BRADLEY UNIVERSITY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Peoria, Illinois 61625

SENIOR PROJECT CONFERENCE

Thursday, April 27, 2017– Sessions I, II, III
Tuesday, May 2, 2017 – Sessions IV, V, VI, VII

All Sessions will be held in the Marty Theater – Student Center

For additional information, contact the following faculty advisors:

Dr. I.S. Ahn	**677-2734**
Mr. S. Gutschlag	**677-2972**
Dr. B. Huggins	**677-2732**
Dr. M. Imtiaz	**689-5419**
Dr. Y. Lu	**677-3564**
Dr. A. Malinowski	**677-2776**
Dr. S. Miah	**677-2260**
Dr. P. Shastry	**677-2733**
Dr. J. Wang	**677-2735**

PROGRAM SUMMARY

Tuesday, May 2, 2017

Session IV Biomedical II **9:00 – 11:00**

IV-1 Self-Activating Fall Alarm 9:00 – 9:40

IV-2 Real-time Electrocardiogram Monitoring 9:40 – 10:20

IV-3 EMG-based Human Machine Interface System 10:20 – 11:00

Session V RF Circuits **11:00 – 12:00**

V-1 Design of a Charge-Pump for Wireless Energy Harvesting at 915 MHz 11:00 – 11:30

V-II Passive RF Energy Harvesting at 5.8 GHz 11:30 – 12:00

BREAK

Session VI Signal Processing **1:00-3:00**

VI–1 Vision Based Autonomous Control of a Quadcopter 1:00-2:00

VI-2 Panduit Localization System 2:00 – 3:00

Session VII Autonomous Systems and Robotics **3:00 – 5:00**

VII-1 Indoor Robot Localization and Mapping using ZigBee Radio Technology 3:00 – 3:30

VII-2 Distributed Vision-Based Target Tracking Control Using Multiple Mobile Robots 3:30 – 4:00

VII-3 IEEE SouthEastCon Hardware Competition Robot 4:00 – 5:00

Tuesday, May 2, 2017

Session IV Biomedical II 9:00 – 11:00

IV-I **9:00 – 9:40**

Self-Activating Fall Alarm

By: Maisha Talukder, William Kelly and Michael McGrath
Advisors: Dr. Imtiaz and Dr. Ahn

The self-activating fall alarm is an “invisible” wearable device which clips on to the waist of the user (i.e through belt, waistband, etc.). This device automatically detects falls with the goal of shortening fall response times, which can prevent serious injury. The self-activating fall alarm utilizes a Bluetooth module (Bluetooth Mate Gold) directly connected to an Inertial Measurement Unit (IMU) to transmit sensor data to a laptop. The data from the three axis-accelerometers, -gyroscopes and -magnetometers, built-into the IMU, are analyzed by a fall-detection algorithm to determine if a fall has occurred. Once a fall has been detected, the system runs a fall-response algorithm through Matlab, which notifies the user’s caregivers and EMT, and reassures the user that help is on the way. The final portion of the algorithm, involves storing the user’s data allowing for physicians to analyze and interpret the fall occurrences to prevent future falls from happening

IV-2 **9:40 – 10:20**

Real-time Electrocardiogram Monitoring

By: Nicholas Clark, Edward Sandor and Calvin Walden
Advisors: Dr. Ahn and Dr. Lu

An arrhythmia is an irregular heartbeat that occurs when the electrical signals controlling the heart's muscular contractions becomes malformed. Patients often wear a Holter monitor at home to collect the electrocardiogram (ECG) data for the purpose of diagnosis. During a subsequent doctor’s visit, the data is analyzed to diagnose arrhythmia. The project aims to develop a wearable medical device for real-time arrhythmia detection. The device can acquire the ECG data through three-lead sensors with sampling rate 360 Hz. It performs ECG signal processing in real-time and alerts the patient’s doctor of an arrhythmia via wireless messaging. At the current stage of project, premature ventricular contractions (PVCs), a common form of arrhythmia, is being monitored. The Pan-Tompkins and wavelet-based Template-Matching algorithms have been implemented for PVC detection. When three or more consecutive PVCs are detected, a short-message-service (SMS) system is activated to alarm a patient’s care provider immediately. In the experimental study, the design has been successfully validated using benchmark records from the MIT-BIH arrhythmia database. Additionally, low-cost digital signal processor and embedded Linux system are used for implementation. This study suggests a viable, low-complexity solution for real-time heart monitoring and arrhythmia detection.

