On Constructing and Using a Precision Digital Facet Angle Display

Some 2 years ago I built a system to measure and display the faceting angle based on Tom Herbst's design published in Amateur Gemstone Faceting vol 2. This has worked well for me and was recently rebuilt and the software adapted.

Presented here is a brief overview of the construction and implementation along with my personal experiences using it. Arduino code and some further notes may be downloaded from ref [1].

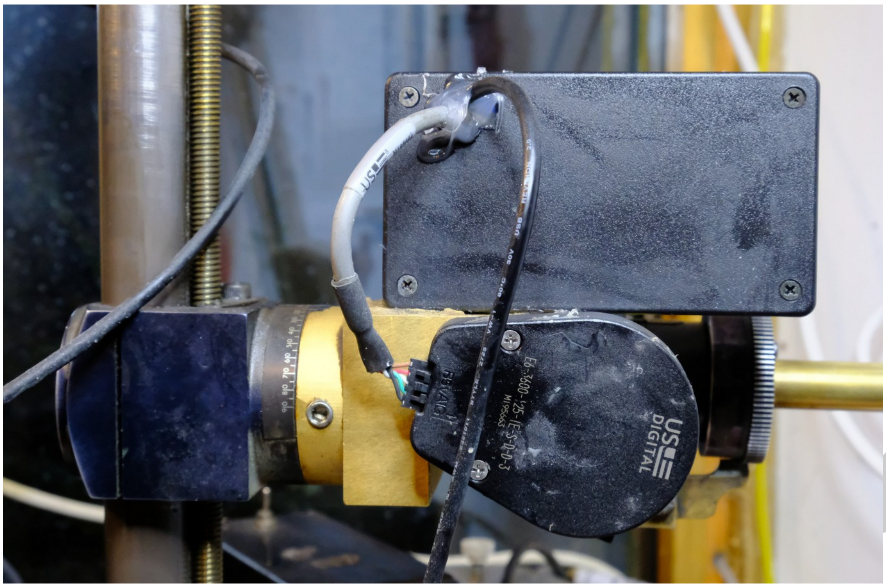
The Faceter

I use a Prismatic H-82 mast machine similar to the Polymetric Scintillator. Originally fitted with an

opto-electric angle indicator a previous owner had replaced this with a budget digital sensor/display of 1/10 degree precision. The faceter also sported a mechanical depth of cut indicator as well as my own Beale/Woolley d.o.c indicator.

As the digital sensor was somewhat erratic I decided to replace it with a more modern and precise device from the US Digital E6 series giving 1/40th degree precision. The sensor is monitored by an Arduino single board computer driving a large, bright OLED display.

The design of the faceting head allowed for relatively easy access to the spindle on which the faceting arm pivots. The optical encoder is attached to this, its disc rotating as the facet arm is raised and lowered. A combined power/data lead goes from the encoder to a box containing the Arduino and display. The system is powered by a usb lead from a simple mains adapter. Total cost is less than £180.



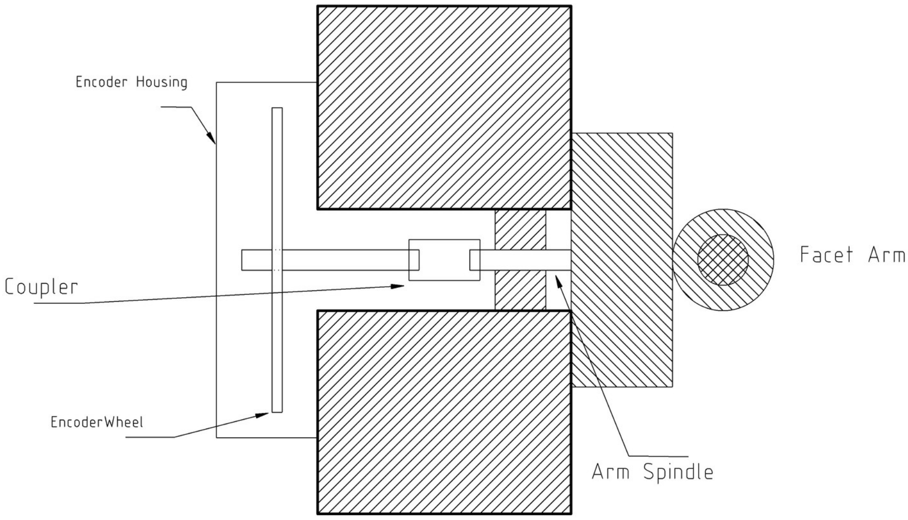
Back View showing encoder housing and display box

The Encoder

Typically optical angle encoders are clear plastic discs with a number of black spokes precisely printed around their outer edge. An LED shines through the spokes onto a sensor. As the disc rotates the light beam is repeatedly interrupted. Whilst one would initially assume that for 1/40 degree precision one would need 40 x 360 = 14,400 spokes ‘quadrature encoding’ reduces this to 3600. The disc I used also has separate index marks. At start-up the arm is rotated past this position calibrating the system to a known angle.

