2019 International Mechatronics Conference & Exhibition

October 23 - 25, 2019

Hosted by

Oklahoma State University
Mechanical and Electrical Engineering Technology
Division of Engineering Technology
CEAT Professional Development
AGENDA

Wednesday, Oct 23

CEAT Endeavor Lab

8:00 am - Registration Open

- 9:00 am - 12:00 pm - Additional Workshop #1
  Additive Manufacturing (3D Printing) for Mechatronics – ENDV RM 120
- 1:00 pm - 3:00 pm - Additional Workshop #2
  Labview Workshop – ENDV RM 170

Wes Watkins Center

2:00 pm - 3:00 pm - Registration Open

3:00 pm - 5:00 pm - Technical Sessions (4 sessions) - RM 108

Thursday, Oct 24

Wes Watkins Center

8:00 am - Registration and Networking

9:00 am - Welcome

9:30 am - Keynote

10:00 am - Break

10:30 am - Technical Sessions (3 sessions) - RM 108

12:00 pm - Lunch

1:00 pm - 5:00 pm Vendor Exposition & Poster Session Open

3:00 pm - 5:00pm Vendor Reception - Sponsored by WEBCO

6:00 pm - 9:00pm MET/EET Alumni Reception(s) - By Registration ONLY

Friday, Oct 25

Wes Watkins Center

8:30 am - Networking

9:30 am - Technical Session (10 sessions) - RM 108 and 109

12:00 pm - Lunch

- 1:30 pm - 4:30 pm – Additional Workshop #3
  Geometric Dimensioning and Tolerancing (GD&T) - RM 108

5:00 pm – Closing
Research and Education at the Convergence of Frontier Technologies

This talk will review the trajectory of education and research activities that began with control technology, transitioned to mechatronics, evolved into robotics, and now has led to convergence research on frontier technologies (robotics, AI, AR/VT, and blockchain).

Vikram Kapila is a Professor of Mechanical and Aerospace Engineering at NYU Tandon School of Engineering, where he directs a Mechatronics, Controls, and Robotics Laboratory; a Research Experience for Teachers Site in Mechatronics and Entrepreneurship; a DR K-12 and an ITEST STEM education research project; all funded by NSF.

His research interests are in control system technology, mechatronics, robotics, and STEM education, with current focus on research @ the convergence of frontier technologies (e.g., robotics, AI, AR/VR, blockchain, among others).

He is an author or co-author of more than 220 peer-reviewed scholarly publications, including edited books, book chapters, journal papers, and conference proceeding articles. He has received five teaching awards and a leadership award, all at NYU Tandon. Moreover, he is a recipient of the 2014-2015 University Distinguished Teaching Award at NYU. He directs K-12 education, training, mentoring, and outreach programs that annually enrich the STEM education of over 1,000 students.
Webco’s mission statement is to

“Continuously build on our strengths as we create a vibrant company for the ages”.

Delivering exceptional tubing products and service to our customers while striving to be the most reliable link in the supply chain is at the core of Webco’s purpose. Our can-do culture empowers teams to find ways to identify, create, capture, and deliver value for our customers and suppliers, and stakeholders. The people we serve expect the best, and that is what our teams strive to provide. Being 100% engaged every day, and seeking reasons to say “yes” gives us the flexibility to develop and deliver innovative solutions when customers need them the most. Our integrated strategy allows us to combine financial and organizational strength along with the organizational agility necessary to deliver on aggressive customer demands.

From the day we began manufacturing tubing in 1969, our hard-working people have focused and built on the company’s strengths, an attitude that has transformed the business into North America’s most dynamic network of tube manufacturing and distribution facilities. It’s a network that we continue to reinvest in, deploying the industry’s best talent and latest technology to meet our customers’ most intricate requirements and long-term objectives. Our ongoing goal is to be a vibrant company for the ages, a partner configured to last forever. Thank you for taking the opportunity to learn more about WEBCO INDUSTRIES, our unique culture, and our ongoing mission to serve you today... and tomorrow.
**Session No.  Technical Session 1 - Schedule**

**Session Title:** Mechatronics Education  
**Date and time:** Oct. 24, 2019 from 10:30 AM to 12 PM – Rm 108  
**Session Chair:** Scott Grenquist  
**Session Co-chair:** Haiyan Henry Zhang

