Building a Barn Door Tracker using a kit of parts -see my finished tracker in action.

1. Kit contents and other parts

I supply kits and bits for these barn doors, but this page isn't about selling, it's about encouraging you to have a go and build your own.

Parts needed :

Barn doors (top and bottom doors) x 2 : 9 mm plywood.

Voltage regulator :12v input, 6 v (variable) output. I prefer a reduction geared motor over a stepper motor. Steppers can cause vibration in their movements, but once set at the right speed they are constant. But the circuit for a stepper motor is much more complicated, so it's down to you which to choose. The circuit I use requires more adjustment, but allows for a more accurate result WHEN you get it right.

Alignment scope mount and a Finderscope : just a cheap simple one - 5 x 24mm for example.- simple aluminium channel will suffice provided you can align it exactly along the axis of the hinge(s). My method relies on the channel having a pattern that allows holes to be carefully centered, so the resulting assembly is carefully aligned with the hinge axis.

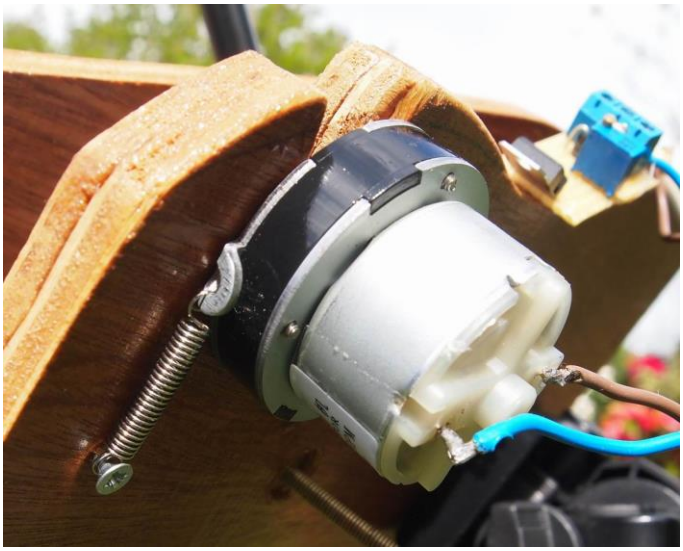
Curved drive rod and 4mm drive nut. You can hand curve suitable rod using this simple but very effective rig.

3:1 reduction drive cogs :these are hard to find so the ones supplied may vary from what's shown in the image - with fitted drive nut.

T nut (to attach tracker to a tripod) - standard is a 1/4" UNC T Nut that fits most non-pro tripods

Wooden mounting block for tripod ball head :The triangular mounting block is screwed and glued (by you) to take your preferred ball head mount. Alternatively you can use a metal camera mount post as used for CCTV camera - but beware, some CCTV mounts use a 5mm thread not a 1/4" UNC thread.

Specialist screws, bolts and nuts - #8 1/2" wood screws for your hinges (x 14), 4mm nuts (domed, winged and locknut), 5mm nuts and bolts for alignment scope (x2).



Drive motor : 6v 3rpm motor - such as this one

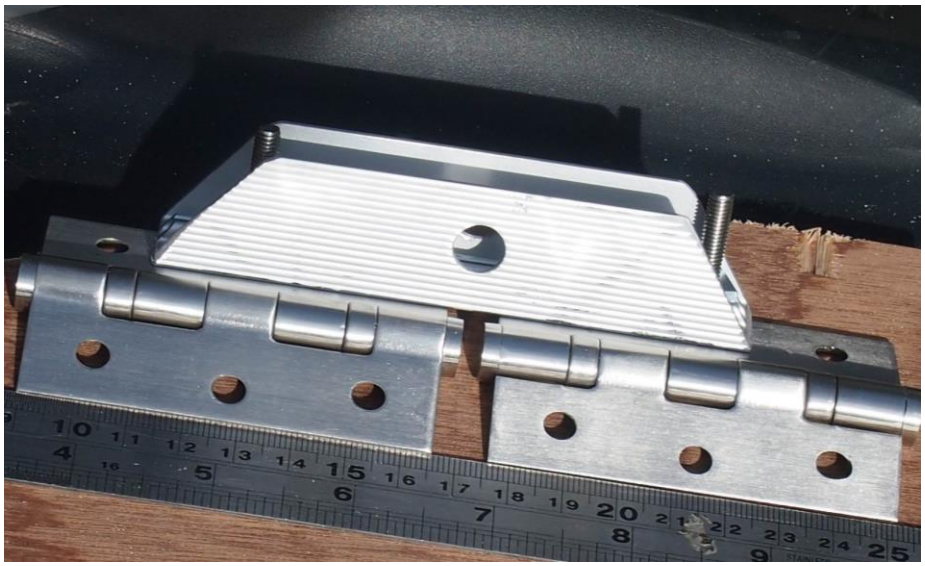
Hinges : 2 x 75mm hinges (I prefer stainless steel ball bearing hinges from Eclipse) You can use a single larger hinge, perhaps a 100mm

