WDPS Software / WDPS LLC

Cat Bowl Monitor2 – Prototype Testing

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Thank you for agreeing to help test the Cat Bowl Monitor prototype. All of the necessary components required to operate the prototype are provided and this document will hopefully explain how to set up the prototype and use it.

You are authorized to use the provided prototype for the duration of the testing period (which is TBD). Please do not share the documents or components of the prototype with others without permission. If the feeder isn't working for you or you no longer wish to test it, please return all major components and the documentation.

The prototype was developed by, and is the sole property of, WDPS LLC, Joe Mattioni, 4163 Spalding Drive, Perkasie, PA 18944, Cell: 215-498-5282.

If you have questions about setup or operation of the prototype please text or call Joe Mattioni. Thanks.

What is It?

Cat Bowl Monitor is an experimental automated cat feeder that can control a cat's access to food in the feeder. The feeder uses AI (Artificial Intelligence) Machine Vision models to detect and recognize cats in front of the feeder. Once a cat is recognized, the feeder will allow or deny that cat access to the food in the feeder according to how you have the feeder configured.

How Does It Work?

The current implementation is a prototype that makes use of as many off-the-shelf components as possible. A commercial version of this feeder would be much more integrated.

The cat feeder bowl is a modified, commercially available feeder with a motorized cover. The modifications to this product enable the bowl cover to be controlled by a mobile phone via Bluetooth.

The brains of the feeder are in an app installed in a mobile phone provided with the feeder (hereafter called the "cat bowl phone"). The app sees a continuous video feed from the camera when it is in Run Mode (more on that later). There are two different AI Machine Vision models running in the app. The first model continuously processes the video feed looking for cat faces. When a cat face is detected that model crops the image to isolate the cat's face. The cropped image is then passed to the second model whose job it is to recognize the cat based on images of each cat selected by you during the training process. If a cat is recognized then the action specified for that cat (bowl open or close) is executed.

Component Placement

Here's what's been working. Feel free to experiment, but keep in mind that changes to the camera's view and lighting may impact any existing training. New and/or different train images may then be required to restore recognition accuracy.

The phone and light are mounted on a metal stand (actually a large bookend) placed behind the cat bowl. Leave a gap between the phone and the back of the bowl. If the phone is too close to the bowl it will have difficulty focusing on the cat's face when they're feeding at the bowl. The phone is mounted in landscape mode because that gives it a wider field of view horizontally. Note the location of the selfie camera on the phone; it should be roughly centered behind the bowl.

A charger and cables are provided. The cat bowl does not contain a battery and depends on the charger to operate. The phone and light have integrated batteries, but because the system is on 24/7 those components must also be attached to the charger at all times. **If two chargers are provided then the phone should have its own charger. The light and bowl can share a charger**. **Ensure the phone and light are fully charged before first use**.

Place the bowl so that its default view (i.e., no cats are around) is static. Moving objects in the background, like a fan, may confuse the AI and should be avoided. A traffic area where people occasionally walk by should be OK. There needs to be a power outlet nearby to plug in the charger(s).

Connect Cat Bowl Phone to Your Home Wifi

Most interaction with the cat bowl app will be done via a web interface. This eliminates the need to pull the cat bowl phone from its mount behind the bowl in order to do setup and training steps. You can access the web interface via a web browser on any device on your home Wifi network, including your own phone or any other computer. The web interface has been tested and verified to work with the latest versions of both Firefox and Chrome.