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<td>10:30 am – 11:00 am</td>
<td>Use of FANUC robots in Manufacturing Curriculum</td>
<td>Iftekhar Ibne Basith</td>
<td>Sam Houston State University, USA</td>
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| 11:00 am - 11:30 am | Analytical Mechatronic Modeling and Analysis for Design of PTU Actuator with ADAMS-Simulink Co-Simulation | Cong Liao  
Haiyan Henry Zhang  
Jerry Chung  
Ravi Desai  
Fred Berry | Purdue University, USA  
American Axle & Manufacturing, Detroit, MI, USA |
| 11:30 am - 12:00 pm | Robotic Navigation Through Simultaneous Localization And Mapping With Convolutional Neural Networks | Olusola T. Olojede  
Biswanath Samanta | Georgia Southern University, USA |
## Session No. | Technical Session 3 - Schedule

### Session Title: Oct. 25, 2019 from 9:30 AM to 12 PM – Rm 108

#### Date and time: Robotics

**Session Chair:** Adrian Smith  
Georgia Southern University, Statesboro, GA

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<tr>
<td>9:30 am - 10:00 am</td>
<td>Mechatronics for Fire Protection</td>
<td>Tim Wilson, Young Chang, Chulho Yang, Avimanyu Sahoo</td>
<td>Oklahoma State University, USA</td>
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<td>10:00 am - 10:30 am</td>
<td>Magnetic Levitated Drone</td>
<td>Ricardo Hernandez, Michael Ferguson, Tanner Stokes, Tucker Reed, Austin Rollen, John O’Hara, Imraan Faruque</td>
<td>Oklahoma State University, USA</td>
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<td>10:30 am - 11:00 am</td>
<td>A Mechatronics Mind-Set to Problem Solving</td>
<td>Frederick Berry, Henry Zhang</td>
<td>Purdue University</td>
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<td>11:00 am - 11:30 am</td>
<td>Development of a Heterogeneous Robot Swarm in a ROS Enabled Cloud Computing Environment</td>
<td>Adrian Smith, John Morrison, Biswanath Samanta</td>
<td>Georgia Southern University, USA</td>
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<td>11:30 am - 12:00 am</td>
<td>Temperature Control and Energy Use</td>
<td>Soumitra Basu, Owen Edwards</td>
<td>Fitchburg State University, USA</td>
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## Session No. | Technical Session 4 - Schedule

### Session Title: Mechatronics Applications

**Date and time:** Oct. 25, 2019 from 9:30 AM to 12 PM – Rm 109

**Session Chair:** Syed Misbahuddin  
Vaughn College of Aeronautics and Technology, East Elmhurst, USA

**Session Co-chair:** Nannan He  
Minnesota State University, Mankato, MN, USA

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<td>9:30 am - 10:00 am</td>
<td>Vertically Mounted Heat Sink Topology Optimization</td>
<td>Daniel Carne,</td>
<td>Oklahoma State University, USA</td>
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<td>10:00 am -10:30 am</td>
<td>Autonomous Position Control of an Unmanned Aerial Vehicle Based on Accelerometer Response for Indoor Navigation</td>
<td>Syed Misbahuddin, Sagufta Kapadia</td>
<td>Vaughn College of Aeronautics and Technology, USA</td>
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<td>10:30 pm -11:00 pm</td>
<td>Data Acquisition Tool in Mechatronics</td>
<td>Imad Abouzahr</td>
<td>Oklahoma State University, USA</td>
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<tr>
<td>11:00 pm -11:30 pm</td>
<td>Model-based development of control algorithms by Matlab/Simulink</td>
<td>Nannan He</td>
<td>Minnesota State University, Mankato, USA</td>
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<tr>
<td>11:30 am - 12:00 pm</td>
<td>Additive Manufacturing for Mechatronics Applications</td>
<td>Hitesh Vora</td>
<td>Oklahoma State University, USA</td>
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Abstract

Actuator selection is a fundamental stage on the design of motion control systems, including robotics. Motors are inherently coupled to the mechanical hardware and the control software on a robotic system, thosus, considerably influencing the system’s specifications such as form factor, cost, reliability, payload, accuracy, repeatability, and control complexity. However, some educational projects, disregard this aspect of the design process, instead of focusing either on the control implementation, or mechanical design. Hence, we propose a set of didactical demos to introduce students to the motor selection process. These set of demos utilizing different types of electromagnetic dc motor configurations will provide an interactive introduction for commonly used actuators and their benefits for different robotics application. Furthermore, we want to offer a sense of the difficulty and limitations for controlling the actuators, showcasing the control paradigms each motor has been optimized (position control, velocity control, and torque control). With the advent of automation and robotics, motor selection is a skill that will benefit students for capstone courses and another project-based curriculum. This educational setup is first meant to be implemented in a research lab setting to aid undergraduate researchers as well as other unexperienced members gain insight into motion systems implementation. In a future, more exploration needs to be done in for scalable environments such as classrooms.

