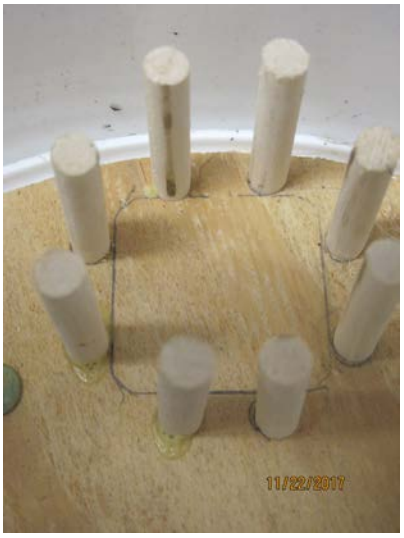
Preparing the Scarecrow Body

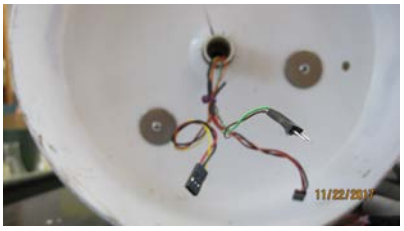
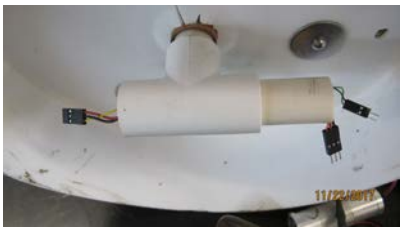
1	Cut off (and keep) the bottom 3” of the 5 gallon bucket. Make sure the cut is parallel to the bottom of the bucket. A cutoff wheel is ideal, but a saw will also work. *One easy way to mark the cutting line is to measure and mark at 8 points around the circumference of the bucket, then put a line of tape just above the marks.*	
2	Use a 7/8” spade bit to make a hole in the exact center of the bucket bottom. Some buckets conveniently have a dimple from molding at the center, otherwise measure carefully.	
3	Use a utility knife to cut 24-32 radial incisions around the circumference of the center hole, trying not to remove any plastic. Each cut should be 1/8” to 1/4" long (3-6mm). *These will allow the sides of the hole to flex and hold the shaft securely.*	
4	Cut a piece of 3/8” plywood the same size as the bottom of the bucket. *A circle is best, but an octagon will work*	
5	Use a 1” spade bit or hole saw to make a hole in the center of the plywood circle	
6	Use fender washers and #8 x 1/2” wood screws to secure the plywood to the outer bottom of the bucket. Screws should make the vertices of an equilateral triangle with the washers on the “inside” of the bucket.	

7	Fit the copper coupling through the center hole, from the plywood side out. The incisions around the bucket center hole should allow for some flex, so that the coupling can be pushed through but will also be held in place.	
8	Use the suspension clamp to align the coupling in a perfectly vertical orientation, 90 degrees from the flat surface of the plywood. Attach the suspension clamp to the plywood using #10 x 1/2” wood screws. *Just put the screws straight into the holes of the clamp as it lies on the plywood. If you try to tighten the clamp it might pull the coupling out of alignment.*	

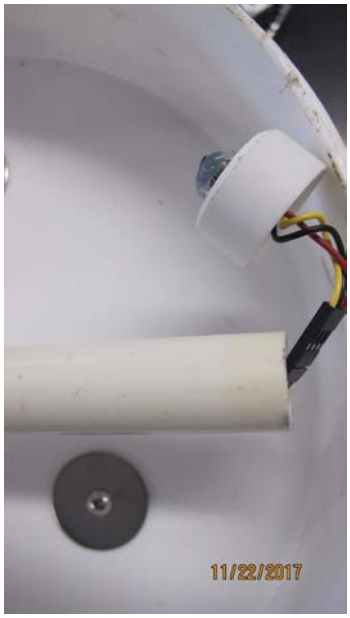
Assemble the Drive Train

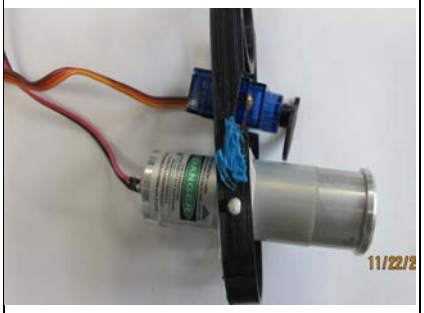
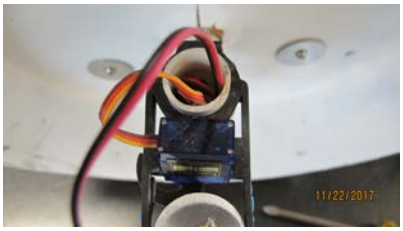
9	Attach a hub sprocket to the clamping hub - two 6-32 pitch 1/4” screws are sufficient - and fit a 3.5” length of PVC into the clamping hub. Tighten the hub to the PVC using the included Allen key screws	
10	Attach the other sprocket to the flat side of the set screw hub, using an external tooth lock washer with each 6-32 pitch 1/4” screw (again, two screws are adequate)	

