2013 Illinois/Indiana Section Conference
April 6th , 2013
Trine University, Angola Indiana

Poster Award Winners

1st Place ($100):

Smart Autonomous Vehicle in a Scaled Urban Environment

Devon Bates, Frayne Go, Thomas Joyce, and Elyse Vernon
Advisor: Dr. José Sánchez

Bradley University

Autonomous vehicles have become of increasing interest with researchers due to their potential to increase road safety and allow those with physical impairments the ability to drive. The focus of this project is the design of an autonomous control system such that a 1/14 scale vehicle (RC MAN TGX 26.540 6x4 XLX) can navigate a proportionally scaled roadway. The top level behavioral objective is for the vehicle to approach an intersection, halt at the stop line, execute a right turn, and stay within lane lines at all times. An OV7670 camera module is interfaced with two digital signal processors (TMS320C5515) to perform the image processing. The primary controller is implemented using a microcontroller (Stellaris LM4F120) and its output is received by a secondary controller housing power electronics for motor interfacing. The TMS320C5515 interfaces with the Stellaris LM4F120 through an I2C bus. The lane detection is implemented using Canny/Hough estimation of vanishing points, to generate an angle of correction by comparing the desired direction of travel to the current trajectory of the vehicle. Stop sign detection is implemented using histogram oriented gradients in a support vector machine for shape classification, which has an 80% detection rate in simulation. The controllers interface with vehicle motors to execute software-controlled speed and steering algorithms. The control loop is closed through the use of a rotary encoder to regulate vehicle speed. All of the control algorithms are based on kinematic and geometric theory.

2nd Place (Tie) ($75):

Cast Iron Spectrometer Standards

Group Members: Benjamin Dvorak, Christina Dillich, and Mark Young
Advisors: Dr. Karra, Dr. Stannard and Dr. Webber

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The use of spectrometer standards in the cast iron industry is of great importance in maintaining quality castings. With the onset of shortages to desired standards, there has been a push for standards with chemistry unique to individual foundries. The challenge of this project is developing the process and design equipment necessary to achieve these standards. For a successful casting process; heat must quickly be pulled away from the liquid gray iron poured. The result pursued is to repeatedly pour standards of a specific chemistry and have a chill depth of 0.8 cm or greater. Based on previous research and experimentation, the standards may be produced with the specific requirements necessary for use. The ability to conduct iron pours early in the project was due to a water-cooled heat sink from a senior design project completed by a previous group who attempted the project in 2012. Using this heat sink, data was procured to establish base results, which improved the research component of the project. The first session of pouring standards provided unsuccessful yet extremely useful results. The liquid metal was poured at temperatures ranging between 2500 -2800 degrees Fahrenheit and cooled. White iron chill depth results ranged from 0.4 - 0.7 cm. Although the necessary chill depth is 0.8 cm and greater, this session supplied data regarding the heat transfer from the iron within seconds of pouring onto the copper surface. Using this data we made changes so that the increased pouring temperature, changed geometry and improved surface roughness created standards of ideal chill depth up to 2 cm. The improved standards hardness tested below the required chill depth yield an average Rockwell C Hardness of 47.95 with a standard deviation of 1.4. This hardness quantity is in the appropriate range for white iron where the average is 47.2 as found on matweb.com. White iron is significantly harder than the gray iron metal prior to cooling which has an average hardness of 20. Based on our current results we began creating and evaluating melting processes and equipment; we are now building an improved casting device that isolates the pouring surface of each standard with a single copper heat sink under each four cavities to optimize heat transfer from the liquid iron to complete our goal.

2nd Place (Tie) ($75):

Thermal and Ultraviolet Modeling, Balancing, and Sensing for TSAT

Adam Kilmer
Engineering Physics Student

Taylor University
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The Taylor Satellite (TSAT) CubeSat carries a payload of sensors for measuring space weather in extremely low-earth orbit, on a flight path which exposes the sensitive equipment on board to a potentially wide set of temperature extremes. As a result, the Thermal and Ultraviolet Modeling, Balancing, and Sensing project (ThUMBS) is the system of sensors and mathematical models with the primary purpose of ensuring the safe operating temperature of the second generation TSAT 2 -unit CubeSat in ELEO. A secondary goal consists of observing the behavior and influences of this temperature for use and analysis in future studies. ThUMBS is comprised of a modeling subsystem to ensure a 220 K - 310 K target operating range, a thermal sensor array of 16 sensors with 0.5 K resolution, and a UV sensor array capable of monitoring incoming radiation from 100nm to 400nm wavelengths. Tertiary goals include passive observation with the UV arrays of phenomena such as lightning strikes and solar flares, and comparison to data from other TSAT sensor arrays. From the beginning, the project has required networking with professors and students, willingness and flexibility to meet changing project requirements, rigorous measures to ensure system modularity, and full integration of systems and data with other projects. Additionally, every important design decision and failure analysis made has been documented thoroughly, as well as data from two prototype launches on Taylor's High Altitude Research Platform (HARP). Implementation of such a regimented documentation protocol coupled with the software modeling used throughout is believed to be of benefit to enhancing student learning and their overall appreciation of the technological advancements made in the applied sciences.

Honorable Mention:

TSAT Mechanical Boom System

Kevin Seifert
Environmental Engineering Student

Taylor University
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In addition to the other instruments, the Taylor Satellite (TSAT) includes a dual electronically controlled mechanical boom system. This system is responsible for extending and retracting Very Low Frequency (VLF) sensors up to two meters away from the satellite in opposite directions. This student design is completely original and will greatly increase the functionality of nano-satellites by allowing instruments out on booms rather than antennas alone. The system is greatly simplified by using a layered carbon boom with wire traces pressed onto it. This eliminates the need for wires out to the booms. Building a unique mechanical machine from the ground up is a growing educational experience. The challenges faced through the design process teach lessons that cannot be taught in a classroom, from concept design to troubleshooting prototypes.

Honorable Mention:

Development of a Computer Program for Wind Tunnel Design

Group members: Patrick Campbell, Jaxon Justice, Solomon Reynolds
Trine University Angola, IN 46703
Advisors: Dr. Jamie Canino, Dr. Jan Stannard, Dr. Pavan Karra, Dr. Brett Batson, Joe Thompson II

Designing and building a wind tunnel is not a simple task. The purpose of this project is to develop a computer program that will simplify this task. This program outputs an optimized open-circuit wind tunnel design based on user needs. The outputs from this program will help design wind tunnels for educational settings. Given a desired test section's velocity and size, the program predicts pressure loss and turbulence intensity. These are the two driving factors in fan or blower selection, screen selection, and honeycomb selection. The geometry of the wind tunnel is also output by the program. An optimized wind tunnel needs to be designed to have straight flow and to run as efficiently as possible. The optimization occurs when the pressure drop and turbulence through the wind tunnel are minimized. Open-circuit wind tunnels are comprised of six sections. Research was done on each of these sections to understand their effects on the turbulence and pressure. An algorithm was developed to determine when the wind tunnel was optimized. Existing wind tunnels' data were compared against the program's outputs. The program is currently in the validation process. The program's outputs will be compared to results from high fidelity computational fluid dynamics. A validation tunnel is being built based on the program's outputs. Physical testing using hot-wire anemometers and pitot tubes will be conducted on the validation tunnel. These three independent tests will verify that the program predicts accurate results. The difficult task of designing wind tunnels will be simplified by the use of this program.