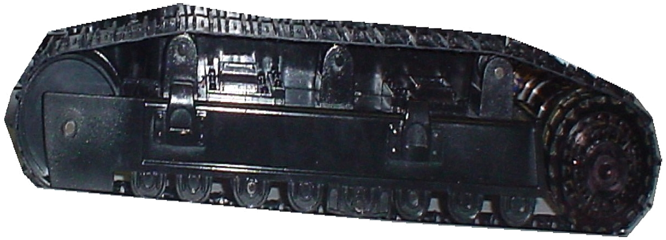
- Blade leveling sensors
- Mechanical motion & range of the servos to:
  - Lift
  - Tilt
  - Angle adjustment
- Automatically controlled 6-Way Blade for:
  - Earth moving
  - Digging ditches
  - Trenches
  - Finish work

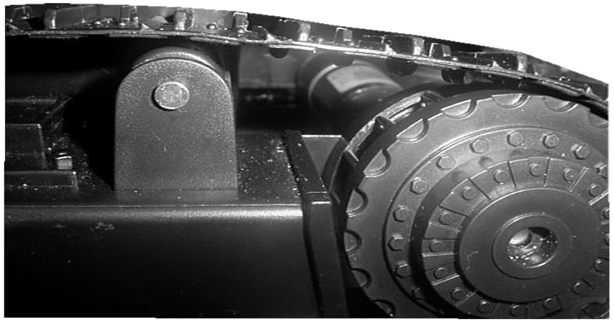



www.deere.com

# Track System

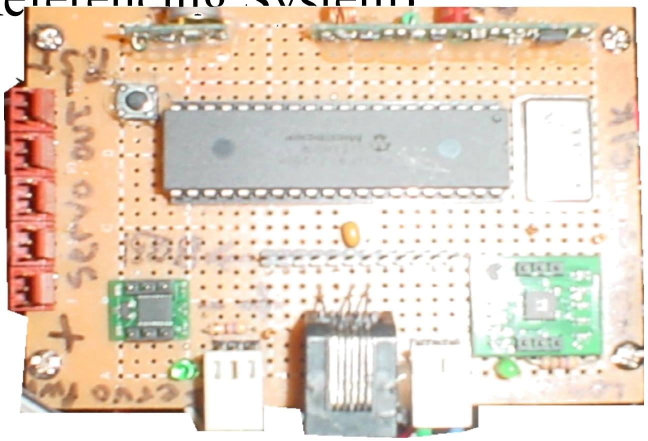
- (2) Tracks
- Independent Drives
- Modified from a toy Track Hoe
- Electronically controlled differential steering system
- Maneuvers the weight & movement ability over different terrains





# Control Circuitry

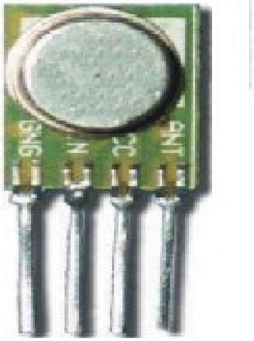
- I/O Control Board
  - Dual-Sided Custom Circuit Board
    - PIC16F877 Microcontroller
    - (2) Motor Driver Circuits
    - (1) Compass
    - (2) 5V @ 3A Regulators for Logic & Servos
    - 3-Axis Accelerometer (Inertia Referencing System)
    - RF TX/RX Modules
  - Functions
    - Used for AI
    - Controls the motors and servos
    - Interfaces all devices



# RF Communications

- WEN SHING RX/TX Modules
- Transmit/Receive Data
- Transmit/Receive Commands
- Used to plan job
- Coordinate operations

