Snap360

User's Guide

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Overview

The Snap360 is an electronically controlled turntable intended for automatic capture of panoramas, 3D Object VR, and wide area surveillance. It is developed specifically for photographic applications, which demand high structural rigidity.

The Snap360 incorporates the Harbortronics DigiSnap 2800 controller, a high torque stepper motor, and a high capacity battery pack. The DigiSnap 2800 synchronizes turntable rotation with the shutter release on a wide range of cameras, including the Nikon Coolpix series of digital cameras, and many SLR and D-SLR's.

The Snap360 is the base element of a very flexible system for automatic 360 degree photography. There are a number of optional assemblies already developed to tailor the Snap360 for particular applications, but the system is designed to allow the photographer to easily customize it for specific jobs.

Applications

Panoramas

The most obvious application for the Snap360 is for panorama photography, where a series of pictures are taken at different angles from the same viewpoint. There are software programs available that can convert that series of images into a larger, continuous image which covers the entire view. While it's certainly possible to take the series of pictures manually, the Snap360 automates the process, rotating to exactly the angle you configure, and takes the picture. Using image stitching programs is most efficient with a particular amount of overlap, and there is no tilt between images. If you do a lot of panoramas, the Snap360 allows you to set up and capture the images very quickly.

As with all photography, the lighting is a fundamental concern. You may want to take several series of shots with different exposures, and at different times of the day, and chose the optimum set of pictures. This is where the Snap360 really starts to get handy… take a set, adjust the camera exposure, and take another set at a single press of a button!

Panorama Virtual Reality (Panoramic VR, Virtual Tours)

Panoramic VR differs from a regular panoramic picture, in that a panoramic picture compresses the 360 degree (or subset) into a single flat image. A panoramic VR is a sort of a movie, where your view has a somewhat natural angle, and by moving the mouse, or simply letting the image scroll, it smoothly rotates your apparent viewing angle, like you are turning your head.

The term virtual tours comes from the real estate industry, where a series of pictures is combined to allow a person to 'feel' like they are walking through a house. In practice, the most common 'tour' is to simply stand in the middle of a room, and turn in a circle. This is an obvious application for the Snap360.

There are a couple other technologies commonly used to acquire these images. One way is to use a fisheye lens to capture an entire 180 degree hemisphere, rotate the camera 180 degrees and take a second picture. By conversion in specialized programs, the two images are combined to make produce a full 360 degree view. Another method is to use a very specialized curved mirror to take a full 360 degree picture in one step. The main limitation of these techniques is the resulting image resolution and distortion. The lens or mirror used to take these pictures is highly curves, and yields an image the must be highly manipulated to yield one suitable for viewing. Even with a high resolution camera, the details are not capture uniformly and the ability to zoom in and out is somewhat limited. For many applications this is not a problem, but given a larger set of high resolution images can only improve the final image quality. The Snap360 lets you take those images quickly and easily…

Object Virtual Reality (Object VR)

When taking panoramas, the camera is rotated to acquire a series of images in a circle. With Object VR, the camera is fixed in position, and the object of interest is rotated, with pictures taken from many angles. By putting those images together in software, you end up with a 'movie' that allows you to rotate that object by hand (mouse), allowing you to spin it back a forth to get a better sense of it than a single picture angle can give you.

By simply turning the Snap360 assembly upside down, the Snap360 becomes an Object VR turntable! Simply set the object on the Snap360, put the camera on a tripod next to it, and the camera will take a picture, rotate the object, take the next shot, etc. For people that take pictures of lots of objects for sale on the internet, such as Ebay, catalogs, etc., the Snap360 can save hours of manual work!

Likewise, you could attach the Snap360 at the top of the turntable, and suspend an object from the bottom, and perform Object VR of things that naturally hang down…

Combined Time-Lapse and Rotation VR

The Snap360 provides for a new sort of object and panoramic VR, that as far as we know, has not been much explored… time-lapse combined with rotation.

There have been many time-lapse movies made of plants growing… you see the seed germinating, the stalk rising above the soil, and growing into a full plant.