3:00 pm - 4:00 pm
Introduction to Robotic Actuator Selection through Didactical Development Kits
Job D Ramirez
University of Texas at Austin, USA

Abstract

For engineering students enrolled in Duy Tan University, a capstone course in their junior year, Introduction to Engineering Education play an especially vital role in their future carrier. In this context, they should acquire all four stages of the Product Life Cycle (CDIO Standard 1). The vision of the CDIO Initiative is to provide students with an education that stresses engineering fundamentals set in the context of Conceiving--Designing--Implementing--Operating real-world systems, processes, and products. Duy Tan University’s mission statement serves as a foundation and guiding principle to focus on in-depth training and research. Accordingly, we must outline from the start of the engineering design process a series of steps that students follow to come with a solution to the given problem using focused-mode thinking and at the same time implementing the concept of Cost-Benefit Analysis. One of the projects assigned to the class in Fall 2018 was to design and construct an electric wheelchair for physically disable persons. The instructor assigns each team consisting of three to four students to investigate the minimum requirement of the wheelchair that meets the individual needs and is safe with a price that is affordable. The students collected needs assessment data from the disabled people in the community. The students worked directly with the wheelchair user and involved them in all aspect of wheelchair design process. With the market data, each team proposed a cost-effective solution of a basic Electric wheel chair. The final design was modified with instructor input to add intelligence using a microcontroller and a collection of sensors that provide navigation assistance to the wheel chair user assuring collision free travel and autonomously transporting the user between locations. The modified design was used to fabricate and assemble the smart electric wheelchair. Adoption of the CDIO program was a great learning experience for both the faculty and the students. It was observed that the process required not just one but a series of CDIO standards in a systematic and integrated curriculum to create well-rounded graduates with strong engineering and entrepreneurial skills. In this respect, we need the customized, integrated approach (Standard 3) in teaching the technical discipline, for example adding the manufacturing processes. Students need to acquire background knowledge in production design and Computer Aided Design, the metal working process, the dynamic calculation driver, even the industrial esthetic design, and finally the system building and testing skills. An integrated curriculum should also focus on workplace environment to implement on-site practices (Standard 6), so it would be attractive and very useful for developing production skills for engineers. The integrated approach presented in this paper for introducing the technical discipline help students identify urgent socio-economic problems, integrate different skills and know-how for feasible solutions, select the optimal solution based on strong design and implementation knowledge, and continuously improve the outcomes and designs by following certain technical, social and ethical requirements. The content of this paper will be of benefit to universities that are looking for ways to improve their introduction to the technical discipline. Technical Session 1 – Continued on next page
Abstract

A final-year, project-based design course is common to most electrical, mechanical and electromechanical engineering degree programs throughout the United States. Although the desired learning outcomes for most of these final-year capstone design projects are similar, the educational methodologies and curriculum designed to attain those outcomes is highly variable. There is yet to be a standardized curriculum framework that encompasses the broader engineering education objectives embodied in the ABET Criteria for accreditation. Many other fundamental, discipline-specific courses have curriculum frameworks that are relatively homogenous across the United States, such as Network Theory, Thermodynamics, Fluid Mechanics, or Digital Logic Circuits. A Thermodynamics course or Fluid Mechanics course that is taught at any accredited engineering degree program within the United States would differ little from courses offered in most other engineering degree programs. This paper presents a detailed curriculum framework for both a one-semester and a two-semester final-year engineering project (FYEP) course. The curriculum of the one-semester FYEP course includes instruction in engineering standards and practices, such as: project proposal guidelines, cost-estimation, project scheduling, and project management techniques. It also contains subject areas in engineering research and analysis, expository writing, video and media presentation, and public speaking skills. The curriculum framework integrates the students’ preceding engineering coursework and analytical abilities into their analysis of the project’s technical goals. Students are also required to present not only standardized engineering drawings of their prototypes, but are also required to complete a series of manufacturing, or production, drawings that would be necessary to manufacture their project prototype. In the two-semester FYEP course, students receive instruction in engineering economics and business practices, as they relate to the engineering industry. This includes creating a business plan, facilities acquisition, labor recruiting, regulatory requirements, and tax obligations. The two-semester FYEP course also introduces topics in intellectual property rights, prior-art searches, provisional and utility patents, trademarks and copyrights, patent application procedures, patent claims and international patent law.

