UNLV ITEST Program Sample Engineering Projects

The engineering projects are carefully designed to address different aspects of ubiquitous intelligence and computing fields targeting smart city and environmental applications including 1) smart citizen services, 2) intelligent transportation system, and 3) intelligent energy planning. In addition, projects on Vex V5 robots (FIRST compatible) are included. The PIs will collaborate with CCSD STEM teachers and college mentors in devising up-to-date computing and engineering projects that: 1) describe a problem of importance to smart city and environmental applications; 2) the problem corresponds to at least one topic listed in the NGSS for both MS and HS levels; 3) utilize the tools that the students have learned during the three-week training and allow the students to develop important technical skills; and 4) permit significant progress over a 2-week period. Below lists 10 sample projects.

- **Smart Citizen Services**

Automatic Attendance Checking System for Smart Classroom (MS-ED, HS-ED: Developing and Using Models, MS-PS, HS-PS: Waves and Electromagnetic Radiation). On regular school days at middle or high schools, teachers need take extra time to call for attendance or have students to sign up on roster sheet. In this project, the students will design an automatic attendance checking system. The system consists of the RFID system and data collection APP. The RFID system consists of the RFID card, token, RFID sensor, Arduino Uno with WiFi module (or ESP32 development board), and a micro-servo motor (optional). Each student has an assigned RFID card with matched token. The RFID sensor subsystem can be mounted at the classroom door entry. When a student taps a card or token on the RFID sensor, it will read the card information and transmit the data to a computer or a cloud. If the card information matches with the record in a student roster database stored on the computer, the sensor system will drive the motor to open the door allowing the student to enter. During the pandemic, it is necessary to monitor students' temperature before they come to classroom. How to expand this system to prompt each student to take temperature before they enter the classroom? Similar smart entrance system can be developed to a building or facility. Click here to learn more about a similar project.

Smart Hiking Trail Tracking System (MS-ED, HS-ED: Developing and Using Models, MS-PS, HS-PS: Waves and Electromagnetic Radiation) LoRa is one of the most widely used network radios in the IoT network technology infrastructure due to its advantages of long-range communication, low power, and low cost. Many hiking trails have no clear signs of direction. People are easy to get lost. Due to the poor mobile signals in these areas, it is very difficult to track people. Is it possible to design a smart hiking trail tracking system? In this project, students will design a smart hiking trail tracking system which consists of the GPS-enabled end node, and the LoRA gateway. The end node integrates of a GPS sensor and a LoRa-enabled ESP32 board. Each hiker will carry the end node (on wrist ideally) which will send the detected GPS location through the LoRa module to the LoRA gateway if within the communication range (up to 10km) or another end node along the hiking trails on fixed time intervals. The end node can relay the hiker's information to the LoRA gateway through point-to-point communication. The LoRA gateway will send the collected location information to a cloud server through satellite network. Trail rangers can access the tracking information by accessing the cloud server. How to cover the locations where GPS signals are not available? Click here to learn more about a similar project.

- **Intelligent Transportation System**

Smart Parking Lot (MS-ED, HS-ED: Developing and Using Models, MS-PS, HS-PS: Waves and Electromagnetic Radiation) Living in a city environment, people need drive and park their cars on daily basis. It is difficult for people to locate the vacant parking spot without detailed information. Some advanced parking garages adopt the technology to monitor the usage of parking lots and indicate the number of vacant spots at the entrance. However, without the detailed guidance, it is not easy for users to find the vacant spot quickly. Is it possible to design a smart parking lot system to help the user find an available parking lot easily? In this project, the students will design a smart parking lot system by integrating the IoT-enabled end node, a gateway node and the mobile APP. Each end node consists of the ultrasonic distance sensor and Arduino Uno with WiFi module (or ESP32 board). The ultrasonic sensor will monitor the usage of parking lot. The Arduino board will send the parking lot ID and occupancy information to a gateway node. The gateway node will upload the occupancy info of the whole parking lot to a cloud server via Internet. Users can access the parking lot occupancy information with detailed layout

through a mobile APP[6]. How to extend this system to a large open parking area where WiFi signals are not available? Click here to learn more about a similar project.