PART TWO

2. Assembly Instructions.

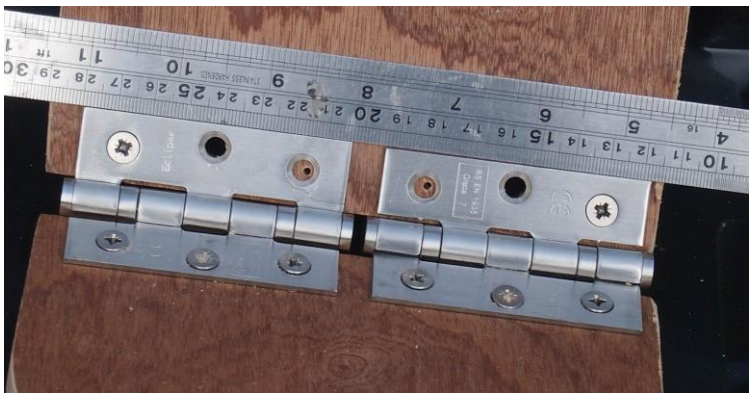
Basic assembly principles are to be as precise in your measurements as possible. Once the tracker is assembled there will be some variance in tracking but simple trial and error will allow you to eliminate these errors and determine if your tracker performs best at 60 secs per revolution, or 58.5 secs or whatever. See fine tuning section 4 below.

Step 1: Aligning the hinges. Bolt the finderscope bracket to the center holes of the two hinges. Holes have been drilled at approx 8.5cm spacing. This would fit 2 x 75mm hinges. Tighten the bolts as much as you can and align the hinges using a straight edge.



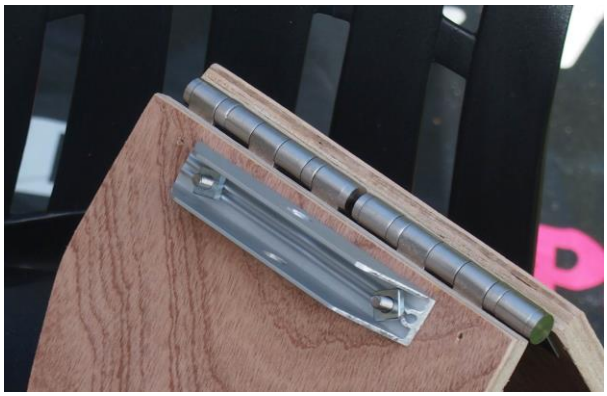
Step 2: Fasten the hinges to the bottom door with screws, checking the alignment before and after. The hinges should operate freely. If you use a single hinge then drill the finderscope bracket to suit your hinge.

Attach upper door. Unbolt the finderscope bracket and attach the upper door using screws. Check general alignment.



Remove the upper door and drill out the two center hinge holes (the ones that the finderscope bolts go through) using a 8mm or larger drill. Make sure the 5mm bolts are perpendicular to the hinge by bolting them directly to the hinges using nuts BEFORE re-attaching the top door.

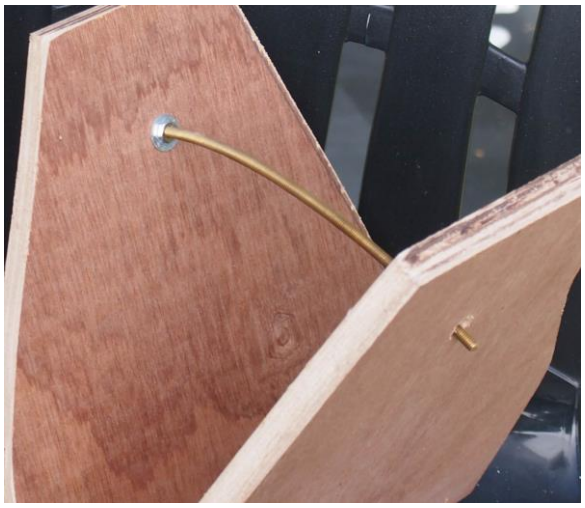
Reattach the upper door using screws and then attach the alignment scope mount using the additional nuts. This way the bolts are locked into alignment with the hinges and the finderscope bracket should be accurately aligned with the hinge axis.



