OnStep Upgrade to iOptron SmartStar PR EQ (CG5 class) Mount

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Last summer I decided to get my feet wet in astrophotography after having retired as an optical engineer-I didn't want my optical skills to go to waste. From a local amateur I acquired a used iOptron SmartStar PR mount (a CG5 clone) equipped with a GOTONOVA 8401 controller and dc servo motors with optical encoders, and a Meade Schmidt-Newtonian optical telescope assembly. The rig also came with a Shoestring Astronomy GPUSB and an iOptron ST4 adapter, as well as an iOptron GPS module, which was subsequently impaired by the recent GPS date rollover issue. Autoguiding was performed with an inexpensive Datayson T7C camera attached to an Orion Mini 50mm Guidescope under the control of PHD2 on an HP Pavilion laptop running Win 7. Image capture is with a Canon Rebel T6i DSLR.

While the setup performed ok, I was dissatisfied that the 8401 required that the Autoguide menu item has to be set in order to enable tracking using PHD2. This proved to be quite a nuisance since it wouldn't allow me to slew the telescope via computer interface, as when using APT or planetarium programs without action from the hand controller. This was especially inconvenient if I wanted to operate the system from the comfort of my warm computer room during cold winter nights. Furthermore, I found that my laptop computer had difficulty supporting more than two wired USB connections, even with powered hubs, whereas the existing setup required four.

When I discovered OnStep, I found that my issues might be solved—even at the expense of removing some $500 retail in hardware and replacing it with less than $100 in OnStep parts. My system now requires just two USB connections (DLSR camera and guide scope camera) and all other mount controls are through the OnStep WiFi interface to my laptop.

Modification of the mount was very straight forward. I didn't want to make any alterations to the mount, itself, and found that NEMA17 stepper motors (17HM19-1684S from Stepperonline.com) could be attached using bolts through the same mounting holes as provided for the original GOTONOVA equipment. The steppers were mounted in commercial stepper brackets from the supplier (ST-M1from Stepperonline.com), which themselves required the drilling of a hole in the right places. I also needed a 1/8" shim between the RA axis mount and the stepper bracket as the mounting surface was otherwise irregular—that came from my supply of model aircraft plywood. The subsequent spacing between the stepper motors and worm gears for both axes worked out to support a 20 tooth G2 pulley on the stepper axis, and a 60 tooth pulley on the worm gear using an 80 tooth (160 mm long) G2 belt. The pulleys came from RubberbeltsOnline.com (5mm-20T-6mm-GT2-Pulley, 6mm-60T-6mm-GT2-Pulley) and the closed loop belts (GT2 160mm) were found from an Amazon supplier. One could make their own custom closed loop belt, but that is not recommended.

Figure 1: Overall view of telescope and mount. Meade 150 mm f/5 Schmidt-Newtonian OTA, 50x162mm Orion Compact Guidescope and Datayson T7 guide camera, Canon T6i DSLR. An HP Pavilion DV6000 laptop is connected via WiFi to OnStep controller, and USB cables to guidescope and DSLR. PHD2, Astrophotography Tool (APT), and Carte du Ciel connect to the OnStep via ASCOM 6 POTH hub. SkySafari 6+ on a Google Nexus 7 tablet also controls the mount.

Figure 2: View of iOptron SmartStar PR EQ mount and OnStep STM32 'Blue Pill' and ESP32 SHC enclosures. Designs downloaded from Thingiverse.com com and 3D printed by a friend. With transparent case, the red power and green tracking LEDs are visible.

Figure 3: NEMA 17 stepper motor (rear) and bracket on DEC axis. Purchased from Stepperonline.com. The original iOptron GOTNOVA drive components were easily removed. They could be reinstalled to the mount if desired, as no changes were made to the mount itself. A clearance hole was drilled in the slot on the NEMA bracket to accommodate an M6 bolt and self-locking flange nut. In retrospect, I should have purchased steppers with shafts extending through both ends—allowing for a possible future upgrade of an optical encoder position wheel.

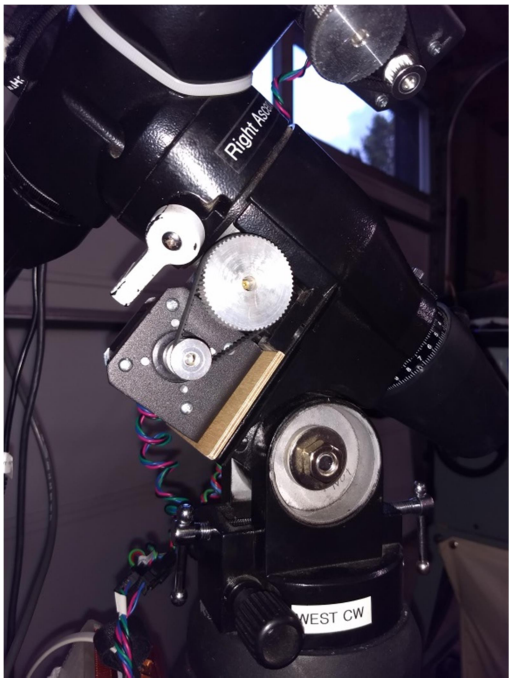

Figure 4: View of RA axis. 20 tooth (5mm hole) /60 tooth(6mm hole) timing gears and 80 tooth GT2 belt. NEMA17 Stepper motor/modified NEMA 17 bracket on 1/8" plywood spacer.

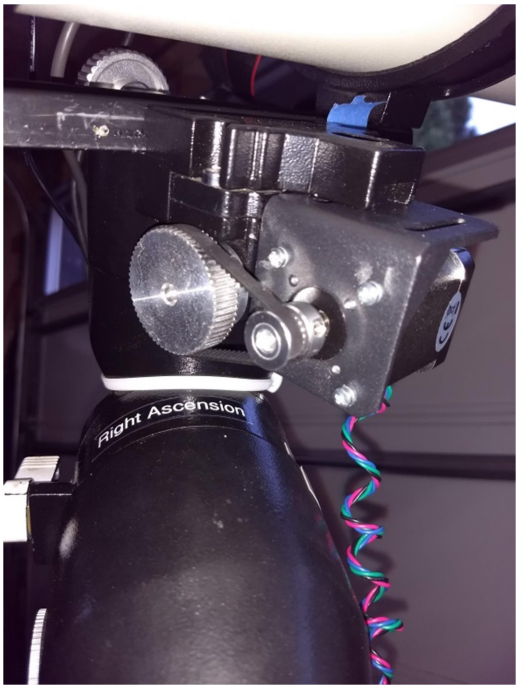

Figure 5::View of DEC axis. 20 tooth (5mm hole) /60 tooth(6mm hole) and 80 tooth GT2 belt. NEMA17 Stepper motor/modified NEMA 17 bracket.

Figure 6: M20 Triffid Nebula, 18x120sec subs. First astrophoto from OnStep-modified system. Seeing was sub-par, but I was able to lock onto and center the target using APT and plate solving.