Quadrature Decoding Circuit for Incremental Encoders with Bluetooth Output

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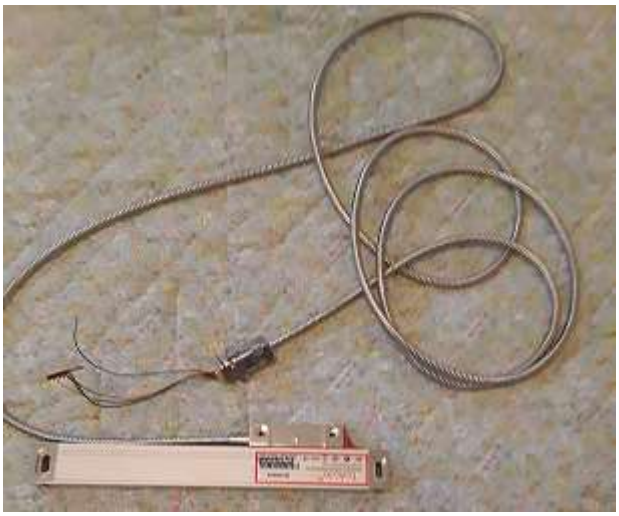
Purpose of the Project:

Design and build an Arduino circuit and code to track XYZ position from 3 incremental encoders and send the position via Bluetooth to an Android application. The Android application can zero or set the XYZ counts in the Arduino.

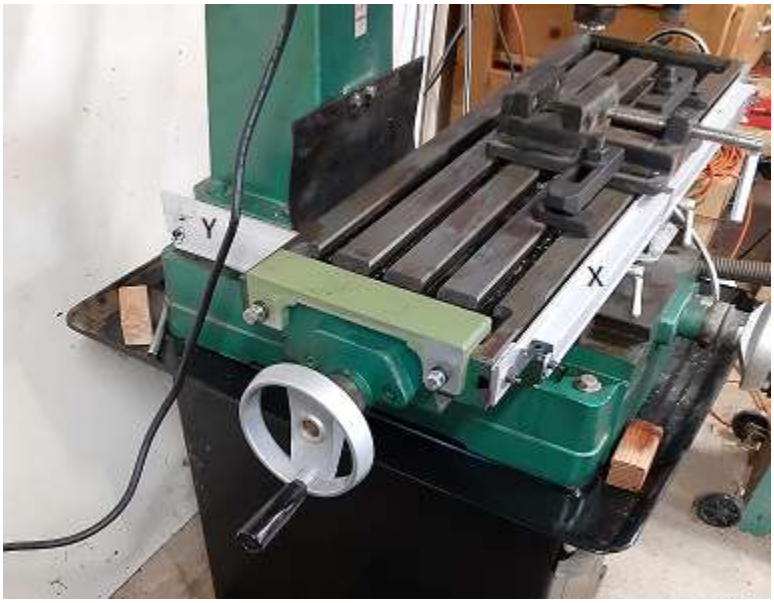
Incremental Encoders

A20 pulse per rev panel mount shaft encoder. Pins left to right Gnd, Vcc, Switch (not used), Signal A, Signal B.

A rotary shaft encoder with 600 pulses per revolution.



A linear incremental encoder 5 micron resolution. Connector is a DB9 but pinout varies by manufacturer. A mating DB9 connector was soldered to a header to connect to the prototype decoder circuit described.



Linear incremental encoders mounted on a vertical milling machine.

A commercial DRO display unit with plastic protective cover. This project duplicates portions of the display unit. The Android App is open source which opens the design to innovation.

The SDRO1 app included in this post adds the ability to read a pattern from a CSV file.

Information about Incremental Encoder Signals

Incremental encoders typically have power connections and two outputs A and B.

When viewed with an oscilloscope the A and B signals display as square waves that are 90 degrees out of phase relative to each other as the encoder position is changed.

The A and B logic values are displayed below. If A and B are exclusive-or'd, the result can be used to trigger an interrupt of the microprocessor. If A and B are combined into a base 10 number, the numerical sequence can be used to determine the direction to count.

