BOB JONES University

Euroclydon

Faculty Advisor Statement:

I, Dr. Bill Lovegrove, Professor of Electrical Engineering at Bob Jones University, do certify that the members of this engineering team have done significant engineering design and implementation of this vehicle that is equivalent to the work that is awarded credit in a senior design course.

Dr. Bill Lovegrove

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1. Introduction

The members of the Bob Jones University robotics team are proud to present to competition, Euroclydon. This year we went with the three wheel design again, but with significant changes. Each will be considered later on in the report but some of the major changes include a Point Grey Chameleon Fire-wire camera, an uBlox GPS, infrared detection, and a new aluminum tower.

1.1 The Design Process

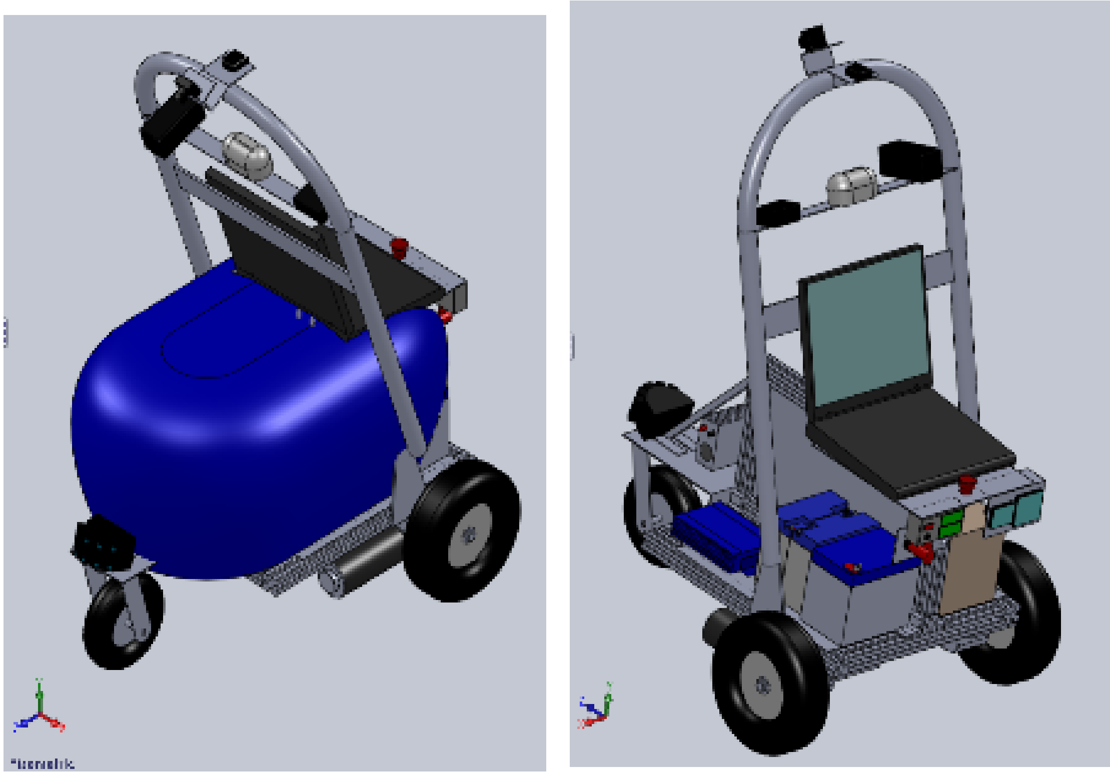
This year's design process was quite different than past years. We used a simple spiral design process that allowed us to concentrate on the most important part at each stage of the design process.

Our spiral consisted of 4 loops:

1. Vehicle running under joystick control.
2. To some extent, the vehicle should make its own steering decisions, follow lines, and avoid obstacles.
3. The vehicle should avoid obstacles on a regular basis.
4. All of the little details should be polished. Finish the Solid Works model and the design report.

1.2 Philosophy

The philosophy this year has not changed from years in the past. We still would like our robot to be completely passive. As such we rely heavily on our camera and image processing. This year we did deviate a bit from that goal and included IR sensors in the interest of being more competitive.