IV-3 **10:20 – 11:00**

EMG-based Human Machine Interface System

By: John Reaser Cochrane, Jon Moron and Thomas DiProva

Advisor: Dr. Lu and Dr. Ahn

Electromyogram (EMG) signals are electric potential generated by muscles when activated by the nervous system. Surface EMG electrodes can be used to assess the muscle motion by attaching the sensors to the skin above the desired muscle. EMG signals can be useful for developing systems to improve the quality of life for those with psychomotor skill disabilities. This project aims to develop an EMG-based human machine interface system for in home assistance, especially for disabled people. A wearable Wi-Fi sensor board is used to record EMG signals. Artificial neural network is utilized to calibrate and classify the EMG signals. Control commands are wirelessly transmitted based on the EMG signal pattern from finger or fist movements. In addition, a service robot is controlled wirelessly by control commands. The robot is also equipped with an IP camera for vision feedback. A video monitoring system assists the user with navigation of the robot.

Session V RF Circuits 11:00 – 12:00

V-1 **11:00 – 11:30**

Design of Charge-Pump for Wireless Energy Harvesting at 915 MHz

By: Mark McKean and Milko Stoyanov

Advisors: Dr. Shastry and Dr. Huggins

Panduit, a manufacturer of communication infrastructure products, requested a receiver be designed and implemented to harvest wireless RF energy to power remote sensors. In the first iteration, the RF signal will be transmitted from a base station operating at 915 MHz with future iterations using the RF energy in the digital TV bands.

This report describes the design, simulation, and implementation of multiple RF-DC charge-pump circuits. Recent literature describes the efficacy of such topologies for RF energy harvesting. Both 2 stage charge-pumps and 5 stage charge-pumps, optimized for different incoming power levels, are presented. These circuits, consisting of a matching circuit, diode-capacitor stages and a load, were designed and simulated using SPICE and ADS. The microstrip circuit boards were fabricated by Micro Circuits based on ADS designs and components inserted by the team members. The report compares simulated results to experimental results.

V-II **11:30 – 12:00**

A Passive RF Energy Harvesting at 5.8 GHz

By: Mitchell Pericak

Advisors: Dr. Shastry and Dr. Huggins

Companies and research groups have investigated the design and implementation of systems that extract energy from wireless signals to power remote sensors. This report describes the design and implementation of such a system operating at 5.8 GHz. The system consists of a basic charge-pump circuit to convert the 5.8 GHz signal to low level DC. This circuit was designed and simulated using SPICE and ADS. The output of this stage is applied to a commercial DC to DC converter (LTC 1502) to increase the output voltage of the system to 1.2V. The microstrip circuit boards were fabricated by Micro Circuits based on ADS designs and components inserted in the Bradley microwave lab. The report compares simulated results to experimental results.

BREAK

Session VI Signal Processing 1:00-3:00

VI–1 **1:00-2:00**

Vision Based Autonomous Control of a Quadcopter

By: Caleb Gill, Jeffrey Deeds, Zackary Woods and Zachary Engstrom

Advisor: Dr. Lu, Dr. Ahn and Dr. Wang

A useful application of Unmanned Aerial Vehicles (UAVs) is to sense and locate persons during an emergency. Imagine using UAVs to locate a hiker lost in the mountains or to spot people isolated in a dangerous area. The real-time video feed and accurate location information from a fleet of UAVs is invaluable for decision makers to efficiently distribute resources and dispatch rescue workers. In this project, an autonomous vision based control system for a quadcopter is designed to execute a mission plan using a vision system. The system includes a *Raspberry Pi 3,* an onboard embedded system that communicates with the *Pixhawk*, an onboard autopilot. The *Raspberry Pi* and the*Pixhawk* are physically connected and communicate through serial communication via *DroneKit-Python,* which is a Python Application Programming Interface (API) that utilizes the *MAVLink* protocol. The *Raspberry Pi* executes a video processing algorithm to locate an *AprilTag,* a type of two-dimensional bar code. The mission plan of the quadcopter is to autonomously take off to a specified altitude, fly to a waypoint with a predefined GPS coordinate, locate a target displayed by an *AprilTag*, position itself over the target, and land near the target. If the target is not detected or the UAV cannot position itself within tolerance, the UAV returns to the takeoff point.