In order to use the web interface feature, the cat bowl phone must be connected to your home Wifi. *A Guest connection will <u>not</u> work since local devices are inaccessible with that type of connection*. The cat
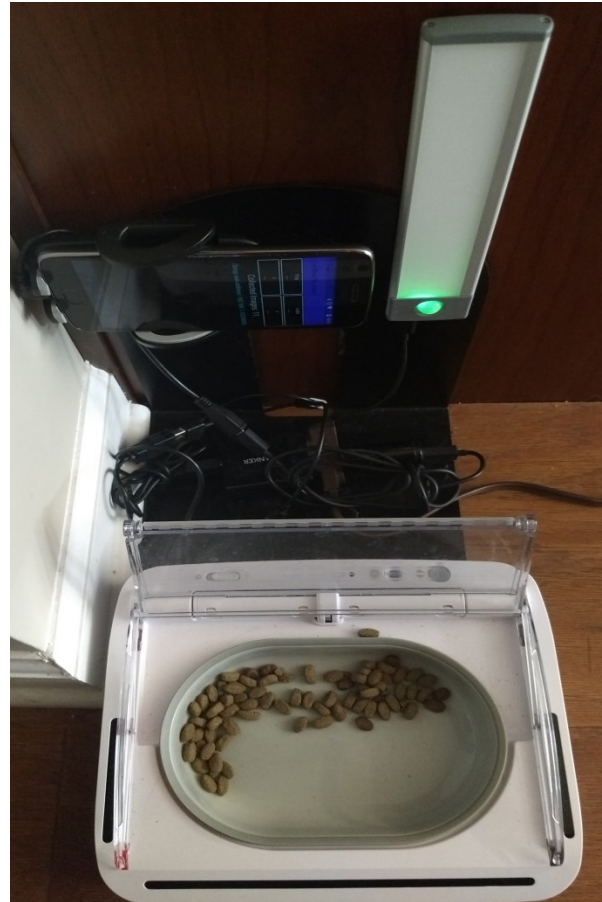
bowl phone does not access the public internet except for the Upload function, which enables you to upload a copy of your current setup and training to WDPS for support assistance (more on that later).

Before placing the cat bowl phone in its mount log it onto your home Wifi as you would for any other phone. Tap the Wifi icon on the phone, select your home Wifi from the list, and then enter the password for your home Wifi. You should not have to repeat this procedure unless you change your router or password.

The cat bowl phone is not on a cellular network and does not contain a SIM card. Most Android apps, including the phone app, have been disabled to minimize overhead. Please do not install any other apps on the phone.

Starting Cat Bowl Monitor

Once the cat bowl is in place you can start Cat Bowl Monitor on the cat bowl phone. Do this by tapping the icon (with a cat face) found on the Home screen of the phone. The app will start and enter Run Mode. It is now ready for setup and training. Attach the charging cord and place the cat bowl phone in the holder as shown and then squeeze the holder tabs to lock the phone in place.
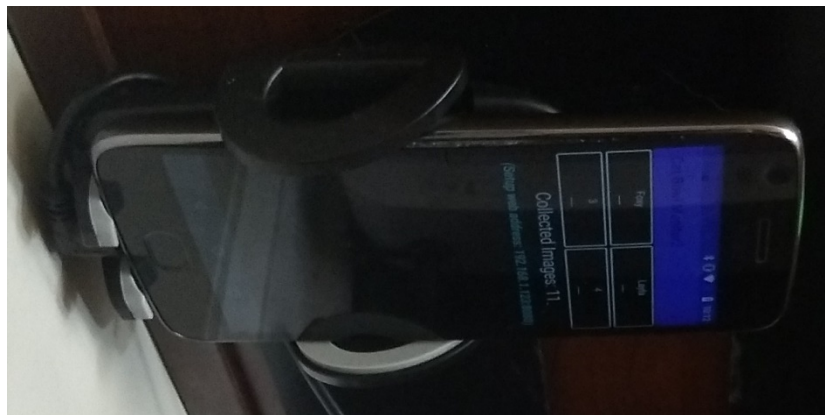
Avoid touching the power button on the side of the phone while mounting it. If you do and the dispay goes blank then just press the power button again to wake the phone. You may then have to re-run the app, or you can select it from the running apps list. The initial screen you see will look like the above photo, except that the four buttons will not yet be present. Those will appear once you've assigned some training images, as explained later.

The cat bowl phone app includes pages that can be used for setup, but it's much more convenient to use the web access via a web browser on your own phone or any other computer connected to your home Wifi. There are a couple of initial setup steps that must be done on the cat bowl phone itself, but those steps should already be done for you. If not, contact WDPS for assistance.