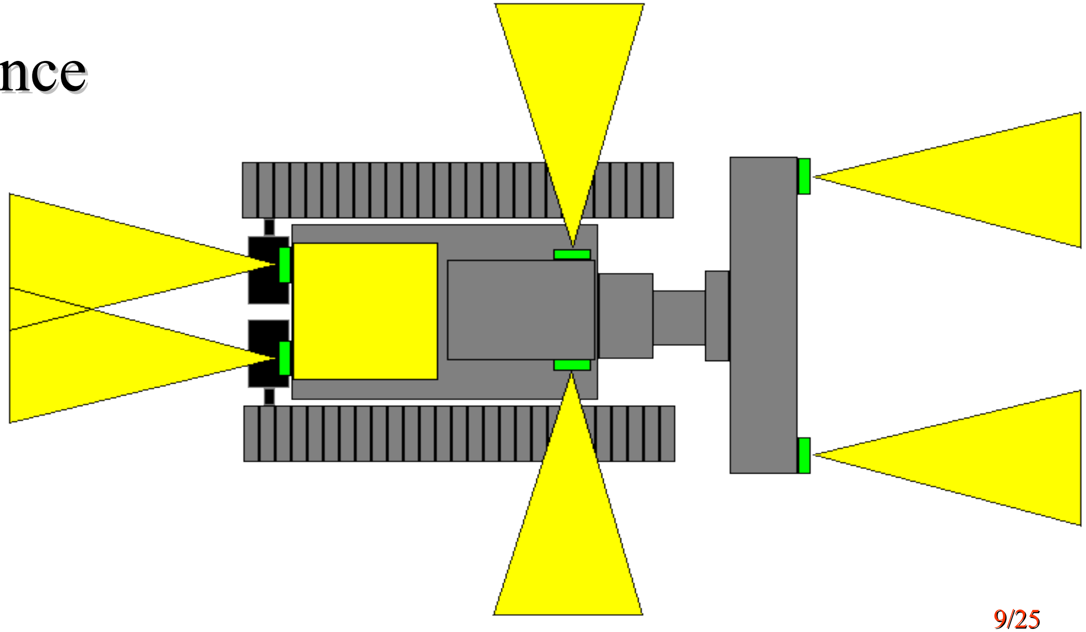

Receiver Module



Transmitter Module

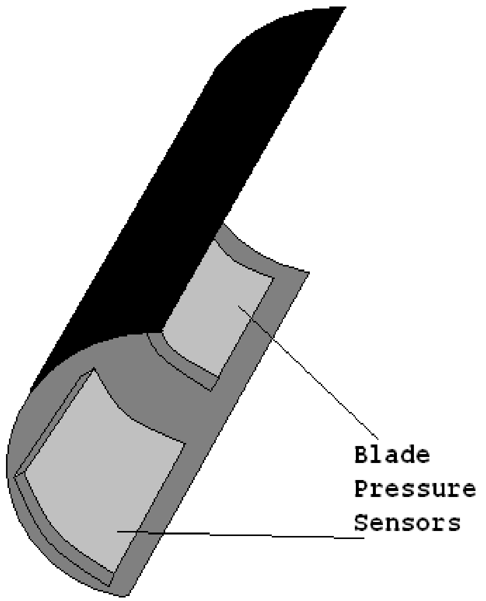
# Collision Detection/Avoidance & Distance Measuring System

- SHARP GP2D12 infrared distance measuring sensors
- Obstacle avoidance detection
- Distance and elevation measurements
- Navigation assistance



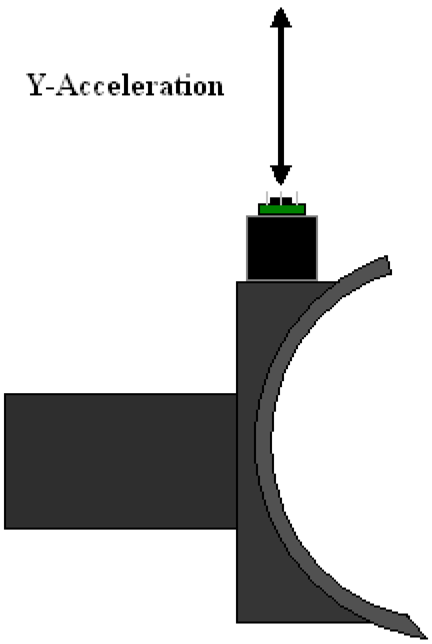
# Tactile Blade Pressure Sensors

- Constructed out of antistatic foam
- Senses differential pressures on left & right sides of the blade
- Used to know if and where blade is in contact with the dirt