Solid Works Models

2. Mechanical and Electrical

This year we did not deviate from the three wheel design because of its stability and previous performance. We wanted to get rid of all of the steel on our body due to its weight and magnetic interference, but did not want to go with a wooden body of any kind because of the lack of rigidity. This led us to the conclusion that we should use aluminum.

2.1 Chassis

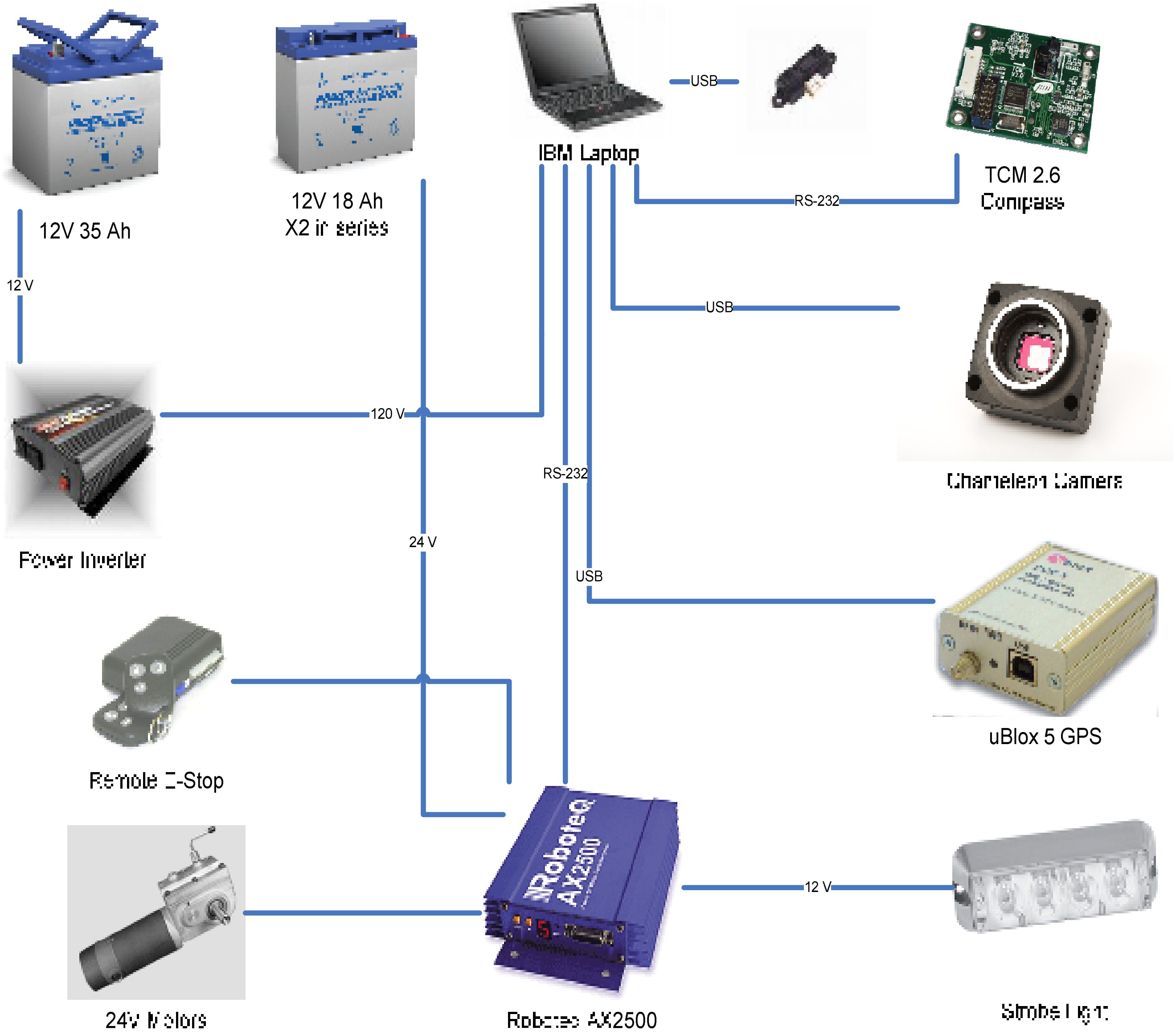
We constructed the new body using an extruded 80/20 frame with a wall running down the middle for more area to mount devices. This construction proves to be incredibly strong and provide plenty of mounting area for our components.

