Coding and Mechatronics Short Course Outline

Michael Gallagher

Presenter: Michael Gallagher
Sessions: Three: April 30, May 7, May 14, 2019
Time: Tuesday 10:00 to Noon
Venue: U3A Bendigo, Room 1, St Mary's

Coding is the skill of making digital circuits perform tasks. Mechatronics is the discipline of interfacing digital control circuits with electro-mechanical devices.

Within a lifetime, digital systems and mechatronic devices have become all pervasive in government, industry, business and homes. A few examples follow. Doors open automatically as we walk towards them. Entry to secure facilities is controlled by systems fitted with biometric sensors. Microwave ovens offer a menu of ways to defrost, warm and cook a variety of dishes. Embedded controllers in washing machines offer options for how laundry will be washed, rinsed and spun dry. Vehicles computers are programmed to activate automatic braking systems, control engine emissions, monitor vehicle security, etc. Smart TVs, smart phones, tablets and PCs offer a vast array communication and entertainment options.

An understanding how the technology works is an asset for digital age citizens. To promote that end, education systems around the world have made coding part of the curriculum of primary and secondary school students. Many older citizens, on the other hand, have been caught by surprise and left wondering about how digital technology works. In the three sessions, how digital devices work and how they are designed and coded will be explained in every-day language and demonstrated by practical examples. Interest for the formation of a U3A Bendigo Coding Group will be gauged. Activities and projects that members may find engaging will be highlighted. (U3A Bendigo may make funds available for a coding group to purchase some equipment).

Session 1

An introduction to Electricity and Electronics

Static electricity

The study of static electricity began in earnest around 1650. Much was discovered about electricity in the next 150 years. Static electricity is generated by rubbing things together—amber with cat's fur, glass with silk. Friction machines were discovered. Statically generated charge can be stored in leyden jars (an early form of capacitors). Positive and negative charge was identified. The principle of charge conservation was discovered—if one body becomes positively charged, another must acquire an equal and opposite negative charge. Conductors and insulators were recognised. Leyden jars could be charged from storm clouds. The lightning rod was inventede. The force of attraction between unlike charged objects and the force of repulsion between like charged objects was recognised. Finally, it was discovered that the force between charged objects was proportional to the amount of charge and inversely proportional to the square of the distance between them. Up until the end of the 18th century, however, only transient currents generated by static discharges could be studied.

Electric circuits

Volta's momentous discovery of the voltaic cell in 1799 made the construction of electric circuits possible. It generated a continuous current and. He called the pressure that drove current around the circuit electromotive force (emf). Within two generations, electricity was put to work lighting lamps and heaters, powering telegraph systems, driving motors… The electrical units were defined and internationally recognised: emf: volts; current: amps; resistance: ohms, power: watts; charge: coulombs; capacitor capacity: farads.

- Charging a capacitor through a resistor - demonstrate
- Lighting a lamp - demonstrate

Electromagnetism

Electric currents produce a magnetic field

- Solenoid - demonstrate
- Electromagnet – demonstrate and discuss
- Electric bell - demonstrate

Electric motors work by energising coils so that their magnetic fields interact with permanent magnets or other energised coils.

- Simple Motor - demonstrate
- Stepper Motor Principle - demonstrate
- Pass out a hybrid stepper motor. Notice the magnetic detent.
- Reluctance Stepper Motor Clip - show
- Hybrid Stepper Motor Clip - show
- Arduino driving a stepper motor - demonstrate
- Raspberry Pi driving a pair of servo motors – demonstrate
- Makita impact driver - demonstrate
- Have you any stepper motors at your place?

Break for tea and Coffee

Electronics

Thermoelectronics

Up until the end of the 19th century, the flow of electricity was controlled by mechanical switches operated by external agents. In 1904, John Fleming invented the diode thermionic valve—an evacuated glass tube with a positive anode and a negative cathode. Electrons released from the heated cathode allowed conventional current to flow from the anode to the cathode, but current flow in the opposite direction was blocked. Four years later, De Forest invented the triode. He added a grid between the cathode and the anode. Small voltages on the grid could control large current flow from anode to cathode. At last, electrons could be used to amplify and switch currents—it became possible to create circuits that could control themselves.

Radio, television, radar, sonar and the first computers are some of the things that became possible.

Semiconductors

- Pass around some transistors
- Pass around a battery, LED and a resistor
- Transistor Action – step through
- Transistor Switch - demonstrate

Integrated circuits

- Pass around some ICs
- 555 Timer IC – demonstrate and discuss astable circuit

Microcontrollers

- Arduino—a microcontroller development board programmed via a PC attached to the device via USB
- Raspberry—a micro PC on a board designed to facilitate interfacing with external devices.
- Demonstrate programming the Arduino via the Raspberry Pi
  - Light a LED on the board
  - Light a LED on a bread board
  - 8-digt 7 segment display
  - LCD display
  - Stepper motor

- Demonstrate programming the Pan-tilt hat attached to the Raspberry Pi