# Accelerometer

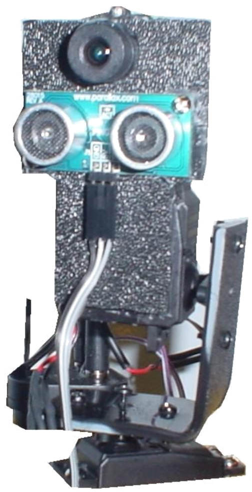
- Blade accelerometer is used to determine the vertical distance that the blade has traveled.




$$\text{Distance Moved} = \iint \text{Y-Acceleration}$$

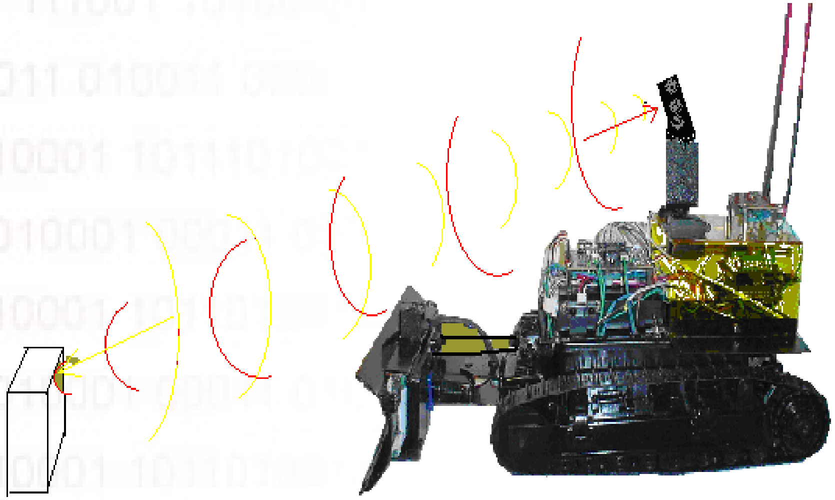
# Scanning Vision System

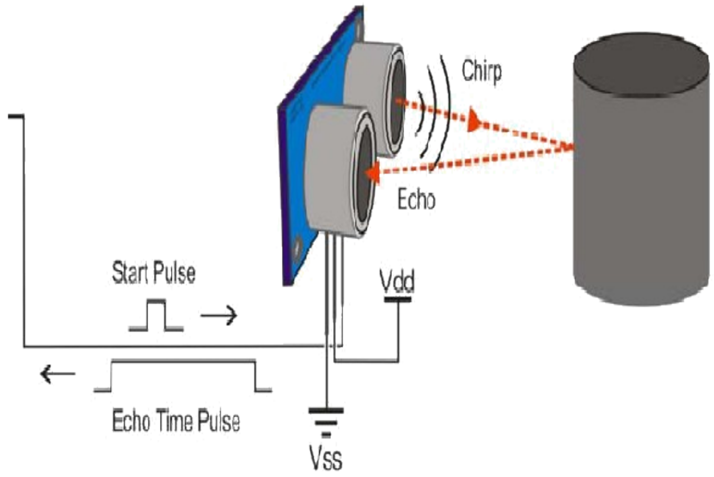
- Equipped with a servo-controlled camera
- Ultrasonic Sensor for near terrain mapping
- Remote-control override capability
- Used to perform a visual systems check