Imagine now doing that same sort of time-lapse process, only this time, using object VR. Once or twice a day, take a rotating series of pictures of the plant, and then make the same sort of 'movie'. You would then have a record of the plant from all angles as it grows. Instead of having one degree of freedom (time), you now have two…

Imagine then a new viewing program that allows you to move a mouse side to side to change the viewing angle, and up and down to change the 'age' of the plant. Imagine a sunset panorama… you can move the mouse to see the color changes on the hillside behind you, or watch the sun slip below the horizon. Watch a construction site being built, from any angle! Sounds like an opportunity for a new twist in virtual reality.

Surveillance

Surveillance cameras are becoming ubiquitous. You see them everywhere, and everywhere you go, they see you. Moving beyond the obvious controversy, let's look at the technology.

The vast majority of surveillance cameras are simple, low resolution video cameras, pointed in a single direction with a wide angle lens. Using a wide angle lens with low resolution video greatly reduces the chance of being able to pull recognizable features from the image, but it at least allows coverage over a good size area at low cost. Next up the quality scale are sweeping video cameras… instead of wasting much of the tape capturing the floor and ceiling with a wide angle lens, the area is more effectively monitored by sweeping the lens from side to side. The resolution is still limited, and the camera can only cover a limited angle.

For higher resolution images, consider the use of a digital camera. Typically the lowest resolution even on a cheap digital camera is VGA (video quality), and the resolution goes up dramatically from there. Images are stored within the camera, which can be good or bad, depending on the installation. Remote power, controls, and monitoring for digital cameras can be applied, but have not matured. The installation / operating techniques have all evolved for video cameras, so there are still a lot of opportunities left for using digital cameras in surveillance.

Consider a Snap360 mounted camera for surveillance. The camera can rotate around a full 360 degrees, so a single centrally located camera can cover a large area, with very high resolution. The system is autonomous, and easy to install & operate. Every day the battery can be charged, and the flash card downloaded for long term storage.

Extreme Environments

A very exciting application for the Snap360 is for underwater monitoring applications. Currently there are a few manufacturers of digital cameras for submersible operation at great ocean depths. Given the rapidly evolving state of digital camera technology, these underwater cameras are typically based on commercial digital cameras from Nikon and Sony, with additional circuitry and mechanical modifications to allow use within pressure housings. These systems are all quite expensive, as they require a great deal of engineering to develop. Note that Harbortronics already sells many controllers for several of these camera systems.

AquaPix LLC (www.aquapix.net) will soon be offering an underwater version of the Snap360 Tower, the SeaSnap360. The turntable / camera is mounted within a glass tube housing, and can be used at depths of several thousand feet. Given the relatively low cost technology used in this system, the product price will be only a small fraction of other commercial submersible digital cameras, all the while introducing 360 degree panorama capabilities to this industry! Fish surveys on coral reefs, sea floor observing, black smoker time-lapse, and other applications will be enhanced with this new system.

Given the relatively low cost and rugged nature of this housing, other opportunities on land may also apply. For instance, there are many sites around the world that are photographed periodically (time-lapse), such as construction sites. Each site is different, and a frequent problem is developing a housing that can withstand the outdoor environment. The SeaSnap360 may well have utility beyond deep sea utility.

Creative Applications

The Snap360 is a very rigid design, and as long the your setup is somewhat balanced, there's no requirement to keep the axis of rotation vertical.