From this point forward you will access Cat Bowl Monitor via its web interface by entering the address (URL) shown on the display of the cat bowl phone. Be sure to bookmark the address once you reach the Dashboard page. On a phone you can also save the Dashboard page to an icon on your Home screen. You can then just tap the icon to access the Dashboard.

Overview of Cat Bowl Monitor Setup and Training

The following pages describe how to configure and use Cat Bowl Monitor. The basic steps involved are:

1. Identify your cats by name and specify a bowl action for each identified cat. The app can accept up to 4 cats.

2. Specify the default bowl state (opened or closed). The bowl will revert to the default state after no activity is detected over a short period of time. Normally, you would choose to close the bowl by default, but there are reasons you may wish to leave it open.

3. Collect some images of your cats. Before you can train the app to recognize your cats you need to gather some images of your cats. It's important that the images collected be in context – that is, with the phone in position behind the feeder. Do not take images of the cats in other locations. Once the phone is in place behind the feeder the app, while in Run Mode, will automatically collect snapshots of any cats that approach the feeder. It does this by using the cat face detection function to decide when to take snapshots.
   During this initial step, the feeder bowl will not be automated since the app cannot recognize cats until the training step is done at least once. To attract the cats to the feeder place some food in the feeder that all cats can eat and leave the default state of the bowl open for now.

4. The collection step above will gather "unclassified" images. A count of the images collected is shown on the app display while in Run Mode. Once several images are collected you can review the Unclassified Images and begin to assign them to specific cats. Be selective about the assigned images. The cat face detector doesn't always snap good photos. If they're excessively blurry or not centered on the face then remove them from the Unclassified Image list and keep trying.
   Ideally, you should have at least 5 images assigned to each cat. The images selected for each cat should all be slightly different, showing a slightly different pose, different lighting, etc. Try to keep the total number of images assigned to each cat less than 15. Too many assigned images will slow down the app. Try to keep the number of assigned images about equal for each cat.

5. After your first assignment of images to cats the app will begin attempting to recognize the cats when returned to Run Mode. Accuracy may be low at this point unless you were able to gather some good quality images in the prior step. However, the app will continue to collect unclassified images that it doesn't recognize, so the training process in the prior step should be repeated until recognition accuracy improves. In this final mode you can continue to refine the set of images assigned to each cat to improve accuracy.

The following pages illustrate the steps and provide details on how to use the web interface…

Dashboard

The Dashboard web page contains buttons for accessing model setup and training. You will see this page once the URL of the cat bowl phone is successfully entered into a browser connected to your local network.

If you're familiar with your internet router it's possible to configure *port forwarding* to enable access to the cat bowl phone from outside your local network. For security reasons this isn't recommended.

Go to **Model Setup** first to enter the names of your cats and the bowl action (open/close) desired for each cat.

Until some "unclassified" images have been collected in Run mode there's nothing to do in the **Training** page.

Please do not change settings on the **Advanced Setup** page unless directed to do so by WDPS support.