Abstract

This research aims to develop an adjustable stiffness suit that will be used as a protective garment of the human body from external impact as well as a structural member of a soft exoskeleton. It is important to develop an auxetic unit cell with adjustability of stiffness in order to design a whole structure with elastic flexibilities in the soft wearable suit. Inflation and deflation mechanisms on the adjustable stiffness pads with auxetic foam play key roles in either the protection of the human body or the assistance of human motion through the reversible configurations of the structure. This paper presents design considerations of a garment with a Cross Chiral Honeycomb (CCH) structure. Periodic cellular structures were first considered in the field of lightweight construction due to their high specific stiffness, damping, and energy absorbing properties. The development of modern 3D-printers has allowed the creation of 3D auxetic structures. Experiments of several specimens were conducted to verify mechanical characteristics of CCH structures. Through this approach, valid geometric parameters of the macro-auxetic structure used in the soft wearable suit could be designated.
Session Title: Oct. 24, 2019 from 10:30 AM to 12 PM – RM 108

Date and time: Intelligent Mechatronic Systems

Session Chair: Iftekhar Ibne Basith
Purdue University, West Lafayette, IN, USA

Session Co-chair: Haiyan Henry Zhang
Purdue University, West Lafayette, IN, USA

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<td>Cong Liao, Haiyan Henry Zhang, Jerry Chung, Ravi Desai, Fred Berry</td>
<td>Purdue University, USA, American Axle &amp; Manufacturing, Detroit, MI, USA</td>
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<td>11:30 am – 12:00 pm</td>
<td>Robotic Navigation Through Simultaneous Localization And Mapping With Convolutional Neural Networks</td>
<td>Olusola T. Olojede, Biswanath Samanta</td>
<td>Georgia Southern University, USA</td>
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Abstract

10:30 am – 11:00 am

To meet the challenging needs of evolving manufacturing industries, highly autonomous equipment’s like industrial robots are now being integrated heavily in the production process to output precise and efficient products. The Department of Engineering Technology at Sam Houston State University (SHSU) is developing a manufacturing-focused curriculum with concentration on Mechatronics. We are working to build an integrated LAB to support this new program with FANUC LR Mate 200iD/4S robots, EMCO Concept Turn 60 turning centers and Amatrol PLC trainers. The robot will be enhanced to include vision capability so both equipment will work cooperatively to manufacture components and human intervention will be eliminated. The authors have been trained as certified FANUC robot operator, and went through both the FANUC and Siemens controllers training for the EMCO turning center. The authors recently received an internal grant to implement this LAB. The goal is to develop the existing basic FANUC robot operation course, a new CNC machining technology course, and possibly an advanced elective course focusing on the robot/CNC programming.

11:00 am – 11:30 am

A spline clutch driven by an actuator provides a Power Transfer Unit (PTU) the functions of power disconnection or speed selection. In the driven system, the PTU actuator is the core mechatronic component to realize the essential functionality. This paper focuses on increasing the performance and stability of the PTU by means of analytical mechatronic modeling and analysis with ADAMS-Simulink co-simulation. By utilizing the Adams, the PTU was modeled and the characteristics of the sleeve walk-out was revealed. The motor and partial mechanical components were modeled in the Simulink and combined with the Adams model for co-simulation. The fuzzy logic with PID position control is developed to suppress the on-set of the walk-out. The effectiveness of the control strategy was validated by the co-simulation. This method can be extended to other actuator driven spline clutch applications to minimize the risk of walk-out.

