LabVIEW and National Instruments (NI) Hardware
Tues, 14:00

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I. Introduction - Why LabVIEW?
II. Determinism
    A. Program Counter (Instruction Pointer)
        1. Top-down Code
        2. Campbell model - Programmable Logic Controller
    B. The real world doesn't always function in a timed loop. Many times real-world interaction is event-driven
        1. Counters (Anemometer, tipping-bucket rain gauge)
        2. Interrupt Service Routine (ISR) - 1989: Global Change data collection
        3. Fortunately, hardware manufacturers, Microsoft, Apple, etc., have handled much of the ISR coding necessary to write modern user applications.
III. Determinism through data flow programming
    A. Lucid - My first introduction
IV. LabVIEW (Laboratory Virtual Instrument Engineering Workbench)
    A. Data Flow Programming Language
    B. Originally Developed for Apple Macintosh
    C. Originally intended to facilitate the use of National Instruments hardware
    D. Has gained popularity as a general use language
    E. Interfaces available for a wide variety of third-party measurement and control devices
    F. Graphical Programming
    G. Graphical user interfaces
    H. Environment includes robust debugging tools
        1. Graphical depiction of execution
        2. Breakpoints (including conditional)
        3. Single-step execution
        4. Ability to probe variable values (No print statements necessary)
        5. Code profiling
V. National Instruments Hardware
    A. Broad array of platforms hosting varying measurement and control configurations
    B. Many platforms are modular
    C. Fast and accurate
    D. Greater acquisition rates allow for characterization and mitigation of noise
VI. Introduction to phenotyping platforms of Kansas State University (Kevin)
    A. System requirements: measure the canopy temperature, the canopy height, and canopy reflections at various spectral wavelengths
    B. Two platforms:
        1. Phenotyping Mobile Unit (PheMU)
        2. Hand held phenotyping unit (PhenoCorn)

C. PheMU design
    1. Three sets of sensors
        a. GreenSeeker – NDVI
        b. Crop Circle – NDVI
        c. Ultrasonic sensor – canopy height
        d. Infrared thermometer (IRT) – canopy temperature
    2. Two RTK GPS units
    3. A high-clearance sprayer vehicle
D. Data acquisition system design
    1. A laptop computer that runs a NI LabVIEW program to record the sensor outputs and save the data into text files
    2. Several types of hubs that extend the ports of the laptop to receive data from serial output sensors
    3. A NI 9207 analog input module that collects data from analog output sensors
E. Software development
    1. Front panels
        a. Setup
        b. Monitor
        c. Raw Data
    2. Block diagrams
        a. Sampling control module
        b. Sensor control module
        c. Data storage module

VII. Demonstration of collection on PXI-Express chassis

VIII. These tools (both Campbell and National Instruments) enable development, but… there are things to realize.
A. There are learning curves associated with each of them
    1. Data flow programming requires a significant paradigm shift
B. Moving beyond simple acquisition and control can require machine-level expertise