Astrophotographers often perform photography mounted on a rotating platform oriented so that it's rotation axis points to the north star (Polaris), and at a speed which compensates for the earth's rotation. Comparison of photos over time can point out moving objects in space. While the Snap360 could easily be configured to rotate at this same effective rate (albeit nowhere near as accurately as a telescope system), there may be some clever applications for using different rates of rotation. One trick that comes to mind would be to generate artificial star trails. If you take a series of pictures of the stars near Polaris, you'll eventually see rotation around that point, as the earth rotates. If you orient the Snap360 so that it's axis of rotation is oriented toward another point, and rotate relatively fast, you can generate star trails around any point you like… how about the moon?
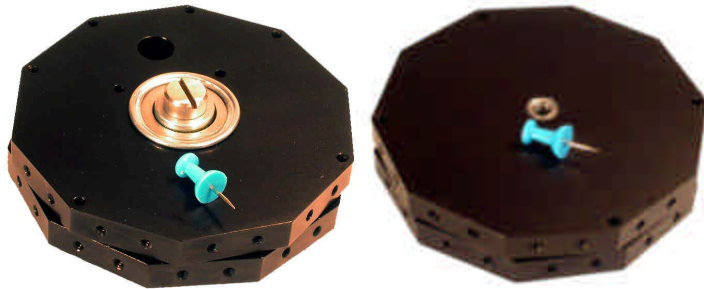
What sort of interesting shots can you dream for a camera rotating horizontally?

If you are feeling especially creative, consider the use of two Snap360's, one mounted on the other at 90 degrees, for an additional degree of freedom!

Snap360 Components

Turntable

The Snap360 turntable is made from a high strength aluminum alloy, and can support a great deal of weight and side forces. As a test, a turntable was mounted between large metal plates, and it was able to easily support a 180 lb adult, even standing 6 inches from t he center of the turntable, putting a large amount of unbalanced force on the bearings. While this is perhaps an extreme anecdote, it is clear that the turntable should be strong enough to handle any reasonable photographic application.

There are a variety of ways to mount devices to the Snap360 turntable. Around the edge of each plate are a series of #6-32 threaded holes. On the face of the plates are four more #6-32 holes. The bottom center of the turntable has a ¼-20 threaded hole, which can be used for mounting the entire Snap360 to a tripod, or other standard photographic mount.

Controller

The DigiSnap 2800 is a member of the popular DigiSnap 2000 family of digital camera controllers from Harbortronics. The DigiSnap 2800 has a variety of control features in addition to camera control. One connector is used to drive the stepper motor on the Snap360. Another connector is used for power connections; from the battery, an optional connection to power the camera, as well as switched power to optional lighting devices. There is also a connector for serial communication with a terminal (for configuration), or to a digital camera serial port for camera control. The final connector is used for control of SLR cameras which have a connection for an electrical switch type of remote control. This includes all Nikon cameras which have the 10 pin connector, Canon cameras which use the N3 or 2.5mm stereo jack connectors, and others. Harbortronics can provide adapter cables to control these and other cameras.

For detailed information on this highly flexible controller, please refer to the DigiSnap 2000 user guide.

Battery

The Snap360 includes a 12 volt, 4 amp-hr rechargeable nickel-metal hydride (NiMH) battery pack. This provides 48 watt-hours of power, which is ten times that of a standard Coolpix camera internal battery. This battery powers the DigiSnap 2800, the stepper motor, and a number of optional devices, so the battery charge life will depend on the application.

A high quality battery charger is provided with each battery pack. The charger is attached to the end of the white cable located in the space above the stepper motor. With the switch (located above the stepper motor) in the Off/Charge position, the battery is disconnected from the system, and connected to the charger cable. Note that the high capacity of the battery pack means that it will take several hours to charge if drained. The battery charger is an Ansmann ACS-410, customized with a different connector.
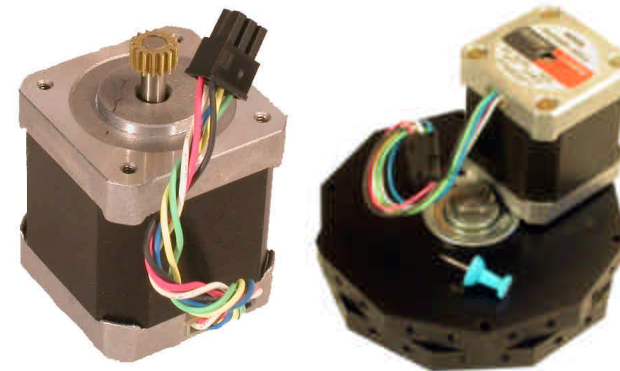
With the switch in the On position, power is applied to the controller, and optionally the camera.