2.2 Motors

We utilized two NPC Robotics-R81 1.15hp 24V wheelchair motors. The steering is differential on the rear axle. Both motors are equipped with encoders that provide a closed loop feedback system from motor controller.

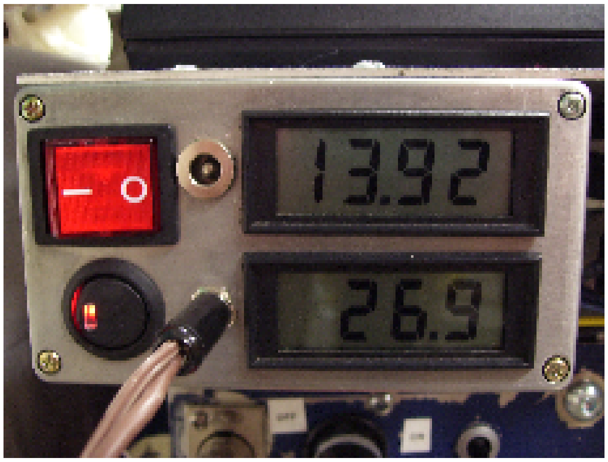
2.3 Power Supply

Euroclydon is powered from (3) 12v batteries. Two of the batteries are connected in series to create a 24v, 18 Amp-hour power supply. The 24v supply drives the two motors as well as the motor controller. The remaining 12v, 35 Amp hour battery is converted into 120VAC using a 700 Watt power inverter. The inverter output supplies power to the IBM ThinkPad, which in turn supplies power to the camera, IR, GPS, compass, strobe, and the wireless E-Stop.



The diagram above illustrates Euroclydon's power grid

2.4 Power Monitoring



Both of the batteries are monitored using a digital voltmeter as well as an analog ammeter. These displays are located on the rear of the vehicle and can easily be read while Euroclydon is functioning. In addition, when the displays show that either battery is low, we can plug a battery charger into the charging port located next to the meter. We then can monitor the charging process using the meters to determine when the batteries are full.

2.5 E-stop

Euroclydon is equipped with both an e-stop momentary pushbutton and a wireless e-stop remote. The red pushbutton is located at the rear, and is easily noticeable. The wireless e-stop was assembled from a vehicle’s keyless entry module. According to the manufacturer’s specifications and our testing, the wireless e-stop has a range of 100 feet. Both systems are wired directly to the motor controller for an immediate emergency stop.