The next two sections describe the **Model Setup** and **Training** pages in detail.
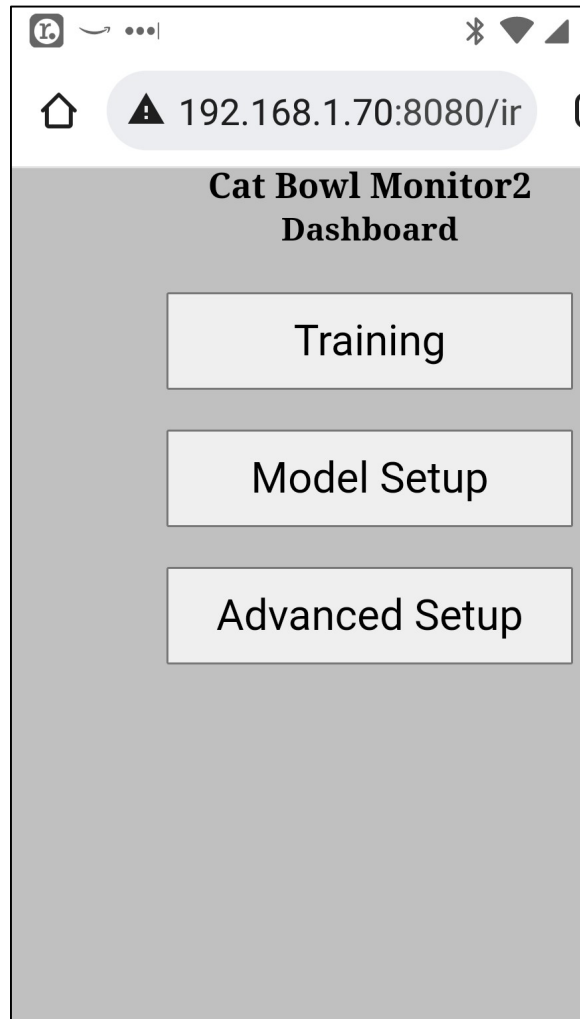
Model Setup

On the web Dashboard page tap **Model Setup**.

Unclassified Image Count shows the number of unidentified cat face images captured by the app. Once there are a few unclassified images available you will review those under the Training page and assign (classify) them to your cats.

Default Bowl Action indicates what the bowl should do when there's no activity. In most cases you'll want this set to Close, but this depends on your cats.

Default Bowl Action Timer specifies the time interval of inactivity before the Default Bowl Action is performed. This interval is repeatedly extended as long as motion is detected at the bowl, so it doesn't need to be a very long interval.

Speak Names specifies whether the app should speak the cat's name when it's recognized. This is mainly helpful for you to hear what the bowl is doing during the training process.

Cat Bowl Monitor2
Model Setup

| Dashboard | |

Unclassified Image Count: 0
Default Bowl Action: Open ⌄
Default Bowl Action Timer (secs): 30
Speak Names: ☑ Camera: Front ⌄
Camera Preview ON: ☐
Min Recognition Interval (secs): 20

#	Images	Cat Name	Acti
1	15	Foxy	Ope
2	14	Layla	Clos
3	0	3	Non
4	0	4	Non

Back Up Setup Restore Setup Upl

Camera specifies whether the Front (selfie) or Back camera is used. ***The current setup requires use of the Front camera***.

Camera Preview specifies whether to show a video preview feed on the display during **Run** mode. A preview can be helpful in initial setup of the camera. It can also be useful to attract a cat's attention to the phone, which gives the app a better chance of catching a good image of the cat's face.

Min Recognition Interval specifies how often the app will attempt to recognize a cat. This interval mainly prevents the app from repeatedly recognizing the same cat at the bowl, which can get annoying to both you and the cat if you have **Speak Names** enabled. This interval is repeatedly extended as long as motion is detected at the bowl, so it doesn't need to be a very long interval. Use the default value to start.

Enter your cat's names in the table and specify the bowl **Action** for each named cat. Up to 4 cats can be specified. The **Images** column indicates the total number of images you have assigned to the cat during training.

Tap **Back Up Setup** to store a backup copy of your setup. Backups are stored in the Download folder of the phone. The backup includes all setup parameters and all current unclassified and assigned images, and all log entries.

Tap **Restore Setup** to restore a previous backup. ***Be careful, this will overwrite your existing setup!***

Tap **Upload Setup** to send a copy of your setup to WDPS Software. You can do this to have an offsite backup if you like, but it will normally be done only when we request it to help in troubleshooting.

Training

On the web Dashboard page tap **Training**.

The Training page has 3 modes: **Classify**, **Review**, and **Log**. The current mode is selected using the drop list button in the upper right side of the page. Click the button and select the desired mode. Modes are explained in the following sub-sections.