Stepper Motor

A stepper motor may not be familiar to many people. Like most motors, the shaft rotates, but with a stepper motor, the shaft rotates in discrete steps, rather than in continuous smooth motion. This means that the motion seems jerky, but that's of no consequence for the Snap360, as the motor only rotates between pictures.

The Snap360 uses a high quality stepper motor, Oriental Motor p/n PK245M-03AA, customized at Harbortronics for use with the Snap360. The motor rotates 0.9 degrees per step and the Snap360 turntable uses a gear ratio of 1/6, so that the turntable rotates 0.15 degrees per motor step, or in other words, each rotation of the turntable requires 2400 steps of the motor. This number becomes useful in later sections.

Snap360 Optional Components

Snap360 Rail

The rail options provide a simple yet flexible way to mount a camera to the Snap360 turntable for automated panoramic photography. The pictures below are of a Coolpix 5700 camera mounted using the short rail (approx 10 inches) option, and the tripod head rail mount. The rails, mounts, and tripod heads provide an extremely rigid mounting system well suited for photography.

The tripod head supplied is a Bogen 3025, which allows rotation around three independent axes. This combined with the sliding mounting plate allows essentially any camera to be mounted in most any reasonable position, with no camera specific adapter plates required. The pictures above show the camera in both portrait and landscape orientations, with the lens nodal point aligned with the center of rotation.

Given the longer rail (approx 20 inches) option, additional devices can be mounted, such as lighting or even other cameras for stereo operation. The picture below shows a stereo configured pair of Coolpix 990 cameras. Note that the Snap360 controller (DigiSnap 2800), can be used with the Harbortronics StereoSnap to control more than one camera at the same time.
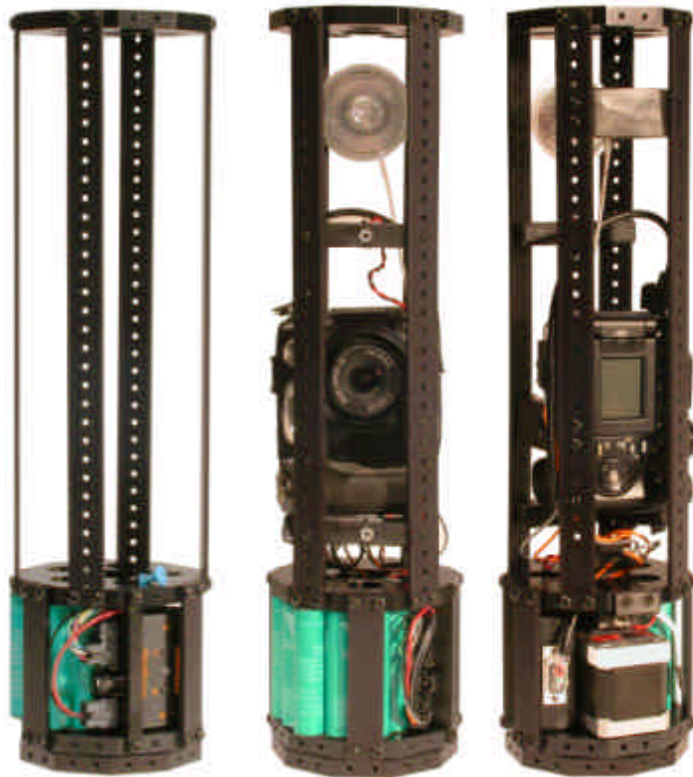
Multiple lamps, or strobes could be assembled using this system, creating a 360 degree monitoring system that works day and night.