# Near Terrain Scanning Elevation Mapping System

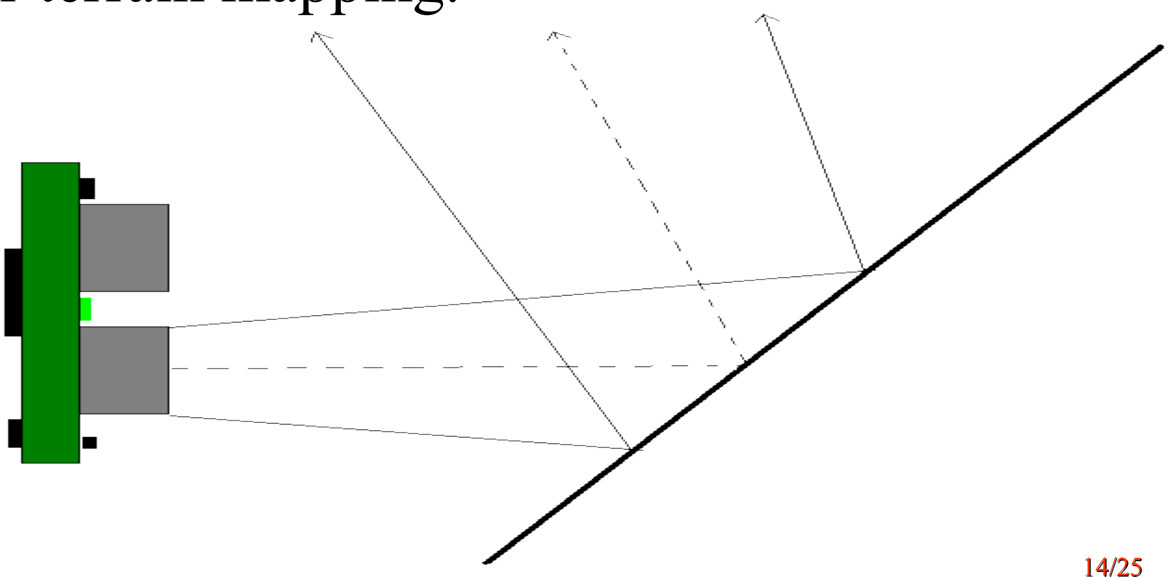
- Uses the Parallax "Ping" Ultrasonic Sensor
- Sensors used to measure distances to terrain
- Ability to detect high/low spots in the immediate vicinity
- Locate and determine the shape of the dirt





# Work In Progress

- Ping Sensor
  - Does not return echo due to critical angle on flat surfaces.
  - Work is under way to find a more reliable sensing device for terrain mapping.



# Work in Progress Cont.

- The following systems are still under development:
  - Wireless Communications System
  - Remote Supervisory Computer Application

