Enhancing Introductory Courses with Hands-on Projects

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Objectives

- Cooperate with UNL–CEEN
- Provide building/assembly experience
- Develop teamwork and supporting skills
- Expose students to programming
- Develop written/oral communication
- Actively engage students
Cooperation and Consistency

- UNL CEEN – Peter Kiewit Institute, Omaha
  - National Science Foundation (NSF) grant
  - CEENbot kits
  - Students use in all 4 years and in class

- WNCC
  - Intro to Engineering – build CEENbot
  - NSF Scholarship class – program CEENbot
  - Extensive support from UNL–CEEN
Students build CEENbot from kits

- $210 for basic kit
- $40 wireless remote
- $30 programming interface unit

Hardware assembly – small hardware
- Frame
- Stepper motors and tires
- Shock absorbers
Component circuit board soldering

Electrical component identification

- Transistors
- Resistors
- LED's
- Pins and I/O ports

Solder techniques (preparation and heat)

De-soldering! (solder sucker/wick)
Teamwork and Supporting Skills

- Cooperation and cohort/team building
- Organization
  - Communication and instructions
  - Documentation and inventory control
- Problem solving/troubleshooting
  - Correct assembly/soldering
  - Correct robot operation
Exposure to Programming

- C programming language (free compiler)
- Microprocessor level
- Basic sequence, selection and loops
- Simple paths
  - Square
  - Figure eight (definition and mathematics)
- Sounds (frequency and duration)
Modes (main loops and remote input)

- Bump bot – uses infrared sensors
- Tank – use remote to navigate
- User defined for simple paths or sounds

Hardware/software interaction

- Joystick imperfection – wheels always turn
- Software fix – widen joystick dead zone

Stepper motors – speed is position/time

```c
if (uiPSX_TimeoutCtr == 0) {  // process PSX activities since PSX is present
    ucSensorStatus = Read_Sensors();  // switch and IR bump sensor data
    Process_Sensor_Data();  // determine what to do with pressed switches
    if (ucOpMode == TANK_MODE) {  // turn on red LED
        PORTD |= (1 << PDS);
        // RESPONSE[8] is left stick forward and backward
        // RESPONSE[6] is right stick forward and backward
        // bit 7 = left
        // bit 6 = down
        // bit 5 = right
        // bit 4 = up
        if (response[8] < PSX_LOW_THRESHOLD) {  // if the left stick is forward
            Motor_L_DIR = 0;  // Set left motor direction forward
            Motor_L_Speed = Calc_Analog_Speed(PSX_LOW_THRESHOLD - response[8]);  // speed between 0 - 120
        } else if (response[8] > PSX_HIGH_THRESHOLD) {  // ELSE IF the left stick is back,
            Motor_L_DIR = 1;  // move left wheel back
            Motor_L_Speed = Calc_Analog_Speed(response[8] - PSX_HIGH_THRESHOLD);  // speed between 0 - 120
        } else {  // ELSE the left stick is near the center, so do nothing
            Motor_L_Speed = 0;  // Turn left motor off
        }
        if (response[6] < PSX_LOW_THRESHOLD) {  // if the right stick is forward
            Motor_R_DIR = 0;  // Set right motor direction forward
            Motor_R_Speed = Calc_Analog_Speed(PSX_LOW_THRESHOLD - response[6]);  // speed between 0 - 120
        } else if (response[6] > PSX_HIGH_THRESHOLD) {  // ELSE IF the right stick is back,
            Motor_R_DIR = 1;  // move right wheel back
            Motor_R_Speed = Calc_Analog_Speed(response[6] - PSX_HIGH_THRESHOLD);  // speed between 0 - 120
        } else {  // ELSE the right stick is near the center, so do nothing
            Motor_R_Speed = 0;  // Turn right motor off
        }
    }
}
```
Communication Skills

- Projects include written reports
  - Proper report format
  - Technical writing
  - Proper documentation (figures and tables)

- Oral reports
  - PowerPoint presentations
  - Should mirror written report but summarized
  - Oral presentation skills/practice
Conclusion

- Cooperation with UNL CEEN and support
- Building/assembly and soldering
- Build cohort groups and supporting skills
- Exposure to programming concepts
- Written and oral communication
- Energized and actively engaged students