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 robot 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 11 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 Pet Feeder (MS-ED, HS-ED: Developing and Using Models, MS-PS, HS-PS: Waves and Electromagnetic Radiation) Pets require fresh food on regular time every day. Instead of remembering to feed them on time, it's desirable to have a smart pet feeder that can dispense food automatically on regular time. When people are traveling for a few days, with this device, they don't need to worry about feeding their pets. In this project, students will design such a system using the Arduino Uno board, a push button, a servo, a food container, and a timer. The timer is set to power on the feeder. When the feeder is on, the pet comes to push the button, the servo controlled by Uno will dispense fixed amount of food from the container. The push button can be set to take one or several pushes to be activated. This idea can be extended to make a smart pet toy which uses other type of sensor (like a LDR) mounted on a polyhedron. Click here to learn more about a similar project.

Automatic Habitat Environment Control for Pets (MS-ED, HS-ED: Developing and Using Models, MS-PS, HS-PS: Waves and Electromagnetic Radiation) Pets like reptiles need well control of their living environment like temperature and humidity level, especially in a dessert environment. It is difficult for people to constantly monitor and control the environment. Is it possible to design an automatic habitat environment control system for reptiles? In this project, the students will design such a system using ESP32, temperature and humidity sensor, mini fan, and a possible water misting system. The sensor will detect the temperature and humidity level in the habitat and send the data to ESP32 which will turn on the mini fan to lower down the temperature if it's needed. The water misting system can be added to sprinkle water mist when the humidity level drops down certain threshold. The owner can be notified through Bluetooth or WiFi if extreme condition occurs. 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 2 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 the WREbot robot car kit. The robot car kit contains a 3D wood frame, two motor-driven wheels, one power bank, one switch, 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. 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.

Obstacle Avoiding Robot An obstacle avoiding robot can be build with the WREbot robot car kit, Arduino Uno board, and one ultrasonic sensor.

Object Follower Robot An object follower robot can be build with the WREbot robot car kit, Arduino Uno board, one ultrasonic sensor, and two IR sensors. 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

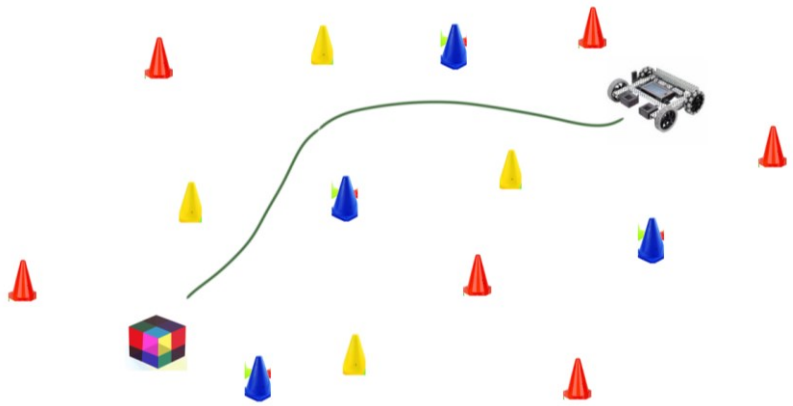
neighborhood, you may encounter water leaking from the landscape on the street. Is it possible to detect the water leakage automatically? In this project, the students will develop a smart gardening system consisting of the end monitoring system, an irrigation controller, and a mobile APP. Each end node 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**

The following projects are implemented using the VEX V5 Robot and all codes to be implemented using c programming language.

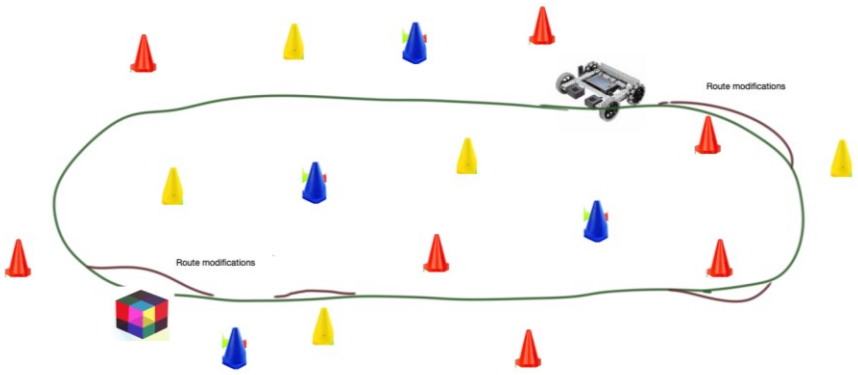
Project 1: Autonomous Exploration:

- The robot will use both proximity and vision sensors for this project.
- The robot should be able to navigate through the shortest path, from an arbitrary point A to point B. Points A and B are known.
- The robot should avoid objects (cones) on its path from A to B.
- The robot should also be able to align to a given object at B (not a cone) in pose (direction).
- Robot should count the number of colored objects (cones) on its path from A to B.



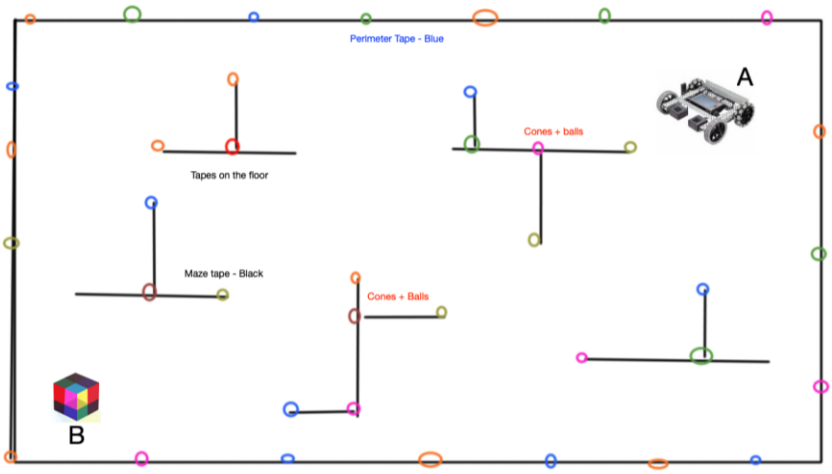
Project 2: Autonomous Line following Robot:

- The robot will use both proximity and vision sensors for this project.
- The robot should be able to follow between guided lines (road markings) using proximity and vision sensors.
- The robot should avoid objects (cones) on its path from A to B.
- The robot should complete the course with the shortest possible time.



<u>Project 3:</u> Autonomous Maze Navigation:

- The robot will use both proximity and vision sensors for this project.
- The robot should be able to navigate through a maze to reach a target/object, from an arbitrary point A to point B using object/obstacle detection using proximity and vision sensors.
- The robot should also be able to align to a given target object.
- The robots will use balls mounted in maze sides to optimally transverse the maze.



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