All modes provide the same navigation buttons for stepping through displayed images. The date/time the image was taken is shown at the top of the image. The number at the upper right of the image is a measure of image sharpness. It's an aid for setting one of the advanced settings used to filter out blurry images.
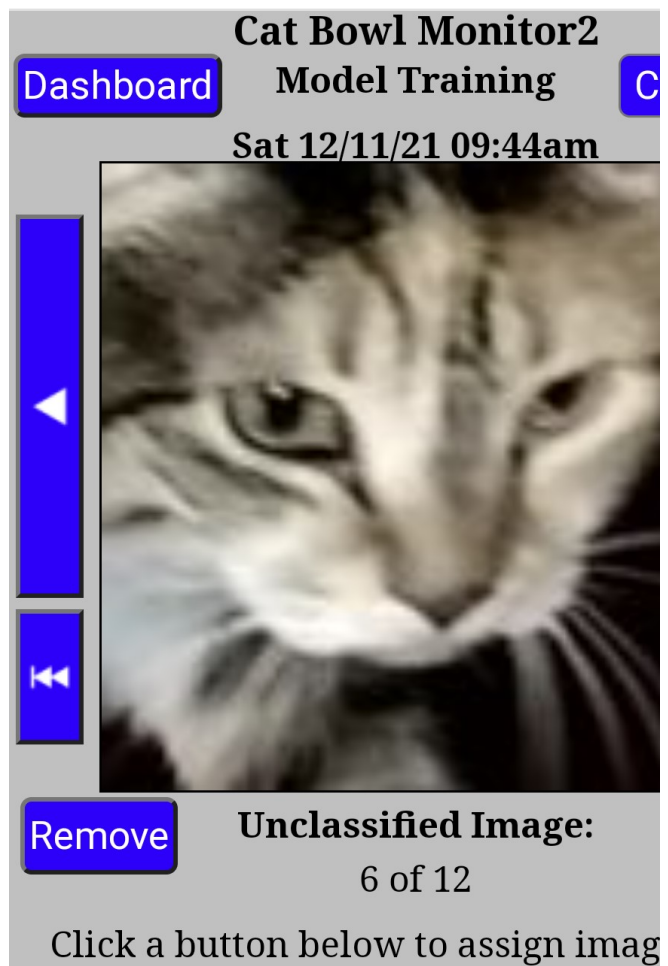
The buttons at the bottom of the page represent the four cats. The cats you named in **Model Setup** should appear in these buttons. If you don't see your cat's names then go back to **Model Setup** and enter them. The number at the bottom of each button represents the number of images assigned so far to the cat. The left-hand number in the middle of the button is the apps match score, indicating how close the image being viewed is to the closest of the images already assigned to the cat. The smaller the score the closer the match, at least according to the AI (Artificial Intelligence) model used in the app. The right-hand number in the middle is the index of that closest image in the set. These were used during development of the app. You can ignore them for now.

Classify Mode

The **Classify** mode is how you assign an unclassified image captured by the app to the cat depicted in the image. This is done by simply tapping the button for the correct cat at the bottom of the page. You are training the AI by classifying images.

When an image is assigned to a cat it is immediately removed from the unclassified image list. The unclassified image list will hold no more than 35 images. After that the oldest image is deleted to make room for a new image.

Multiple images of a cat are generally necessary for good recognition accuracy basically because AI is not all that smart. It does not evaluate an image for similarity the same way that we do. A slight

Cat Bowl Monitor2
Model Training
Dashboard
Sat 12/11/21 09:44am
◀
⏮
Remove
Unclassified Image:
6 of 12
Click a button below to assign imag

change in pose or lighting can confuse it. In assigning images, try to include as many different poses (head tilt/angle) of the cat's face as possible. Do not assign images that are not cropped to the face. Face detection will sometimes snap images that don't include the face. You might even see some images of yourself in there. Do not assign images that are too dark or blurry. Unusable images should be removed from the list by tapping the **Remove** button, which permanently deletes the image.

Review Mode

Review mode enables you to review images you have assigned to each cat. It's a good idea to occasionally review the images to ensure they're good representations for the cat. The button for the cat being reviewed is highlighted with an orange border and the name of the cat is displayed below the image window. Tap the button for a different cat to review its images.