Snap360 Tower

An alternative to the rail mounts is the vertical tower configuration, which is intended to attach components into fixed, repeatable positions. This approach proves some mechanical protection for the mounted devices, and minimizes the size of the structure. The tower is made from 12 inch long vertical bars with holes located every 3/8 inch. These holes are drilled to accommodate #4 or M3 screws. The Snap360 tower option includes four vertical bars, in an arrangement which suits the accessory mounts, described in the next section. With the four bars installed, the structure is extremely rigid, and it's possible to configure the tower with a different number of bars, or positioned in alternate arrangements for other equipment. The picture on the left (below) is of the tower option with no mounts installed, and the center and right show several of the developed mounts for a particular system configuration.

Tower Mounts

Harbortronics has already developed several specific mounting brackets, and can develop additional devices as required. Please contact us if you have specific needs.

MR16 Lamp Mount

A commonly used lamp format is the MR16. Most MR16 lamps are available for 12V operation, with a variety of wattages, and beam angles. Note that the DigiSnap 2800 can switch up to 60 watts of power, timing the lighting to illuminate the scene only when needed for the photograph. The pictures below show the mount developed for these bulbs. The mount consists of a bracket that attaches to the vertical bars, a spring loaded bulb fixture, and a short cable for attaching to the DigiSnap 2800 power cable assembly.

Laser Mount

Some applications may find utility in having a laser beam, or pair of laser beams visible in each picture. Harbortronics has developed a mount for a small laser diode module, which can also be powered from the DigiSnap 2800.
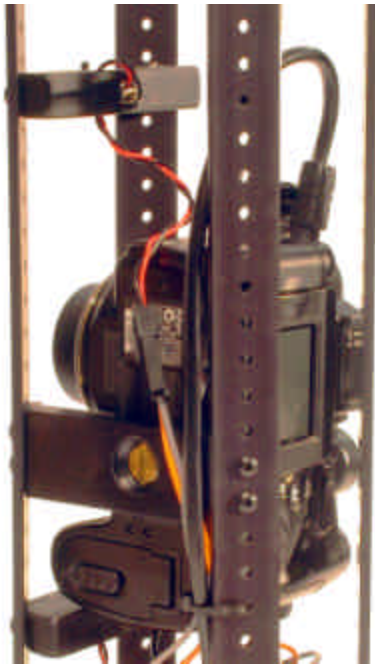
The pictures above show this laser mount for the vertical tower. The picture on the right shows a dual configuration, which can be used to place a pair of dots in each image with a fixed separation distance, providing a measurement reference. Each laser mount has set screws for fine adjustment of the laser beam direction.

Coolpix 5400 Mount
The vertical tower provides enough interior room to mount some cameras. Harbortronics has developed a very simple mount for the Coolpix 5400 digital camera, which still allows access to most of the camera controls and displays. This camera (among others) can be controlled by the DigiSnap 2800. The camera can also be powered from the battery pack, making a very nice integrated package.

Strobe Mount
Harbortronics is currently developing a 100 watt-second (joule) strobe and mount for use with the tower configuration.

Cable Sets

Power Cables

Three power cables sets have been pre-defined for purchase, but Harbortronics would be happy to build other cables as required. The battery voltage, both switched and always on, as well as a +5V supply are all available.

Basic Power Cable
The most basic power cable simply connects the battery to the controller, via a power switch (located above the stepper motor).

Standard Power Cable
The standard power cable adds three additional connections to the Basic Power Cable to power external devices, in concert with the shutter release operation. For example, if connected to the MR16 option, or the Laser option in the Tower configuration, these devices will be powered on just before the camera takes the picture, and shut off again after the image is saved.

Coolpix Power Cable
The Coolpix power cable adds a connection to the Standard Power Cable that can be plugged directly into the external power jack of any compatible Nikon Coolpix camera, to apply the 12V battery voltage to the camera. Note that many of the Coolpix cameras have been tested at 12V, and found to work OK. Refer to the External Power PDF on the Harbortronics website for more details.

Camera Release Cables

The DigiSnap 2800 was designed to work with two classes of camera. Many low-to-medium cost camera models include a set of remote control functions via a serial port. In particular, this includes most of the Nikon Coolpix line, as well as many older Olympus cameras. All DigiSnap 2000 controllers are compatible with these cameras.