A	B	XOR(A,B)	ABbase10
0	0	FALSE	0
0	1	TRUE	1
1	1	FALSE	3
1	0	TRUE	2
0	0	FALSE	0
0	1	TRUE	1
1	1	FALSE	3
1	0	TRUE	2
0	0	FALSE	0
0	1	TRUE	1
1	1	FALSE	3
1	0	TRUE	2
0	0	FALSE	0

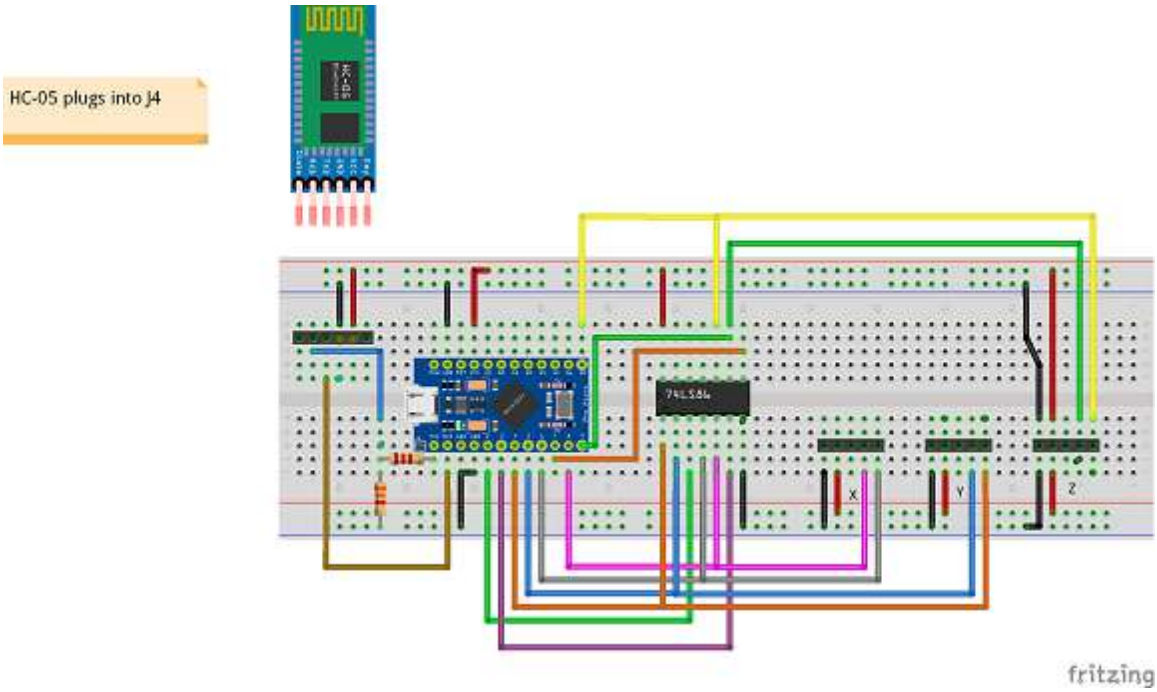
0	1	TRUE	1
1	1	FALSE	3
1	0	TRUE	2

Note: Swapping pins A and B reverses the counting direction.

A table is used by the interrupt service code to determine the direction to count.

```
int table[4][4]=
                        { 0,-1, 1, 0,
                          1, 0, 0,-1,
                         -1, 0, 0, 1,
                          0, 1,-1, 0};
void countx() {
    newvalx=digitalRead(pinXA)*2+digitalRead(pinXB);
    X+=table[newvalx][oldx];
    oldx=newvalx;
    flag=1; //signal main loop to send data change.
}
```

The circuit:



Fritzing Diagram of the Circuit, Power is supplied via USB cable. Red wires are +Vcc 5 Volts, Black wires are Ground.