The geometry of the attachment should result in the finderscope scope bracket being very closely aligned with the axis of the hinges. Check everything is true using a straight edge. Apply a little superglue or epoxy around the hinge edges etc to keep everything fixed in place.

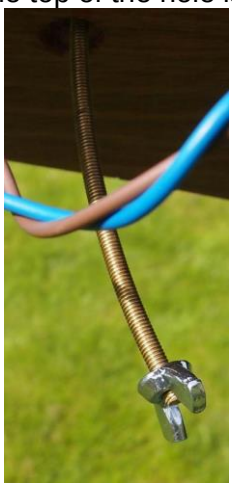
Step 3: Drive rod attachment. Using a compass or other means, mark a radius from a fixed point on each hinge onto the bottom plate. Where these radius marks cross is exactly in the middle between the two hinges. Repeat this with a different radius to give a 2nd mid-point. If these two midpoints are used to draw a straight line then that line is at 90 degrees to the axis of the hinge, and equidistant from the hinges. It is along this line that you will drill the guide hole for the drive rod.

Measure (as accurately as you can) 160.4mm from the center of the hinge axis, along the line and drill a 6mm hole. These hinges have a 10mm diameter axis, plus another 20mm of hinge. 10mm/2 + 20 mm = 25mm from the center of axis to the edge of the hinge. 160.4 mm from the center of axis = 25mm +135.mm. So I just measure 135.4mm from the edge of the hinge to drill the hole.



Glue the drive rod washer at this point. Try and get the center of the hole in the washer as close to 160.4mm as possible. The drive rod has a tendency to pull back and will scrape along this edge rather than sit in the middle of the hole.

Close the doors and using the hole as a guide, drill a fine (2mm) hole through the top door. This hole will become the mounting point for the drive rod. Drill out this hole in the top door to 4mm. Try and angle the hole slightly so that the top of the hole is a mm or so closer to the hinge than the bottom of the hole. This compensates for the slight curve in the drive rod and makes aligning the rod to go through the bottom hole easier.



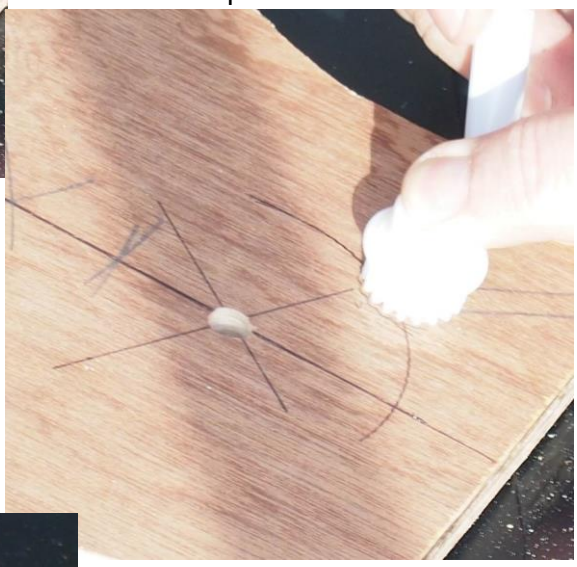
Fasten the drive rod in place using the nuts and washers provided. The rod should slip into the bottom hole with a little encouragement and the doors should (more or less) move freely. Use the dome nut and wing nut to attach the drive rod to the top plate.

A wing nut is supplied for the end of the drive rod to stop a camera overbalancing the tracker and flipping open the plates with possible disastrous results. Remove the drive rod (it will be reattached later once the rest of the work is complete).