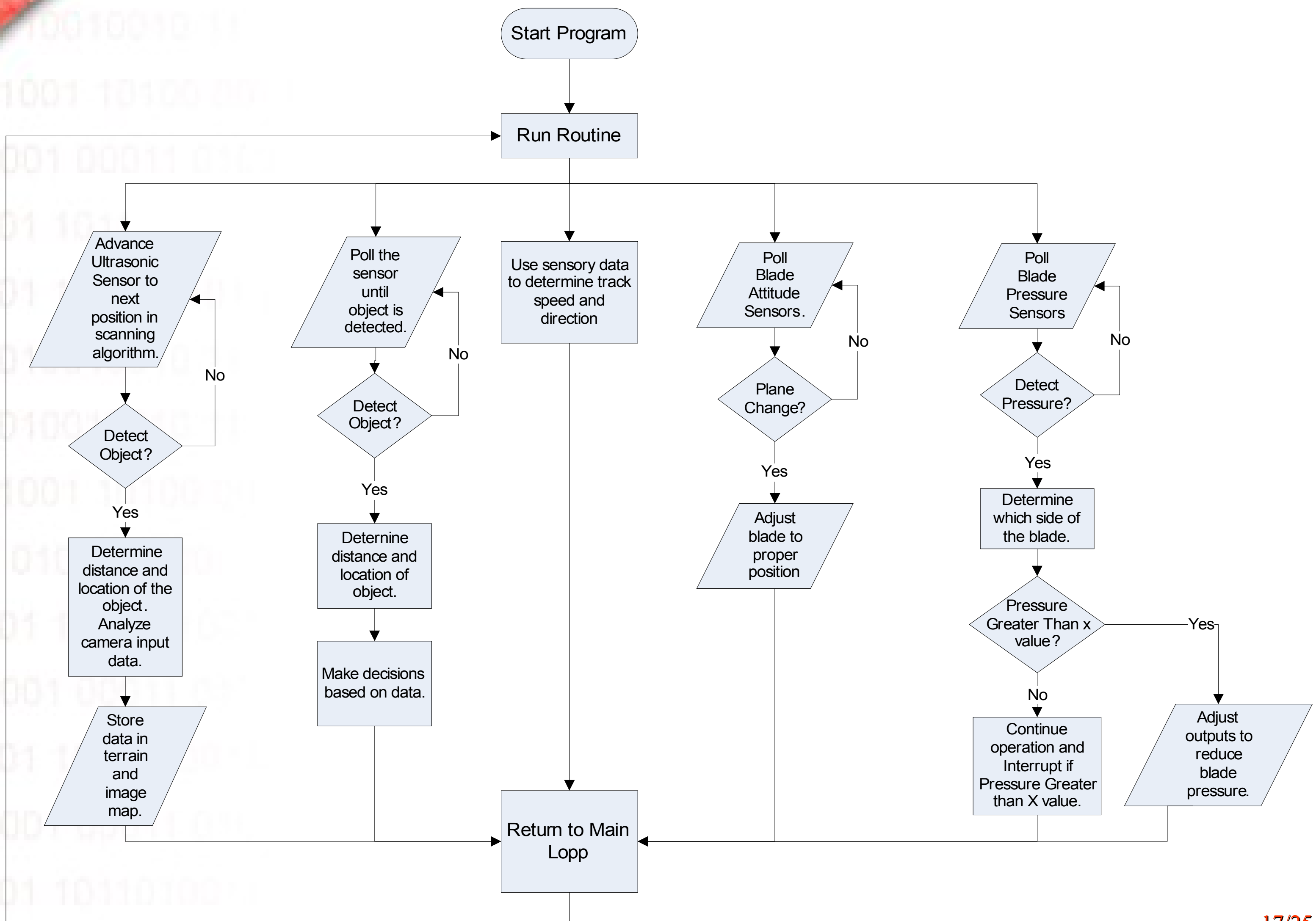
# Future Goals

❖ Plans to include the Laser-Based Systems for Grading and Excavating produced by (Spectra Precision Laser) for automatically keeping the Blade at Grade Level.


❖ **How it works**

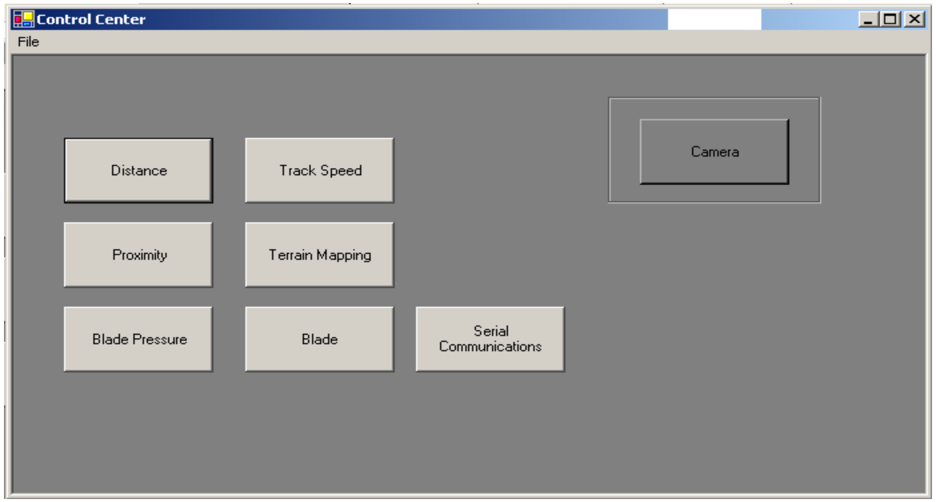
A laser receiver is mounted above the cutting edge of the blade. The Spectra Precision Laser CB25 control box and a hydraulic installation kit are tied into the machine's hydraulic system. Grade information from a rotating laser is processed and automatically directs the machine's hydraulics to maintain the blade elevation.