VI-2 **2:00 – 3:00**

Panduit Localization Project

By Nicholas Pratt, Nathan Ruetten and Michael Stanczyk

Advisor: Dr. Malinowski

Many organizations, including Panduit, currently utilize various types of wireless sensors for many applications such as temperature and pressure measurements throughout an environment. It can be advantageous to know the physical location of these wireless sensors. Conventional location determination systems, such as the Global Positioning System (GPS), cannot be used in certain environments and a different solution is needed. In some cases, sensor locations can be manually assigned and fixed. However, for deploying a great number of sensors, it would be easier to have this location be determined automatically and allow the sensors to be moved through a closed environment. Our research focuses on designing a location determination system using IEEE 802.11 WiFi to determine the location of a sensor with an accuracy of 1 meter or less in two-dimensional or three-dimensional space

Session VII Autonomous Systems and Robotics 3:00 – 5:00

VII-1 **3:00 – 3:30**

Indoor Robot Localization and Mapping using ZigBee Radio Technology

By: Jacob Knoll and Kyle Hevrdejs

Advisor: Dr. Miah

Addressing the navigation (localization and motion control) problem of a mobile robot, coupled with its mapping problem, remains a significant challenge to date. The well--known simultaneous localization and mapping (SLAM) problem of mobile robots has been addressed in the literature without specifically taking into account the robot's motion control tasks. Moreover, its implementation can cost more than the robot itself. Robot's motion control strategies developed in the literature either (i) rely on sophisticated hardware platforms, (ii) assume noise-free environments, or (iii) are based on abstract theories which are validated using computer simulations only.

The work presented herein solves the navigation and mapping problems of mobile robots using open--source hardware and range--only measurements from a network of radio sources. The hardware platform used in this work is customized such that it is cost--effective and easy-to-implement, addressing the aforementioned issues in developing motion control strategies. Here, the robot estimates its position and orientation, builds a map of its operating environment using radio frequency (RF) signals received from radio sources. It then navigates through a path defined by a set of 2D points on the ground using a motion control strategy in cooperation with a tool of computational intelligence. The proposed robot navigation and mapping scheme is tested in an indoor laboratory environment and its performance is compared with the simulation counterpart using a commercial robot simulator.

VII-2 **3:30 – 4:00**

Distributed Vision-Based Target Tracking Control Using Multiple Mobile Robots

By: Anthony Le and Ryan Clue
Advisors: Dr. Wang and Dr. Ahn

In this project, a distributed vision-based control system is designed for multiple mobile robots to address the target tracking problem while maintaining the specified formation among robots. The system mainly consists of two modules. One is for target identification and the other is for target tracking and formation control. In the target identification module, the robot is controlled to pivot around its center and perform the survey of the environment using its on-board vision sensor. Specifically, an image is acquired every 15 degree and processed based on the use of image thresholding and blob detection techniques. Once the target is detected, the coordinates of its centroid are then taken as the input to the target tracking and formation control module. The switching between two modules is coordinated through a state flow mechanism. A leader-follower control strategy is further adopted to solve the formation control problem of multiple robots. The proposed distributed vision-based control is experimentally tested using three QBot2s from Quanser, Inc. The QBot2 is a standard two-wheel differential drive mobile robot and operates using a host-target structure. The Kinect RGBD camera on the QBot2 is used to detect the target, a yellow ball in the experiments. The overall system is programmed using MATLAB/Simulink on the host computer, which is further integrated with QUARC (Quanser Real-time Control) for the real-time interface with the target computers on the robots. The experiment results validated the proposed design.

IEEE SouthEastCon 2017 Hardware Competition Robot

Cameron McSweeney, Kendall Knapp, Brian Roskuska, and Daniel Hofstetter
Advisors: Dr. Jing Wang, Dr. In Soo Ahn, and Dr. Yufeng Lu

The 2017 IEEE SouthEastCon Student Hardware Competition requires participants to build a robot that autonomously navigates through a Star Wars themed arena. The robot dimensions are constrained by a 12-inch cube. It must complete four tasks within four minutes. In Task 1, the robot must approach a stage with six copper pads on it. Five of the pads are connected to five different electronic components and the sixth is common to all of the components. The robot must determine the position of each of the components. In Task 2, the robot must detect the magnetic field present in the arena when it is turned on. The robot must strike a lightsaber when the magnetic field is on. In Task 3, the robot must turn a knob in alternating directions governed by the component position code determined in Task 1. In Task 4, the robot must deposit up to three Nerf darts into a hole on the far side of the arena. Based on those competition guidelines, our robot was constructed with four modules to perform four tasks. Two microcontrollers were programmed for the basic functions of robot navigation, components measurements, magnetic field detection, servo motor control for the gripper and swing arm, and dart firing. The robot is equipped with infrared sensors, ultrasonic distance sensors, contact sensors, and wheel encoders for navigation. Each module was implemented individually and all were integrated on a robotic platform. The robot was thoroughly tested to ensure it would meet the requirements of the IEEE SouthEastCon Hardware Challenge.