11:30 am – 12:00 pm

A study is presented on intelligent robot navigation through simultaneous localization and mapping (SLAM) with convolutional neural networks (CNNs). The objectives of the study include: (1) re-training a pre-trained CNN network for object detection and recognition, (2) implementing a visual SLAM (vSLAM) algorithm within robot operating system (ROS) framework, and (3) integrating both the re-trained CNN and vSLAM to intelligently guide a robot during navigation to reach target objects while avoiding obstacles. The visual SLAM (vSLAM) with CNN for object detection, recognition and depth estimation was adapted and implemented in real-time on a mobile robot platform, namely, a Kobuki Turtlebot with Xbox 360 camera along with its on-board laptop (CPU based). The proposed system successfully combined the capabilities of vSLAM with CNN for real-time autonomous navigation of the robot in an enclosed environment. The power of edge computing with a graphics processing unit (GPU) based hardware platform, Jetson TX2, along with open-source software library TensorFlow suitable for implementation of deep learning architectures including CNN were utilized within ROS for real-time operation. The effectiveness of the system is illustrated through case studies that required the robot to avoid obstacles while locating designated objects within the map, without and with a maze, in a laboratory setting. In each case, the robot was able to plan a path towards the target objects using the map it saved from the vSLAM-CNN implementation. The map was continuously updated accommodating changes in the environment while the robot was navigating towards the target objects. Details of algorithms, hardware and software support, real-time implementation, and results of different case studies represented along with recommendations for future work in the overall framework of intelligent robotics and mechatronics.
Session No.: Technical Session 3 - Details
Session Title: Oct. 25, 2019 from 9:30 AM to 12 PM – RM 108
Date and time: Robotics
Session Chair: Adrian Smith
Georgia Southern University, Statesboro, GA
Session Co-chair: Soumitra Basu
Fitchburg State University, USA

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<td>09:30 am -</td>
<td>Mechatronics for Fire</td>
<td>Young Chang,</td>
<td>Oklahoma State University, USA</td>
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<td>10:00 am</td>
<td>Protection</td>
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Abstract
The integration of robotics, electronics, computers, and systems control, i.e. mechatronics, has been occurring in numerous fields for many decades. One field in particular, industrial loss prevention, employs mechatronics to improve capabilities in the areas of fire prevention and occupational safety. This presentation discusses some key historical events and shows the utilization of mechatronics through the decades to mitigate the effects of and sometimes even eliminate the potential for industrial loss.

10:00 am -    | Magnetic Levitated Drone   | Ricardo Hernandez                 | Oklahoma State University, USA       |
| 10:30 am     |                            | Michael Ferguson                  |                                      |
|              |                            | Tanner Stokes                     |                                      |
|              |                            | Tucker Reed                       |                                      |
|              |                            | Austin Rollen                     |                                      |
|              |                            | John O’Hara                       |                                      |
|              |                            | Imraan Faruque                    |                                      |

Abstract
Insects flying in crowded assemblies are able to robustly interact with each other. Identifying the strategies they use would be improved by stimulation with robotic insects, but current micro aerial vehicle technology does not provide this capability. Our project objective is to develop an alternative mechanism using electromagnets that are able to produce movements on a magnetic particle that are comparable to realistic airborne insects. To accomplish this, initial models of electromagnetic coils and the resulting magnetic field were created using simple analytic expressions of a circular current loop developed by NASA. Using these models we were able to size the electromagnetic coils and set design requirements for the electrical circuit that controls the current driven through the coil. This current control system was implemented within a matrix of electromagnetic coils, which each individually can suspend a permanent spherical magnet in a vertical axis. This is combined with a computer vision system that provides feedback to the overall control system which allows for the implementation of a proportional and derivative controller within MATLAB, both necessary to accomplish levitation. Further modifications incorporating the controller and an algorithm specific to the matrix parameters will allow movement within a limited 3D-space. The purpose of the algorithm is to generate specific currents through individual coils simultaneously which would produce desired magnetic force vectors between the coils allowing for the controlled movement of the particle from coil center axis to coil center axis. At present, experiments using the proportional controller showed desired oscillations of the current at a fixed frequency, resulting in suspension of the particle for a limited time. The derivative controller has been implemented and appropriate derivative gain tuning is a current focus of work.