In this mode the numbers in the middle of each button represent the next closest match within the cat's set of images. This can aid in weeding out duplicate images. The middle numbers shown for other cats indicate the closest match to the displayed image within that cat's set of images. With cats that look a lot alike you may find that the match scores are very close together. In the example screenshot shown the match score for the displayed image is actually lower for a different cat.

Tap the **Remove** button to remove an image from the cat's set of images. In this mode the image is not permanently deleted. It is instead sent back to the unclassified image list where it can be permanently deleted if desired.

There is no set limit on the number of images that can be assigned to a cat. However, an excessive number of images will slow down the recognition process. A reasonable limit is about 15 images per cat. If the cats do not look alike you may find you can use fewer images. You want the fewest number of images that achieves good accuracy.
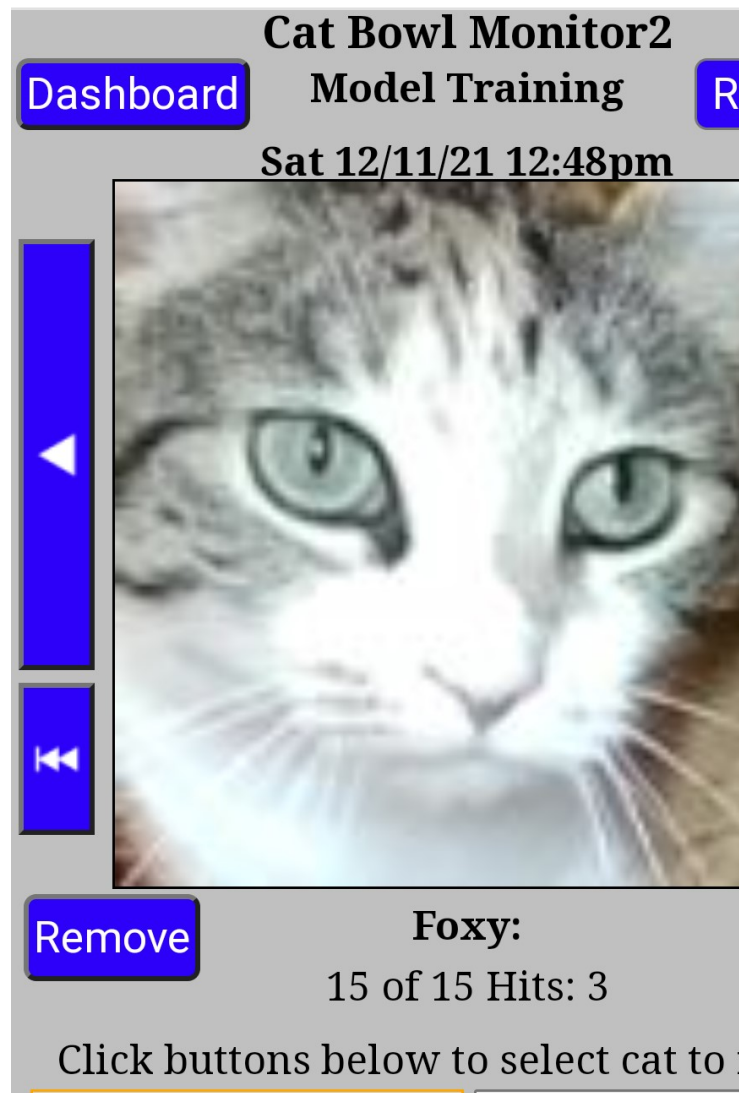
Log Mode

Log mode enables you to review the accuracy of the app. This log will remain empty until after you have assigned some unclassified images to cats. It may take a day or two to see entries in the log depending on the amount of cat activity at the bowl.

Each time a cat is recognized a log entry is created here. The name of the cat determined by the app is shown at the bottom of the image. This, of course, may or may not be correct. If the app was wrong you can assign the image to the correct cat by tapping the button for that cat. This additional training should help improve future accuracy for that cat. Do this only if the image is of acceptable quality, as recommended for unclassified images.