Line Follower Robot (MS-ED, HS-ED: Developing and Using Models, MS-PS, MS-PS, HS-PS: Waves and Electromagnetic Radiation) Arduino is very suitable to be used as the controller for robotics projects. In this project, the students will build a line follower robot with an Arduino Uno board, infrared (IR) sensors, and a self-built robot. A simple robot can be built with two motors, a base board, two wheels, and two motor drivers, a battery, and Arduino compatible expansion shield. The shield is used to extend the pins from the Arduino board to connect the motor drivers and IR sensors. Mounted on the front of the robot, two IR sensors will detect if the robot is aligned in right angle. Based on the detected signals, Arduino will control the left and right motors so that the line can be followed. The robot can be expanded to avoid obstacles using an obstacle sensor or ultrasonic sensor. It is possible to use Lego robots controlled by Arduino to perform certain tasks. How to make the Robot play music with adaptive LEDs while it is driving? Click here to learn more about a similar project.

- **Intelligent Energy Planning**

Intelligent Solar Tracker (MS-ED, HS-ED: Developing and Using Models, MS-ESS, HS-ESS: Earth's System). In a smart city, solar panels are widely used to power city facilities like street lamps and pedestrian passing lights, and other decoration lights. To maximize power generation, the solar panel needs to be pointed at the Sun. As the sun direction changes during the daytime, how to track the sun direction so that the solar panel can be rotated to maximize the sun exposure? In this project, the students will design a sun tracker with Arduino. The tracker is made with a solar panel, photo resistors, Arduino Uno board, a small servo, and a wood frame. The students first need to assemble the solar panel(s) with the wood frame to make it rotatable. The two photo resistors mounted on two sides of the panel will detect the light intensity. The Arduino board receives light intensity data and controls the servo to rotate the panel to face the sun straightly. For a standalone tracker, a battery need be provided to power the Arduino board. How to expand the system by making use of the output of the panel to charge a cell phone? Click here to learn more about a similar project.

Smart Gardening System (MS-ED, HS-ED: Developing and Using Models, MS-ESS, HS-ESS: Earth's System). In Las Vegas, the weather can be extremely hot but sometimes thunderstorms come suddenly. Your garden needs a more intelligent watering system. When walking in the neighborhood, you may encounter water leaking from the landscape on the street. Is it possible to detect the water leakage automatically? In this project, the students will develop a smart gardening system consisting of the end monitoring system, an irrigation controller, and a mobile APP. Each end node consists of a temperature sensor, soil sensor, a water level sensor, and an ESP32 node. The soil sensor detects the soil humidity and the water level monitor sensor detects the water leakage. The ESP32 board will send the collected data to a cloud server and control signals to the irrigation controller through WiFi. The irrigation controller consists of an ESP32 node and a switch to turn on the irrigation system. On the mobile APP, the data collected can be shown, a water leaking alarm can be notified, and a manual switch can set to control the irrigation controller. How to make this system expandable to a large community gardening system? Click here to learn more about a similar project.

- **Vex V5 Robots (FIRST Compatible)**

The following projects are implemented using the VEX V5 Robot and all codes to be implemented using Python programming language. The complexity of the projects on a scale 1~5 are specified along with description of the projects.

Project 1: Autonomous navigation of the VEX V5 Robot using proximity sensors in a complex environment. The robot should be able to navigate through the shortest path, from an arbitrary point A to point B. The robot should also be able to align to a given pose (direction). [1]

Project 2: Autonomous navigation of the VEX V5 Robot using image processing algorithms. The robot should be able to follow a line or guided lines using image processing algorithms. The robot should also be able to align to a given target object. [2]

Project 3: Autonomous navigation of the VEX V5 Robot using image processing algorithms. The robot should be able to navigate through the shortest path, from an arbitrary point A to point B using object/obstacle detection image processing algorithms. The robot should also be able to align to a given target object. [3]

Project 4: Autonomous navigation of the VEX V5 Robot using image processing algorithms. The robot should be able to navigate through the shortest path, from an arbitrary point A to point B using object/obstacle detection image processing algorithms. The robot should also be able to recognize locations using ArUco or QR Code image processing algorithms. The robot should also be able to align to a given target object using ArUco or QR Code. [5]