Technical Session 3 – Continued on next page
This paper will present the state of capstone education in the School of Engineering Technology (SoET) at Purdue University, West Lafayette, IN. Each year, SoET launches a two semester capstone course sequence for our soon-to-be graduating engineering technology students. SoET’s capstone sequence is multi-disciplinary, consisting of mechanical engineering (MET), electrical engineering (EET), manufacturing engineering (MFET), industrial engineering (IET) and supply chain and sales engineering (SCSET) technology students. Mechatronics is considered a multi-disciplinary branch of engineering and technology generally focusing on the combinations of different engineering discipline to create a mechatronics graduate. However, by using open-ended projects from industries that need more than one technical discipline to solve the problem, we can now give all students an experience which requires a mechatronics mind-set to problem solving. The capstone sequence uses a stage/gate process to move the student teams from team formation, project proposal, conceptual design, preliminary design, critical design review, fabrication and test, and to final deliverable. There are a total of six gates throughout the academic year. At each gate formative and summative assessment methods are used to measure the progress of students and teams. These assessment methods include rubrics and peer-to-peer assessment tools. Rubrics are used for the individual notebooks and the team reports and presentations. The presentations at gates 2 and 4 are critical design reviews, which are hour and half juried-presentations. The judges for these critical design reviews are the industry and academic mentors and course instructors. The panel size will vary from 5 to 8 individuals. These two juried-presentations are essential to team success. The judges and the students develop deeper understanding about the projects, which are translated into real action items that impact team success. Peer-to-peer assessment is done at each gate using ITP Metrics. Training takes place before the ITP Metrics survey is administered to the students. At gates 1 and 2, the assessment results from ITP Metrics are formative. The course instructors and academic mentors meet with the teams and talk about their results and possible consequences of continued behaviors. After gate 2 the results of the ITP Metrics survey are summative. Student grades, at each gate, can be raised or lowered based on the results from ITP Metrics. ITP Metrics is an effective tool to monitor teams and individual students to determine if the academic mentors and course instructors need to step in. Another tool being used is Gradient. Gradient assignments have been developed to engage students in a multistage writing workspace to assure all students engage in writing and to perform additional peer-to-peer assessment. Students are trained on what to look for in specific Gradient assignments, which improves the quality of student feedback, enhances learner confidence, and promotes deeper engagement in the writing process. After evaluating peer contributions, students consolidate and apply their gains by reflecting on their own submission. However, the biggest benefit of Gradient is to the academic mentors. Examining written assignments gives mentors clear insight into their students’ understanding and provides the mentors more opportunities to provide commentary and guidance so critical to improve future performance.
The paper presents development of a heterogeneous robot swarm in a robot operating system (ROS) enabled cloud computing environment for teaching and research in a University setting. The robot swarm consists of mobile ground robot platforms like Turtlebot, P3-DX, P3-AT, Arlobot and locally designed miniature unmanned aerial vehicles (mUAVs). Currently there are four Turtlebots, four Arlobots, one each of P3-DX and P3-AT and two mUAVs. The heterogeneous nature of the robot platforms brings in variety in terms of capabilities but presents challenges in terms of differences in hardware and operating software bases. Robot operating system (ROS) is used to integrate the robots within the cloud computing environment for communication and data sharing. In addition to cloud computing support, Turtlebots are equipped with edge computing platform Jetson TX2 for onboard processing of deep learning based object detection and recognition applications. Arlobots are equipped with ping sensors for short-range object detection and obstacle avoidance and a 9-degree-of-freedom IMU for relative motion tracking. Arlobots are interfaced with Raspberry Pi 3B and Arduino Mega for on-board processing of local sensor data, drive control and communication within the cloud robotics environment. P3-DX and P3-AT modules have sonar sensors at both front and back for obstacle avoidance and can communicate with leader robot through the wi-fi link. The aerial robots, mUAVs, are quadcopter style drones made using laser cut plywood as a frame with drone motors and 11.1 volt 2600 mAh batteries. The mUAVs are controlled using Pi Zeros as the ROS node and PXF Minis as the flight controller. The robot swarm is integrated within the ROS enabled cloud robotics environment for proper task coordination and planning. The system is used for teaching and research in the broad area of intelligent robotics and mechatronics in the Mechanical Engineering Department at Georgia Southern University. Details of hardware and software platforms, ROS enabled cloud robotics infrastructure, and typical case studies are presented along with ongoing efforts to integrate other modules within the system.