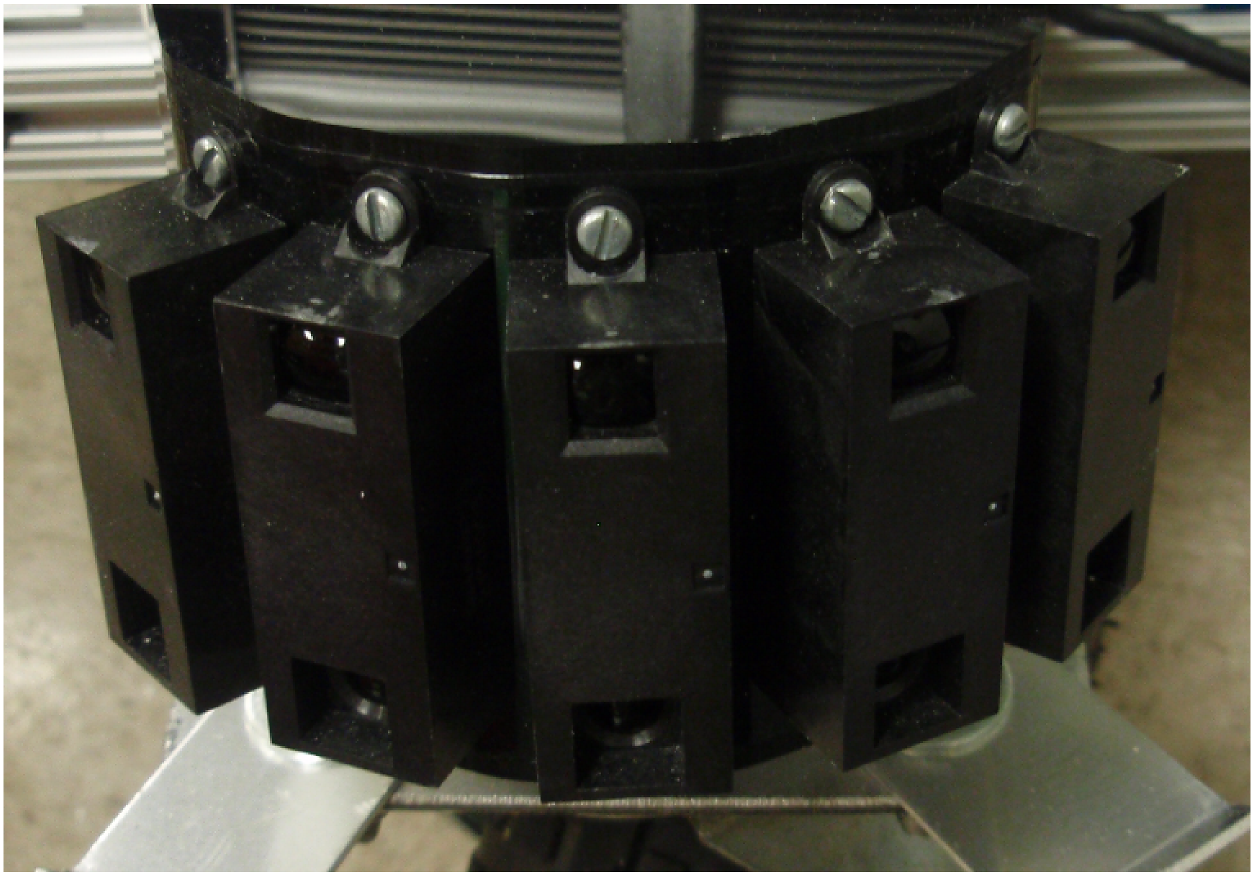
3. Sensors

3.1 Chameleon Digital Camera

Our vehicle is outfitted with a USB 2.0 digital video camera. The Chameleon's tiny casing is only 25.5 mm x 41 mm x 44 mm, and is positioned at the pinnacle of the aluminum frame. Mounted on the camera is a 2.8mm lens to give it a wide field of view. The camera is the primary means of boundary line and obstacle detection. The camera transmits the captured video to the computer at 18 frames per second.

3.2 Infrared Detection

This year a team member redesigned and constructed a new infra-red sensor. The previous sensor gave us hope for the opportunity of infra-red, but it had bugs and was more complex than necessary. In the new design we started over with the most basic parts: 5 IR Sensors, PIC microcontroller, USB serial converter, Self-printed circuit board, and DC-DC stepper. The IR sensors each have 5 beams 5 degrees apart available to use one at a time. The measurement of the selected beam is outputted as a voltage roughly between .3V and 2.3V corresponding to 300cm and 40cm. The higher the voltage the closer an object is to the sensor in that beams path. Connecting the 5 sensors to the PIC in parallel except for the outputs, the PIC can turn on a beam and cycle through digitizing each sensors output for that beam to send to the computer. The computer collects the data from a virtual serial port, calculates its position in the plane of the camera, and places a blocked path square in our decision frame.



For the construction of the IR we had a hand fabrication plastic company in town bend acrylic plastic to create a box with 5 faces all 25 degrees apart. Mounting a sensor on each face placed the center beams 25 degrees apart covering 10 degrees to the left and right of the center beam. This gives us continuous readings every 5 degrees 60 degrees left and right of the center of the robots current path. It was also angled upward approximately 18 degrees to avoid seeing the ground at the maximum possible slope according to rules. The sensor was also mounted as very low so that it would be able to pick up short obstacles. The DC-DC stepper used can except any range for Direct Current Voltage between 8V and 36V. This gives the IR flexibility for future years to take advantage of our new development, because it can run on something as small as a 9V battery, or as large as the 24V batteries for the motors.