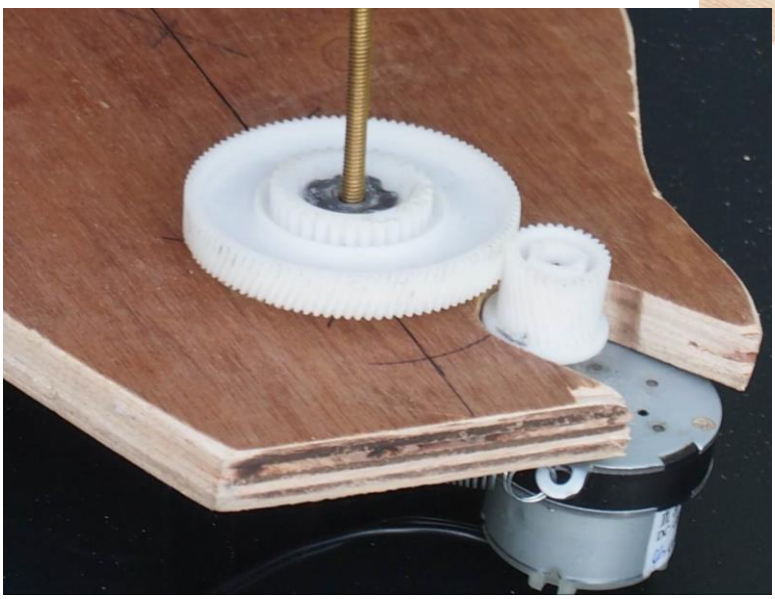
PART THREE

Step 4: Motor attachment. Using the large drive cog, mark the bottom door to show the circumference of the cog around the hole.

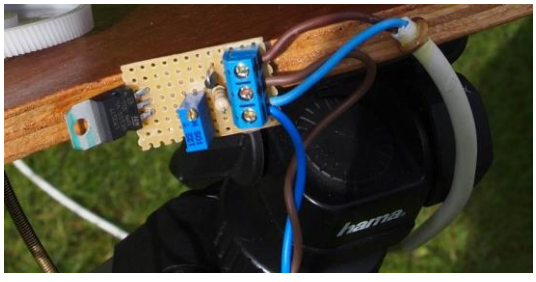
Using this small cog, mark the circumference with some overlap. This allows you to see where the motor must be positioned. Cut out



space for the small cog, mark the motor points including attachment for the spring. Assemble all the components so that the motor cog securely engages the rod cog.



Step 5: Electrical assembly. Attach the voltage regulator (if you want the circuit please email me for it). I prefer to attach it directly to the tracker using glue in such a way that the adjustment screw is easily accessible. You could however attach it inline along the cable to the 12v supply.



Solder leads to the motor, wire up the regulator and test that the motor revolves in the right direction. Note: V in goes to the positive of your

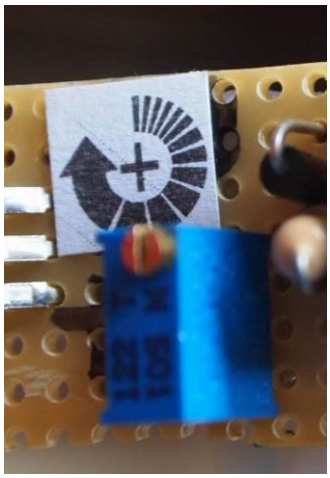
battery. Gnd has 2 wires. One to the negative of your battery and one to the motor. V out goes to the other lead of the motor. If the motor revolves the wrong way then simply swap around V out and gnd.

Which is the right way? The rod (larger) cog should rotate clockwise when looked at from above.

Step 6: Final assembly. Reattach the drive rod, power up the motor and check the rod cog rotates clockwise at approx. 1 rotation every 60secs.

I mark the cog so I have a visual reference when timing the rotation speed. Use of

the voltage regulator adjustment screw will allow you to fine tune the speed of the tracker and to iron out any errors in assembly tolerances. Clockwise speeds up the motor etc.



Step 7: Attachments. Fitting the attachment for a tripod is easier. Drill a 8mm hole in the middle of the bottom door, around 75mm from the hinge axis. Press the T nut into the hole from above. Your tripod should screw directly into this nut. If your tripod has a short thread you may need to recess the T nut so the thread can reach the nut.

Step 8: Mounting the ball head mount (BHM)

There are two ways of doing this. You can use a CCTV style postmount, in which case the postmount simply attaches with three screws to your tracker. It can be attached directly to the top door of the tracker, but I prefer to fit it to a wedge so that the mount post remains vertical once the tracker is aligned with the North pole.

If you want to use a more sophisticated ball head mount (BHM), then you will need to use a bolt to attach the BHM to the tracker. You can bolt it directly to the top door or mount it on a wedge. This revised wedge mount is made up of 3 components, plus a suitable bolt matched to your ball head – I cannot supply this bolt.

There are two outside wedges pieces and a central 9mm piece that can be cut out to accommodate the bolt head. Assemble with glue and screws.

The recess in the capping piece is filled with a hard glue to hold the bolt in place. The assembly is now glued and screwed onto the wedges (previously glued together).

The finished assembly is screwed and glued onto the tracker so that your camera sits slightly above the main body of the tracker.