This paper presents the results of an undergraduate project in "Automated Manufacturing II", which is a hands-on mechatronics course that reinforces knowledge and skills in the automation of manufacturing systems. The objective is to investigate the energy consumption in indoor space heating and ventilation both experimentally and theoretically. For this purpose, a 12 inch enclosed cube is designed and fabricated with CAD-CAM tools. A micro-controller (Arduino) is programmed to activate a relay that turns on a heater inside the structure. The temperature is measured with a thermister, and experiments are designed to have the microcontroller trigger a relay when the temperature drops below a set point. The impact of the temperature tolerance (highest - lowest temperature read by the thermister) and insulating walls on energy use is measured. The heating and cooling process is modeled theoretically and the results are compared with experimental observations.
With the rise of 3-D printing, topology optimized heat sinks are now becoming a manufacturing reality. However, the means to optimize thermal systems are still lacking. This research investigates methods to optimize multi-physics systems, specifically looking at 2-D vertically mounted heat sinks. If you assume a constant fluid temperature, the problem becomes easy, and optimizes for the best material layout with constant boundary conditions, because the fluid temperature is not changing. Once you add in a solver for the fluid temperature, the problem becomes substantially harder. As soon as you add or remove material from the heat sink during optimization, the air temperature changes. This could be thought of as a conduction optimization problem with changing boundary conditions. There are several different ways to optimize systems like this, one of them being generative design. This is where you start with only the base, and it “grows” the heat sink from there in a specified design domain. Generative design is attractive to many because this is what nature does. Trees, plants, and animals all grow from a very little starting point. This method works very well for increasing efficiency of heat sinks and for designing heat sinks in areas with obstructions. However, problems remain in numerical approaches to create this design. The purpose of this research aims to find ways to improve those algorithms and compare the best generative design methods.

Abstract

Autonomous indoor drone navigation has been posed with various challenges, including the inability to use a Global Position System (GPS). As of now, Unmanned Aerial Vehicles (UAVs) either rely on 3D mapping systems or utilize external camera arrays to track the UAV in an enclosed environment. This research introduces an algorithm that allows the UAV to be navigated indoors using only the flight controller and an onboard companion computer. In this paper, open source libraries are used to control the UAV which will only use the onboard accelerometer on the flight controller to estimate the position through double integration. One of the advantages for such a system is that it allows for low-cost Micro-Aerial-Vehicles (MAVs) to autonomously navigate indoors without advanced mapping of the environment or the use of expensive high-precision-localization sensors such as 360° LIDAR. The algorithm also allows easy integration of additional systems such as computer vision and package delivery for a complete autonomous MAV.
Abstract
This paper describes the content of EET 3363 Data Acquisition course, in the Electrical
Engineering program at Oklahoma state university. Information such as binary description of
information, Digital to analog converters, and Analog to digital converters, and sensors are
discussed, with LabVIEW used as a tool to communicate with NI data acquisition boards.

Abstract
Nowadays, controller systems based on Programmable Logic Controllers (PLCs) and ARM
microcontrollers dominate devices in safety critical industrial automation control systems. Failures in
these systems can cause catastrophic damages. Model-based development (MBD) is an emerging
methodology for developing complex computing systems. More system modeling tools have started
supporting the MBD, such as the Simulink software package from MathWorks. By the use of domain-
specific notations to design executable models, Matlab/Simulink makes programming easier compared
with low-level text-based programming languages like C. This allows engineers with limited
programming experiences to focus on their domain knowledge. By supporting automatic code generation,
Simulink has two outstanding advantages - eliminating errors from hand-coding and regenerating code
easily for different application targets. Furthermore, by promoting the continuous model-based
verification and validation, the MBD can make the development cost-efficient by identifying design flaws
at the early stage. In particular, Matlab/Simulink recently allows users to directly configure and program a
wide range of low-cost, easy-to-use hardware boards, like Raspberry Pi and PLCs. It also started to
support the MBD of PLC programs via a PLC Coder. Instead of hand coding PLC code, users can apply
the tool to automatically generating the PLC program coded in the IEC 61131-3 Structured Texted (ST).
We investigate the transformation of Ladder Logic programs to Matlab/Simulink models, and then apply
PLC coder to generated Structured Texted code. We propose a mutation-based test case generation
approach to generate test suites on Matlab/Simulink models. An automated formal method called Model
checking has been applied to rigorously verifying these models. This paper also reports two case studies of
industrial applications. We also explored the MBD with Matlab/Simulink in developing a microcontroller-
based application to control a robotic Arm. We not only applied existing Simulink block libraries for
programming Raspberry Pi(RPi) board, but also developed several customized blocks for controlling RPi.
The goal of this project is on the MBD of smart sensing and controlling nodes in the Internet of Things
applications.
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