Lesson Plan: Robotics & Industrial Controls

[This document is in revision and will be updated; the outline and course organization is largely complete. Please check back for updates]

Due to the class structure the overall yearly class/project will be split in half. Seniors will be allowed to commandeer single functions in the project as a senior project. All students will subject to quizzes and the maintenance of engineering notebooks followed by lab time work ethics and participation. Class configuration:

30-45min of instructional time on aspects they will be using

1. Engineering

    a. What is it

    b. Fields Covered – Geez don't have all month.

    c. Drawings

        i. Electrical

        ii. Electronic

        iii. Mechanical

        iv. Electro-mechanical

        v. Flowcharting

2. System level components/integration

    a. Electrical

        i. Hard programed vs. AI

            1. Dynamic

            2. Intuitive

        ii. PLC - Programmable Logic Controller

            1. A **programmable logic controller** (**PLC**) or **programmable controller** is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and

machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a *hard* real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.

2. When powered on I/O outputs are in a preconfigured state or the state they were in at power down.

iii. PAC – Programmable Automation Controller

1. A **programmable automation controller (PAC)** is a compact controller that combines the features and capabilities of a PC-based control system with that of a typical programmable logic controller (PLC). PACs are most often used in industrial settings for process control, data acquisition, remote equipment monitoring, machine vision, and motion control. Additionally, because they function and communicate over popular network interface protocols like TCP/IP, OLE for process control (OPC) and SMTP, PACs are able to transfer data from the machines they control to other machines and components in a networked control system or to application software and databases

iv. Computer

1. A **computer** is a programmable machine designed to sequentially and automatically carry out a sequence of arithmetic or logical operations. The particular sequence of operations can be changed readily, allowing the computer to solve more than one kind of problem. An important class of computer operations on some computing platforms is the accepting of input from human operators and the output of results formatted for human consumption. The interface between the computer and the human operator is known as the user interface.

v. Embedded Computer

1. An **embedded system** is a computer system designed for specific control functions within a larger system. often with real-time computing constraints. It is *embedded* as part of a complete device often including hardware and mechanical parts.

2. Embedded System: A specialized computer system that is part of a larger system or machine. Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface -- watches, microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an

operating system, but many are so specialized that the entire logic can be implemented as a single program.

b. Drive systems

   i. Motors & Controls

      1. DC

         a. Brushed - A Brushed Motor has a rotating set of wound wire coils called an armature which acts as an electromagnet with two poles. A mechanical rotary switch called a commutator reverses the direction of the electric current twice every cycle, to flow through the armature so that the poles of the electromagnet push and pull against the permanent magnets on the outside of the motor. As the poles of the armature electromagnet pass the poles of the permanent magnets, the commutator reverses the polarity of the armature electromagnet. During the instant of switching polarity, inertia keeps the classical motor going in the proper direction.
            i. A **commutator** is a rotary electrical switch in certain types of electric motors or electrical generators that periodically reverses the current direction between the rotor and the external circuit. In a motor, it applies power to the best location on the rotor, and in a generator, picks off power similarly. As a switch, it has exceptionally long life, considering the number of circuit makes and breaks that occur in normal operation.
         b. Brushless - A DC Brushless Motor uses a permanent magnet external rotor, three phases of driving coils, one or more Hall effect devices to sense the position of the rotor, and the associated drive electronics. The coils are activated, one phase after the other, by the drive electronics as cued by the signals from the Hall effect sensors, they act as three-phase synchronous motors containing their own variable frequency drive electronics.
            i. **HALL EFFECTS** refers to the potential difference (Hall voltage) on opposite sides of a thin sheet of conducting or semiconducting material in the form of a 'Hall bar' or a van der Pauw element through which an electric current is flowing, created by a magnetic field applied perpendicular to the Hall element. The ratio of the voltage created to the amount of current is known as the Hall resistance, and is a characteristic of the material in the element. Dr. Edwin Hall discovered this effect in 1879.
            ii. **VARIABLE FREQUENCY DRIVE** (sometimes abbreviated VFD) is electronic equipment that allows an electric motor to be run at varying rotational speeds.
            VFDs are frequently used to start large three-phase

AC synchronous motors. These motors cannot be started simply by applying line frequency mains power; the rapidly rotating magnetic field would be unable to overcome the inertia of the rotor (and any connected load). Using a VFD provides one possible means to start these motors: the VFD will start using a low frequency that the rotor can follow, ramping up the frequency as the rotor accelerates. And unlike other starting methods, the VFD also allows very efficient speed control once the motor is running (simply by varying the ultimate frequency of the supplied power).

  c. Stepper

2. AC

  a. 1-phase

  b. 3-phase

ii. Gearing

1. Concept reason

  a. Rpm

  b. Torque

  c. Calculating speed/torque

2. types

  a. Inline

  b. Planetary

iii. Belt/chain

1. Types of belts

  a. Pants

  b. SAE

  c. DIN

c. Motion control

i. Drivers

1. Current

2. Cooling

     ii. Feedback

     iii. PID

     iv. Filters

  d. Pneumatics/hydraulics – **SAFETY**

     i. Pressure

1. Pneumatic – 0-250psi

2. Hydraulic – 400-9+kpsi

     ii. fluid

     iii. Plumbing

     iv. Valves

     v. Pumps

     vi. Rotary motion

     vii. Linear motion

  e.

3. System level

  a. Factory level

     i. Material handling

1. Conveyers

2. AGV

3. Robots

  b. Process center

     i. Material handling

1. Conveyers

2. AGV

3. Robots

   c. Machine Cell

      i. Conveyers

      ii. Robots

      iii. CNC

      iv. Manual – ok humans allowed

4. Specialized components

   a. Jigs

   b. Clamps

   c. Automatic or manual

5. Conveyer systems

   a. Vision systems

   b. Barcode reading

   c. Object passes Y/N

6. Robots

   a. Mounted arm

      i. Degree-of-Freedom

         1. Axis

      ii. Types of bots

      iii. Actuation

         1. Electric

         2. Pneumatic

         3. Hydraulic

         4. Oh heck the combo mess

      iv. End-effector

1. What is it

2. Types

   a. Grabbers

   b. Vacuum pickup

   c. Custom clamps, hole grabbing

   d. Tools

      i. Grinders

      ii. Cutters

b. AGV – Automated/Autonomous Guided Vehicle

   i. Major components

   ii. Drive

   iii. Navigation

   iv. Weight

   v. Weight Distribution