Warning! - The ball head and the mounting block are all that holds your camera to the tracker. Please make sure that the assembled mounting block is strong enough to take the loading from your camera.

Note: Make sure there is enough space between the alignment scope mounting and the ball head mounting to allow the camera to move freely. My first attempt was too close together.

The alignment scope simply pops onto the channel where it can be attached by tape or a rubber band.

And that's pretty much it, apart from aligning (on Polaris) and calibrating the tracker speed.

Tracker speed alignment is a bit hit and miss. Keep altering it until you get round stars in your longest focal length lens. - sounds simple, but be methodical in your approach. My next page is about fine tuning your tracker - whether it's based on my notes or one you have designed yourself I'm sure there's something you can do to improve it.

FINE TUNING

General Notes:

Some of my suggestions below may help with barn door/scotch mounts of other designs - for example two arm mounts or straight drive rod mounts - variable speed mounts. But these hints and tips are intended for the curved drive rod single arm scotch mount as described by me in the pages above.

Construction Accuracy

Some parts of the construction need to be precise, others can be less so, but the overall approach has to be one of consistency otherwise your tracker will work fine one day, brilliantly another and be total rubbish a third night.

Things that have to be consistent:

1. The curve of the drive rod. 160.4mm is the target, but if it's a bit off then "we can compensate". But it must be the same curve throughout its length if you want to be able to use the full length. Mine are, but I still concentrate on using the same 25 - 50 mm length. After all, 50mm is good enough for more than 1 hour of continuous use. You cannot easily bend a rod by hand; you need some form of jig. So if nothing else think about buying your rod pre curved, or get a local machine shop to bend it for you.

2. Hinges should have very little free play in them. I use stainless steel ball bearing hinges for this reason. But some I bought from Ebay still had too much slack in them, so I only get them from a local supplier and I give them a good twist to ensure there is no free play.

3. The drive train - cogs, drive nut, push washer. These will be free moving under no load, but with the weight of the camera on them they should rotate consistently and the drive cog should not wobble too much. If the drive nut/push washer interaction is not smooth you may find that over a full rotation there is a variation in the tracking. This can show itself up as a trail at an angle to what would be a normal star trail, or the dimmer stars forming little hat shaped trails. This means the drive nut isn't smooth and even as it rotates.

4. Attachment to the tripod. Many modern tripods have a quick release mounting plate that unclips. This plate can often be a bit loose and this makes the tracker wobble a bit. I prefer to use old fashioned tripods that have a simple bolt on arrangement.

5. The load on the tracker. If are using a heavy lens and swing it from East to West you will change the apparent load in your tracker drive train. This may cause the tracker speed to change. You may have to recheck the speed if you suddenly get trailing images.

6. Tracker speed - the time taken for one full rotation of the driver cog. Once you have calibrated your tracker, always try and keep the speed as close to the ideal speed as possible.

Things that have to be accurate

1. The alignment of the finderscope axis to the hinge axis.

2. The alignment of the tracker to the north pole.

Things we can compensate for

1. Inaccuracy (but not inconsistency) in the radius of the drive rod, the exact position of the drive rod hole in the bottom plate. Some small errors always crop up as 160.4mm is a bit hard to achieve with basic wood working skills.

It's not a problem as all you have to do is accurately work out the best rational speed for your tracker. Do this using the longest lens you can and progressively longer exposures. I usually finish with a 1000mm lens and 60 secs exposure. If I get nice round stars with this I'm very very happy.

My last tracker produced ideal results with a speed of 58.17 secs per rotation, averaged over 10 rotations. I worked this out using a 100mm, then 500mm and finally a 1000mm lens, with exposures of 15, 30 and 60 secs.

2. Roughness in the drive train - emery or fine wet and dry can help make everything smoother running, as can a little grease on the drive rod.

Things to try

1. Set up the tracker and take a shot to the West or East with the tracker unpowered. This will produce a star trail so that you can see the direction of rotation.

2. Take a normal (tracker powered) photo with the exposure time. Compare the two images. If your tracker is at the wrong speed then you will get a trail, but the trail will be in the same direction as the unpowered trail. If it's at an angle then either the tracker is badly aligned or there is slackness/movement in the hinge or drive train.

You can combine the two approaches by taking a long exposure, initially unpowered and halfway through turn the power on. If there is too much movement in your tracker then as the motor takes up the slack the image will wobble all over the place, and perhaps set off at another angle as the trail completes.

For more guidance please try my notes on alignment and calibration