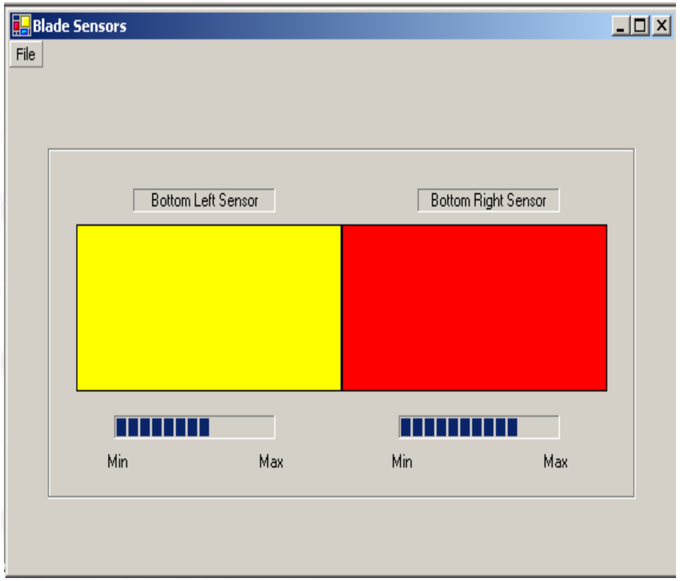
# Flowchart

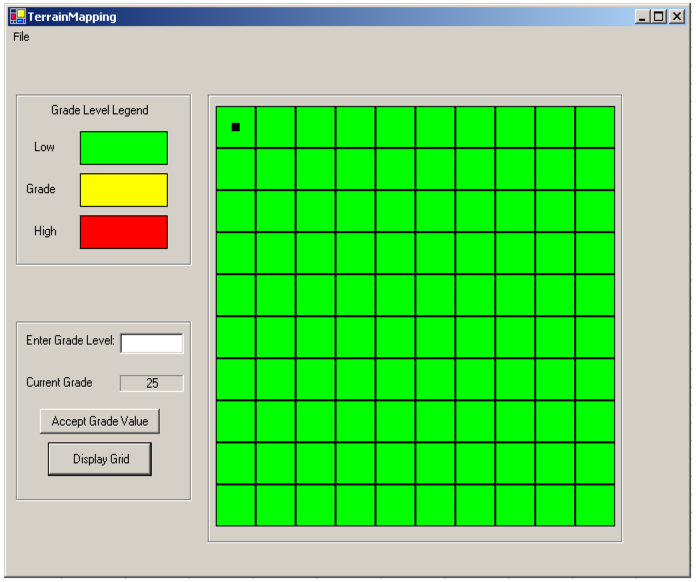


Start Program
Run Routine
Advance Ultrasonic Sensor to next position in scanning algorithm.
Detect Object?
No
Yes
Determine distance and location of the object. Analyze camera input data.
Store data in terrain and image map.
Poll the sensor until object is detected.
Detect Object?
No
Yes
Deternine distance and location of object.
Make decisions based on data.
Use sensory data to determine track speed and direction
Poll Blade Attitude Sensors.
Plane Change?
No
Yes
Adjust blade to proper position
Poll Blade Pressure Sensors
Detect Pressure?
No
Yes
Determine which side of the blade.
Pressure Greater Than x value?
Yes
No
Continue operation and Interrupt if Pressure Greater than X value.
Adjust outputs to reduce blade pressure.
Return to Main Lopp

# Remote Application



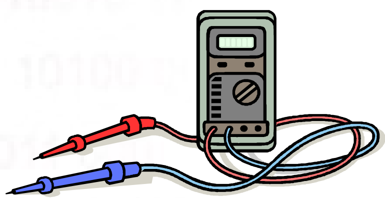
# Marketing Data

- Safety Issues
  - Reduce occupation-related injuries
  - Reduce risk for accidents
  - Reduce the number of fatalities
- Cost Factors
  - An average cost of a typical bulldozer ranges from $10K to $200K depending on its quality; in comparison, this system ranges from the hundreds to a thousand
  - Over $100,000 could be saved annually due to the reduction in operating hours, equipment, and labor costs
- Potential Markets
  - Industries (Farming, Construction), NASA, Hazardous material cleanup, Toys, etc.
- Advantages
  - Use of a microcontroller-based control to reduce the time, cost, and increase the efficiency
  - Single operator to control multiple bulldozers