In addition to serial control, the DigiSnap 2800 has an isolated 'switch contact' output signal which is compatible with camera designed for optional electrical/electronic release cables, such as most SLR (Digital and Film) cameras. This includes all Nikon cameras with the '10 pin connector', all Canon EOS cameras, etc. We generally make these cables to order, so we can make them to various lengths as required.

Nikon Coolpix 8 pin cable adapter
Compatible with Nikon Coolpix 880, 990, 995, 4300, 4500, 5000, 5400, 5700 cameras.

Generic Serial 3 pin cable adapter
Compatible with Nikon Coolpix 700, 800, 900, 950 cameras, and Olympus digital cameras with serial ports.

Nikon 10 pin cable adapter
Compatible with any Nikon (or derivative body) SLR camera that has the standard 10 pin connector.

Canon mini plug adapter
Many Canon SLR cameras use a 2.5mm stereo jack, for use with the RS-60E3 remote release cable. These cameras are all compatible with the DigiSnap 2800.

Canon N3 adapter
Most of the other Canon SLR cameras use a 3 pin connector (commonly referred to as N3), for use with the RS-80 remote release cable. These cameras are also compatible with the DigiSnap 2800.

Other Cameras?
If your camera has *some* means of remotely controlling the shutter release, we can almost certainly develop an adapter for your camera. For example, older cameras with mechanical cable releases can be controlled via a solenoid arrangement. These would be more expensive to build, but still, it can be done!

Using the Snap360

The DigiSnap 2800 controller can be configured for two different time-lapse processes, for rotating the turntable in various ways, and controlling external lighting. The DigiSnap 2000 user guide describes the details of how to configure the controller, so this section will describe what can be done.

Time-Lapse Operation

In order to take a series of pictures, the time-lapse feature of the DigiSnap will be used. There are two different time-lapse modes available with the DigiSnap, Simple Time-Lapse, and Advanced Time-Lapse.

Simple Time-Lapse

With Simple Time-Lapse (STL), the DigiSnap will take a number of pictures, with a delay between each. In many applications, this will be the best way to use the Snap360. For instance, if you want to make a single 360 degree panorama having 10 pictures, you would configure the time-lapse settings to take 10 pictures, with a zero second interval (0 hours, 0 minutes, 0 seconds). In practice, it will obviously take longer than 0 seconds to take the picture, store it, and then rotate to the next position, but configuring the DigiSnap for a zero second interval simply allows it to operate as fast as it can.

You could set the DigiSnap's operating 'mode' a couple of ways… if configured to operate in 'Simple Time-Lapse Mode', then when you wake up the DigiSnap (turning the power switch on), it will automatically take the 10 shots, and then shut itself off. For many applications, this might be the easiest way, allowing you to send the equipment off with an assistant, and not have to explain how to 'use' the DigiSnap.

If the DigiSnap is set up for 'Single Shot Mode', then the DigiSnap will not do anything when it is powered on, except for initial setup operations with the camera. This can be useful in many situations where you may want to perform some particular camera setup before starting the sequence, such as zoom or exposure lock. When ready, simply press the time-lapse control button on the DigiSnap, and it will start taking pictures. When finished, it will revert to idle.

Advanced Time-Lapse

The Advanced Time-Lapse (ATL) function allows triggering the capture of images at particular times of day. Up to eight different STL sequences can be defined, such as… take 20 shots with 20 second interval, starting at 9:15 AM, then 10 shots with a different interval at some other time of day or night.

ATL can be extremely useful for a range of long term image collection applications, such as animal monitoring, construction documentation, work flow

analysis, etc. By configuring the DigiSnap appropriately, a panoramic image of an entire area could be collected several times a day.

As with STL, the DigiSnap can be configured to start the ATL process when it is turned on, or manually via a button press.

Note that the DigiSnap 2800 does not have an internal clock… the time of day is determined from the time stored in the camera. If the camera cannot report the time of day through a serial port connection, the DigiSnap will set the time to midnight. This allows the ATL mode to still be used with SLR cameras, with some additional work for the user to calculate the correct time offset depending on when the ATL process starts. Contact Mark at Harbortronics if you need help.