11	Install the hub-and-sprocket assembly onto the shaft of the stepper motor, with the sprocket side facing down towards the motor. Lower the assembly until only a very small clearance remains between the heads of the screws and the top of the motor. Tighten the hub onto the shaft with the 3/32” hex key	
12	Place the PVC/clamping hub assembly into the copper coupling in the bucket bottom, and fit the assembled plastic chain around the sprocket. Fit the other end of the chain around the sprocket on the stepper motor. Move the stepper motor away from the center of the plywood until there is no visible slack in the chain, but stop before there is noticeable tension. Trace the footprint of the stepper motor on the plywood. *This is to ensure that, when parts are more permanently installed and the unit is powered on for operation, the spacing between the stepper motor sprocket and clamping hub sprocket is such that the chain tension is correct*	
13	Using a drill and six short pieces of dowel, install a frame to hold the stepper motor in place along the outside edge of the traced outline. The side of the outline facing the copper coupling and PVC/clamping hub assembly in the center of the bucket **should be left open** -NOTE: this is different from the illustration for this step- For an idea of the correct dowel cage, refer to the illustration for Step 22. Use hot melt or wood glue to secure the pieces of dowel into their holes *The motor will be mounted later*	

14	Insert the slip ring into the top of the clamping hub sprocket so that the wires contained in the braided mesh are coming out the top. Attach the plate of the slip ring gently to a free hole in the sprocket using a 6-32 pitch 1/4” screw	
15	Pull the wires from the slip ring through the PVC shaft and out the bottom.	
	Feed the female 3-pin connector through the top and out one side of the PVC “T” fitting. Feed the male 2- and 3-pin connectors through the top of the “T” fitting and out the other side. Slide the 2” piece of PVC into the side of the “T” fitting with the male 2- and 3-pin connectors.	

Laser Assembly

16	Insert the 3 3/4” long piece of PVC pipe into the side of the “T” fitting with the single female 3-pin connector. Run the female 3-pin connector out the other end of the PVC and attach it to the male 3-pin connector attached to the IR sensor cap. Place the cap over the end of the PVC pipe.	

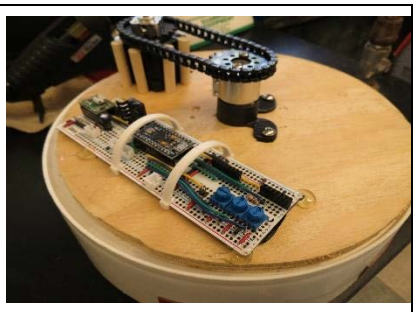
17	Install a 6-32 hex nut and 6-32, 3/8” screw in the laser module support ring, and fit the support ring into its holes on the PVC pipe hanger/servo mount. Install another hex nut and screw into the top of the pipe hanger/servo mount	
18	Install the servo motor on the PVC pipe hanger/servo mount	
19	Fit the laser module into the laser module support ring. Feed enough of the laser through the support ring that when no external pressure is applied, the lens end of the laser module is swung upwards by the downwards pull of the cable end. When the desired balance is achieved, place a piece of clear protective tape over the portion of the laser module that will be in contact with the tightening screw in order to prevent damage to the laser housing. Ensure that the cable end of the laser module is on the same side of the pipe hanger/servo mount as the cable end of the servo motor	
20	Feed the servo and laser wire strands through a 2” piece of PVC in the top of the pipe hanger/servo mount. Attach the female 2- and 3-pin connectors to their respective male connectors from the “T” fitting. Insert the 2” PVC into that side of the “T” fitting	
21	Gently fold or coil the excess lengths of wire from the servo motor and laser module, and tuck them inside the 2” length of PVC. Use tape and zip ties to prevent the wires from coming out the end of the PVC. Make sure to leave just enough slack outside of the PVC that the pipe hanger/servo mount can be rotated 90 degrees for transport or storage of the laser	

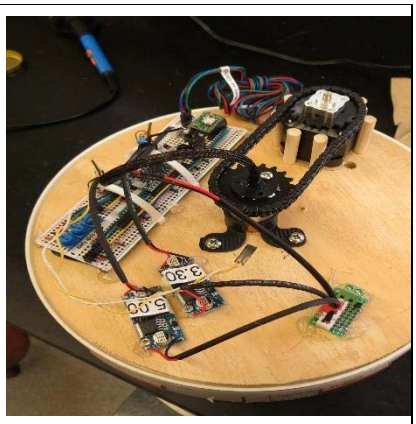
	scarecrow	

Mount the Stepper Motor

22	Place the stepper motor into the dowel cage with the wires running towards the bucket. Wrap rubber bands around the dowel cage and stepper motor to hold the motor in place securely, while making sure to allow for proper tension for the chain	