Photo from Digital Camera

Image obtain from IR Sensors

3.3 Digital Compass

Euroclydon is equipped with a sophisticated compass, PNI-TCM2. The compass uses a 3-axis sensor which is capable of calculating roll, pitch, and yaw. The primary purpose of the compass is to calculate which direction to travel for each successive way-point in navigation mode. One of the greatest changes to our vehicle this year is the removal of the steel used in the body. As a result, Euroclydon's body does not impart magnetic interference; therefore the compass has very low magnetic anomalies.

3.4 GPS

We furnished Euroclydon with a new GPS this year, the U-blox Antaris 4. This U-blox model fits well into our budget, performs more accurately than a standard GPS receiver, and functions at 4Hz compared to the 1Hz of our previous GPS. Moreover, the

U-blox GPS is quite efficient in power consumption when not being utilized. The GPS uses 80µA in sleep mode and 8µA in back-up mode.

4. Software

4.1 Image Processing

Primarily, we just avoid white altogether to avoid lines; however, to improve our line detection we have integrated a Hough transform. The transform has proven helpful to fill in the gaps for dotted/ dashed lines. We also run a simple smoothing algorithm to help eliminate spurious single point obstacles; after possible obstacle pixels have been identified, if not enough of those pixels occur in a box around a possible obstacle pixel, then it is not treated as an obstacle.

4.2 Obstacle and Line Detection

There are three main parts to the obstacle detection. First, we attempt to identify various obstacles based on color -- orange, red, black, grey, etc. We then use the smoothing algorithm as referenced above to eliminate spurious points. Second, we also attempt to identify obstacles based on texture. Since barrels, cones, and similar obstacles tend to be smooth, as opposed to grass, which is rougher, we split the picture into small bins and calculate the range of red, blue, and green in that bin. If the bin exceeds a certain amount (texture is rough), we mark that area as not an obstacle; however, if the bin is less (texture is smooth), then we mark that area as an obstacle. Finally, we also have an IR sensor array that is used to detect obstacles as well.

4.3 Path and Control Decisions

We mostly decide where to go based only on what is right in front of us; we don't use any mapping or other memorization techniques. If the path is completely clear, we go straight ahead. If that is blocked, but completely clear to the right or left, then we head that direction. If all directions are blocked, then we choose the direction where the path is longest before it's blocked.

5. Cost

Our team had the challenge of construction a competitive vehicle on a very low budget. Our academic department informed us that our budget for Euroclydon could not exceed $1,500. First, we foraged through components of previous vehicles entered at IGVC. Second, we used wise and early planning to determine exactly what should be purchased.

Component	Retail Cost	Team Cost
USB Chameleon Camera	$375	$375
Camera Lens	$20	$20
U-blox GPS and Kit	$199	$199
IR Sensors and System	$208	$208
PNI-TCM2-20 Digital Compass	$699	$0
G40 ThinkPad Computer	$450	$0
Power Sonic batteries	$144	$0
NPC-R82 motors	$570	$0
Motor Controller	$600	$265
Wheels and tires	$75	$0
USB to Serial (Cable and Hub)	$70	$20
Aluminum Tubing	$55	$55
80/20 frame and steel	$150	$0
Switching Power Supply	$16	$16
Emergency stop system components	$70	$0
Meters	$20	$0
Strobe	$20	$0
Fiberglass Shell	$75	$0
Miscellaneous	$20	$20
Total	$3,836	$1,178

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IGVC Team Members 2009:

Jonathon Baize: Electrical Engineering

Philip Campbell: Electrical Engineering

William Few: Electrical Engineering

Andrew Fry: Electrical Engineering

Josh Hendrich: Electronics and Computer Technology

Jacob Hrinko: Electronics and Computer Technology

Ryan Johnsonbaugh: Electrical Engineering

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Joseph LaPoint: Electronics and Computer Technology

Peter Wagner: Electronics and Computer Technology