It can be difficult to select a suitable encoder. After much confusing research I choose the US Digital E6 encoder, a remarkably rugged and precise sensor which has performed flawlessly in a workshop exposed to wide temperature and humidity fluctuations for over 2 years. Postage from the US to UK is fast and reasonably priced though you will have to sign an end-user certificate. The software I have written should work with other manufacturers with a little modification.

Mating Encoder and Facet Head



This is the tricky bit! I was fortunate in having access to the arm's spindle. The encoder's spindle was attached to this using a small coupler. Then the encoder housing was simply glued to the rear of the facet head using silicone sealant.

Before embarking on a project such as this I would ensure that you can successfully mate the arm and encoder. US Digital can supply their encoders with a range of spindle lengths and diameters – it is important to get this right!

It is recommended to play with the sensor first so that you can set a suitable index position – mine is about 45 degree pointing upwards.

The Electronics

Here I began to diverge a little from Tom's excellent design. I used an Arduino Nano as opposed to Uno. The Nano is smaller and I recommend mounting it on a breakout board as shown. The allows connections from the encoder and to the display via screw terminals rather than soldered or push in pins. Cost of Nano and breakout less than £30 – considerably less if you want to use a clone. The Nano uses a smaller usb power/data connector than the Uno allowing it to be reprogrammed and configured via the one cable without having to open up the enclosure.

My initially display was a backlit LCD was per Tom's book. However at only about 1" square - this was a little too small for comfort. For the second build I replaced this with a budget Waveshare colour 1.5" OLED display (<£20). Coding for this alternate display was somewhat tricksy.

The Arduino Program

For the first build I simply used Tom Herbst's excellent program ('sketch') available for download from his website [4]. This required a little alteration as I was using a different display and encoder to his.

The Arduino is programmed via its' combined USB power/data cable from a PC. The Arduino programming tool (i.d.e.) is free and can be either installed onto a PC [5] as I did or run within a web-browser.

For version 2 I cut out a lot of Tom's functionality. As well as displaying the facet arm angle his program displayed the output of a Beale/Woolley d.o.c indicator and allowed one to store previous facet angles into temporary memory by pressing and holding a switch.

I had found that the 1/40 degree precision meant that I simply did not use either d.o.c. indicators at all.

Stored actual facet angles may have been useful however it required the use of a switch – and I wanted to simplify the system as far as I could. The switch also shifted the display to show the actual index count from the encoder which is useful when setting up as one has to manually determine the pulse count at 90 degrees.

Aside from the difficulty of shoehorning the switch into a suitable case the problem with storing angles cut is that the information is lost on power-off. There is a way around this but it greatly complicates the code. Instead I simply use a whiteboard.

So I lost the the switch , d.o.c. indicator, and the angle storing functionality simplifying both construction and the code. The larger display displays the facet head angle in large yellow numerals with the encoder count below in small green numbers for the rare time when that is needed. At boot-up the display indicates that the head has to be swung past the index point calibrating the system before an angle is displayed.

Boxing it Up

This is where I habitually fall down. I went through 3 enclosures before I also got it almost right. Wanting to mount the electronic/display box directly onto the faceter head I shoe-horned the display and electronics into a Hammond 1591XXBSBK (113 x 63 x 28mm) enclosure. The display was glued behind a cut-out with the front covered by an old camera screen protector. This as then glued onto the faceter head with silicone sealant.

Was it Worth the Effort?

For me – most definitely. I now have a system that is consistent and precise – unaffected by temperature shifts and not suffered from drift during usage. This system makes faceting faster and rather more enjoyable for me. I certainly still eyeball stones but I can rough & fine cut almost by numbers. Only when I get down to pre-polishing at 3 microns does the eye really take over. I did toy with ordering a new encoder disc to take the precision to about 1/80 degree however my lap flutter is above that.

Now out of sheer perversity, when funds permit I am looking at getting an Imahashi/Sterling platform faceter.

If you have an older mast machine you may wish to consider such a system. I would strongly recommend reading the sections in Tom Herbt's Amateur Gemstone Faceting vol 2 first. My Arduino code and further notes may be downloaded from [1].

Ian

Refs

[1] Ian's Construction Notes and Code

www.starfishprime.co.uk/downloads/downloads.html

[2] Waveshare OLED

www.amazon.co.uk/Waveshare-1-5inch-RGB-OLED-Module/dp/B07DB5YFGW

[3] US Digital E6

https://www.usdigital.com/products/encoders/incremental/kit/E6

I used a E6 Kit Encoder, 3600 CPR, 1/8" Bore, Index, Single-Ended (not differential output), Default Cover, Default Base, Individually Packaged.

Also recommend buying a cable Cable Assembly, Shielded cable, FC5 Connector to No Connector, 1 ft length (note – you may need a longer length if not mounting the display box onto the faceter head)

[4] Tom Herbst's Website

http://www.facetingbook.com/

[5] Arduino IDE

www.arduino.cc/en/guide/windows

[6] Arduino Nano (pre-soldered header pins)

https://store.arduino.cc/arduino-nano

[7] Arduino Nano breakout board.

EBay - as per image