Installing the circuit board

23	Use hot melt glue to attach the breadboard to the plywood, off to one side of the chain/stepper assembly and oriented parallel with the chain	

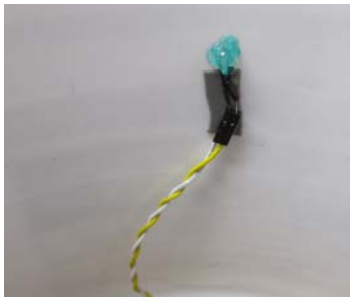
24	Use hot melt glue to attach the 12V power supply, the 3.3V supply and the 5V supply to the plywood. *Locate them such that when the wires are attached to the breadboard, they will not come into contact with the chain or clamping hub sprocket, as the wires could become damaged during operation.* When attaching the power supplies to the plywood, make sure that each wire can reach the part of the breadboard it needs to without excess tension or sharp angles	

Bucket Mounting System

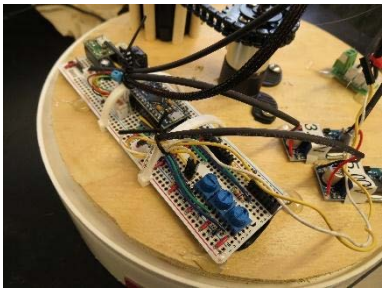
25	Drill five holes, ~1/4” diameter, into one side of the top part of the bucket, with the top four holes spaced to fit the two U-bolt clamp assemblies. The fifth hole, below and in line with two on the left, will be where the power cord enters the unit	
34	Install the U-bolt clamps with their corresponding 3D-printed parts on the bucket. Fit a 1 1/4” diameter piece of PVC, cut to ~6 1/2”, into the U-bolts on the outside of the bucket, and tighten the bolts until the PVC cannot slide up or down. Avoid excess tightness as it may deform the shape of the bucket	

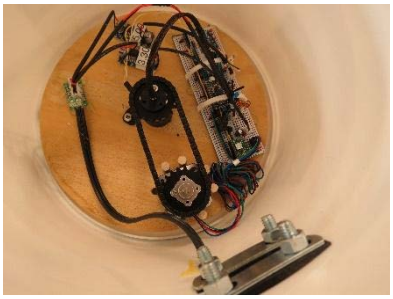
Daylight Sensor

26	Using a drill (~1/32” bit) or a utility knife, make two small holes on the upper rim of the bucket opposite the U-bolt and power cord holes. These holes will be for the daylight sensor wires to enter the bucket	

27	Feed the daylight sensor wires through the holes. Cover one wire in shrink wrap and insert both wires into the 2-pin female connector with wiring that connects the sensor to the breadboard. Use hot melt or double-sided adhesive to secure the female connector to the inner wall of the bucket.	

Final Assembly

28	Place three ~2” pieces of outdoor mounting tape equidistant around the outer rim of the bottom of the bucket. Leave ~3/4” between the mounting tape and the bottom edge	
29	Slide the top section of the bucket over the bottom piece, plywood-side up, and push the top all the way down to ensure adhesive contact with the mounting tape. When lifted from the top, the bottom piece should not move at all or be loose within the top	
30	Connect all internal wires to their ports on the breadboard, and use one or two 3D-printed “bridge clamps” and pieces of twist-tie to secure the wires well out of range of any of the moving mechanical parts	
31	Insert the power cord into the bucket. Use hot melt to secure it to the plywood- this will keep it out of contact with the chain and gears, and also help to prevent dislodging or damage to internal electronics should the cord be accidentally tugged or pulled during setup of the unit in the field. If desired, the cord can also be knotted just inside of the bucket to prevent it from being unintentionally pulled out	

32	Use a small flathead screwdriver to open the ports for the power cord, and insert both strands of the power cord into their respective ports. Ensure that the positive side of the cord (in our build, the strand with stamped writing on the insulation) goes into the positive port	
33	Power on the unit by plugging the power cord into the battery and assess functionality. If all electronic and mechanical pieces are functioning as desired, use small amounts of hot melt to secure all of the male-to-female connector joints in the rotating PVC arm, the attachment of the IR sensor cap to the PVC, and the points where PVC is inserted into the “T” fitting	
34	Place the lid back on the bucket to protect the electronics from water, dirt, etc.	