Log images assigned to a cat do not remove the entry from the log. The log holds a maximum of 50 entries. After that the oldest entry is deleted to make room for a new entry.

Cat Bowl Monitor2
Model Training
Sun 12/12/21 11:01am

Dashboard

◄

|◄◄

Remove

Layla

Log Entry:
50 of 50

Click a button below to assign imag

Filling the Feeder Bowl

If you've chosen a default bowl state of "closed" then you need an easy way to open the feeder to fill it with food.

The slide switch at the back of the feeder, on the left, has been adapted for this function. Just slide the switch to the left (O position) and the feeder will open. <u>The lid will remain open until the switch is returned to the right-hand position, so don't forget to do that when done filling the feeder</u>. The other buttons on the modified feeder have no function.

Slide switch to left (O) to lock feeder lid in open position.
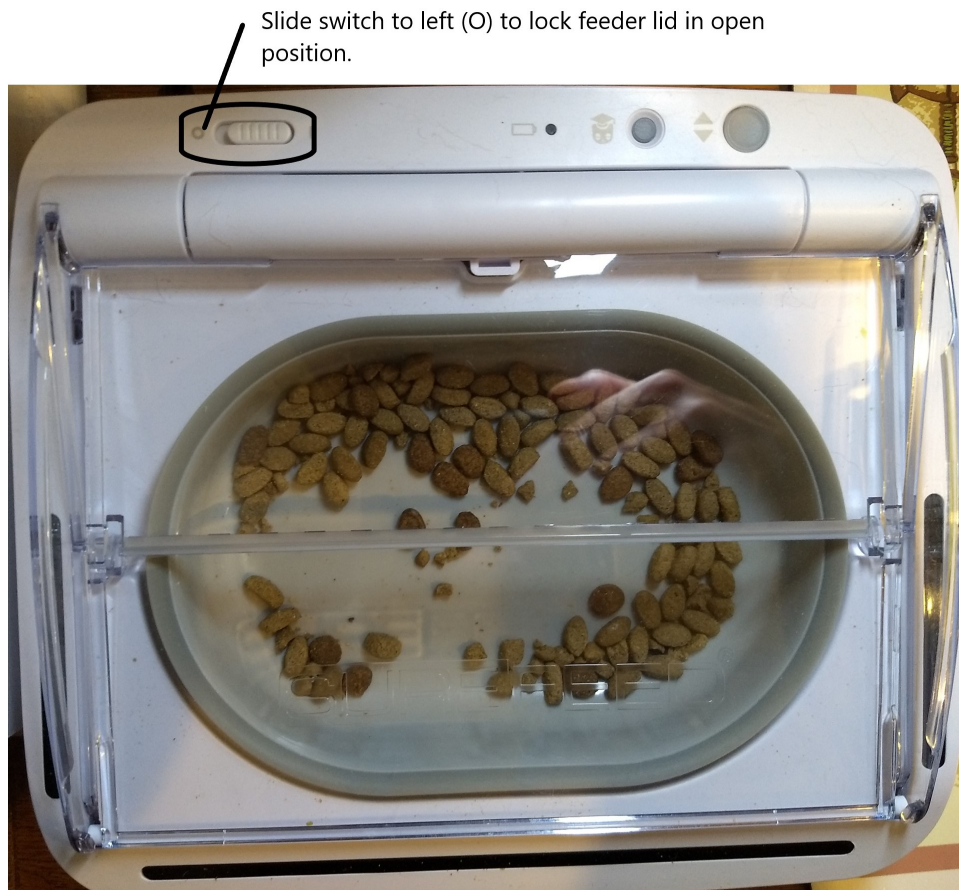
Reporting Test Progress

Once the feeder has been in operation for a few days please report back periodically on how well it's working. This can be done via text to Joe Mattioni (215-498-5282), or via email to jdm@wdpsoftware.com. Thank you!