Parts and Software:

1 HC05 Bluetooth Module

HiLetgo HC-05 Wireless Bluetooth RF Transceiver Master Slave Integrated Bluetooth Module 6 Pin Wireless Serial Port Communication BT Module for Arduino

https://www.amazon.com/gp/product/B071YJG8DR/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&psc=1

1 Arduino Leonardo

HiLetgo 3pcs Pro Micro Atmega32U4 5V 16MHz Bootloadered IDE Micro USB Pro Micro Development Board Microcontroller Compatible to Arduino Pro Micro Serial Connection with Pin Header

https://www.amazon.com/gp/product/B01MTU9GOB/ref=ppx_yo_dt_b_asin_title_o03_s01?ie=UTF8&psc=1

1 74LS86 Quad XOR gate

New 20Pcs SN74LS86N 74LS86N 74LS86 DIP-14 Integrated Circuit IC

https://www.amazon.com/SN74LS86N-74LS86N-74LS86-Integrated-Circuit/dp/B07WLT2X9F/ref=sr_1_4?dchild=1&keywords=74ls86&qid=1617393993&s=industrial&sr=1-4

1 6 pin 2.54mm connector for HC05

3 5 pin 2.54 connectors for outputs

3 Incremental encoders

Example choices of encoders. (Do some shopping for your application)

Rotary Encoder 20 pulses per rev

Taiss / 5Pcs KY-040 Rotary Encoder Module with 15×16.5 mm with Knobs Cap for Arduino

https://www.amazon.com/gp/product/B07F26CT6B/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&psc=1

Incremental Rotary Encoder, 600P/R Photoelectric Optical Rotation Encoder 5V-24V Wide Voltage Power Supply 6mm Shaft

https://www.amazon.com/gp/product/B08HVC4J5Y/ref=ppx_yo_dt_b_asin_title_o01_s02?ie=UTF8&psc=1

TOAUTO 2 Axis 3 Axis Digital Readout DRO Glass 5um Linear Scale for CNC Milling Lathe EDM Machine,100mm(4'') or 150mm(6'') or 200mm(8'') Travel Length

https://www.amazon.com/TOAUTO-Digital-Readout-Milling-Machine/dp/B086X9171J/ref=sr_1_3?dchild=1&keywords=linear+glass+scale&qid=1617449802&sr=8-3

1 Breadboard prefer solder type for reliability, or custom PC board

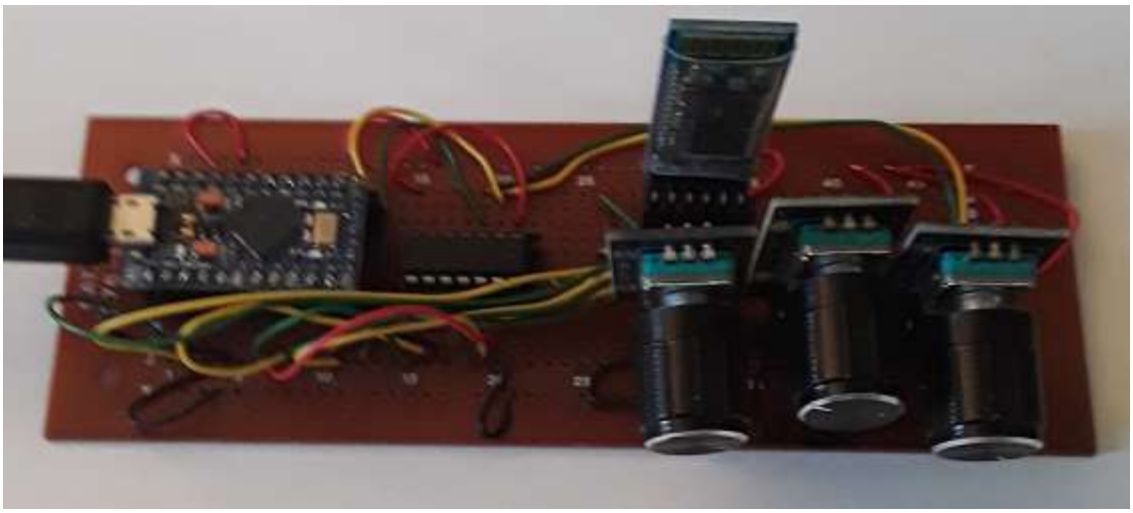
1 USB cable

1 USB power supply

1 Arduino IDE downloaded to PC or Mac

https://www.arduino.cc/en/software

1 Downloaded Arduino Sketch from this site.



A soldered breadboard of the circuit. The shaft encoders on the right side of the board can be unplugged and a connector to the linear encoders can be inserted.