Motor Control

The DigiSnap 2800 has a wide range of stepper motor control features as well. As mentioned previously, a stepper motor rotates in discrete steps. With the Snap360, there are 2400 steps needed for a full 360 degree rotation of the turntable. The fundamental process of the Snap360 is to take a picture, rotate a certain amount and take the next picture. The number of steps between pictures can be configured in the DigiSnap 2800. For instance, if you wanted to take a series of shots such that 10 images were collected per complete rotation, then you would configure the DigiSnap to step 240 times between pictures (2400 / 10 = 240). The Snap360 was intentionally designed so that a wide range of shots per rotation would result in whole numbers of steps, so that there will be very good repeatability from sequence to sequence.

Shots per rotation	Steps per picture
2	1200
3	800
4	600
5	480
6	400
8	300
10	240
12	200
15	160
16	150
20	120
24	100
25	96
30	80
32	75
40	60
48	50

Another characteristic of a stepper motor is that it has maximum torque at low speeds. Given that the Snap360 must start and stop the camera system for each step, this is a good thing! At higher speeds, then it's power drops off quite a bit. If operated too fast, the motor will eventually not be able to keep up. With the Snap360, a reasonable speed to operate is about 100 steps per second. This keeps the motor torque high, while allowing the Snap360 to rotate fairly quickly. The motor speed can be configured with the DigiSnap 2800. Given the way the DigiSnap works, the speed is defined as a number of milliseconds per step rather than steps per second… to calculate the time between steps, divide the number of steps per second into 1000… i.e. 1000 mS / 100 steps per second = 10 milliseconds per step. Depending on your particular application and setup, feel free to vary this speed… you will not hurt anything!

A nice feature of stepper motors compared to most other motor types is that the stepper motor tends to hold it's position between steps. In most setups, there is no external force acting on the camera setup, so this natural holding force is enough. If additional holding force is needed, the DigiSnap can be configured to apply power to the motor between steps, so that it holds position very solidly. This draws a lot of current from the battery, and heats up both the motor and the DigiSnap 2800, so you may want to leave this for situations where it's absolutely required, i.e. when the system is tilted, and not perfectly balanced.

Turntable Rotation

Unlike most motorized turntable systems, there are no cords to get tangled when the system rotates, so the Snap360 can be rotated in either direction, continuously! The direction of initial rotation can be set by the DigiSnap 2800.

Some applications may not require a full 360 degree field of view. The DigiSnap 2800 can be configured to limit the rotation, sweeping a camera over a defined range of rotation. Given that there are no mechanical stops on the Snap360, the DigiSnap uses it's starting position as the center of this range. The DigiSnap would be configured with the number of steps to rotate in either direction, from this starting point.

There are two ways that the Snap360 can be configured to sweep inside this range, back and forth, or unidirectional. If set for back and forth, the Snap360 will rotate to one limit, and then start rotating back the other way. The resulting collection of pictures taken this way (some sweeping clockwise, others counter-clockwise), might be confusing, particularly if the images are then stitched together into panoramas.

The unidirectional sweep operates by stepping in one direction until one limit is reached, and then cycling all the way back to the other limit, and taking pictures again from that point. This way the resulting picture sequence will all appear to be 'moving' in the same direction.

Service / Warranty

All Harbortronics products are warranted against any manufacturing defects for a period of one (1) year from the date of purchase. Defective products should be returned prepaid to Harbortronics. Harbortronics will at its discretion, repair or replace such products without charge, and will return to the customer prepaid. Except as mentio ned above, no other warranty expressed or implied, applies to this Harbortronics product. All other claims, of any nature, including but not limited to camera damage are not covered. This warranty does not cover damage caused by misuse, accident, or abuse. This warranty does not cover consequential damages or other incidental damages. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusions may not apply to you. Contact Harbortronics at www.Harbortronics.com for service instructions.