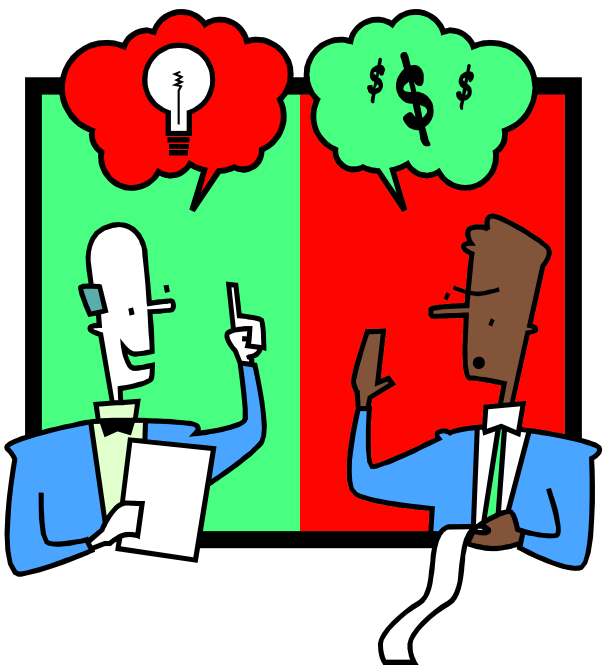
# Cost Analysis

- ***Parts Cost*** *(Table 1.1)*

- ***Equipments Cost*** *(Table 1.2)*



- ***Labor Cost*** *(Table 1.3)*



# Parts Cost

Table 1.1

| Item No. | Parts | Source | Quantity | Actual Cost |
|---|---|---|---|---|
| 1 | Toy Track Hoe | Toys R Us | 1 | $ 51.99 |
| 2 | Project Box | Radio Shack | 1 | 10.98 |
| 3 | DC Gear Head Motors | ACE Electronics | 2 | 29.90 |
| 4 | Servos | M&M Hobby Center | 4 | 150.66 |
| 5 | 12V Battery | EPO | 2 | 23.90 |
| 6 | HB-25 Motor Controllers | Parallax | 1 | 99.90 |
| 7 | Circuit board Kits | Radio Shack | 2 | 100.00 |
| 8 | 8051 Microcontroller | BiPOM | 1 | 75.00 |
| 9 | Diodes/IC | Jameco, EPO | 3 | 39.70 |
| 10 | Transistors | Radio Shack | 4 | 8.58 |
| 11 | Camera/Wireless Kit | EPO | 1 | 107.95 |
| 12 | HITACHI HM55B Compass Module | Parallax | 1 | 29.95 |
| 13 | SHARP GP2D12 Sensors and Cables | Parallax | 1 | 83.70 |
| 14 | HITACHI H48C Tri-Axis Accelerometer | Parallax | 1 | 39.00 |
| 15 | Ultrasonic Sensor | Parallax | 1 | 24.95 |
| 16 | Transmitter Kit | EPO | 2 | 20.90 |
| 17 | Assortment of Parts | Bering, Home Depot, Michaels, EPO | N/A | 89.11 |
| | | | **Totals:** | **$986.17** |

# Equipments Cost

Table 1.2

| Item No. | Parts | Quantity | Actual Cost |
|---|---|---|---|
| 1 | Digital Multimeter (DMM) | 1 | Donated |
| 2 | Oscilloscope | 1 | Donated |
| 3 | Dremel Tool | 1 | Donated |
| 4 | Drill | 1 | Donated |
| 5 | Soldering Iron | 1 | Donated |
| 6 | Heat gun | 1 | Donated |
| 7 | Wire Stripper/Cutter | 1 | Donated |
| 8 | Tools (wrench, screwdrivers, ect.) | 1 set | Donated |

# Labor Cost

Table 1.3

| No. | Project Tasks | No. of Labors | Wages | Hours per Week | No. of Weeks | Total Cost |
|---|---|---|---|---|---|---|
| 1 | Planning & Designing | 3 | $25.00 | 20 | 3 | $4,500.00 |
| 2 | Mechanical Assembly | 2 | $25.00 | 20 | 2 | $2,000.00 |
| 3 | Electrical Assembly | 2 | $25.00 | 20 | 2 | $2,000.00 |
| 4 | Programming | 3 | $25.00 | 20 | 5 | $7,500.00 |
| 5 | Test & Debug | 3 | $25.00 | 20 | 3 | $4,500.00 |
| | | | | **Total:** | 15 | $20,500.00 |

# References


- United States Patent Office. <www.uspto.gov>
- Caterpillar. <www.cat.com>
- Electronic Parts Outlet. <www.epo-houston.com>
- CSAO. <www.csao.org>
- M&M Hobby. <www.mmhobby.com>
- John Deere. <www.deere.com>
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# Questions