Weather Station Raspberry Pi Construction

By David W. Enström

This personal weather station uses the SparkFun weather sensors (Argent Data Systems), and the BC Robotics add-on hardware (HAT) to interface these sensors to the Raspberry Pi.

See: https://www.sparkfun.com/products/8942 and https://www.bc-robotics.com/tutorials/raspberry-pi-weather-station-part-1/

The weather station monitors (and optionally shares the data with Wunderground):

- **Wind Speed** – in km/h
- **Wind Direction** – in degrees
- **Rainfall** – in mm
- **rainRate** – in mm/hr
- **Temperature** – in degrees C
- **Air Pressure** – in hecto Pascals
- **Humidity** – in percent

Instructions for setting up this weather station and installing all the required software are in the "`Weather-Station-Raspberry-Pi-software-setup.pdf`" PDF file.

Raspberry Pi

The weather station is connected to a Raspberry Pi … it is actually to a HAT (Hardware Attached on Top). The HAT is from BC Robotics and uses the BME280 temperature, pressure, and humidity sensor, the DS18B20 Digital temperature sensor, and the SparkFun Weather sensors from Argent Data Systems for wind and rain. The Pi communicates via Wi-Fi to the world.

Required Components

As can be gathered from the photo, the weather station is mounted on the roof using a support structure made of wood. The temperature sensor is housed in a sun shield made from "Carpet Savers" bolted together and mounted on a PVC conduit strapped to the mast. The mast is a 1" galvanized conduit with the wind sensors mounted on the top. The Raspberry Pi and HAT are mounted inside a plastic junction box.

The electronics and sensors:

Raspberry Pi	$85.00
Weather sensors	$100.00
BME280 Temperature Humidity Pressure Sensor	$28.95
DS18B20 Digital Temperature Sensor	$6.95
GPIO Header for Raspberry Pi HAT	$2.95
Raspberry Pi HAT Hardware	$2.50
Raspberry Pi Weather Board	$19.95
Terminal Block - 3-Pin 2.54mm	$0.95
TOTAL	**~$216.03**

These parts are available at BC Robotics, see:

- https://www.bc-robotics.com/shop/raspberry-pi-3-plus-starter-kit/

- https://www.bc-robotics.com/tutorials/raspberry-pi-weather-station-part-1/
- https://www.bc-robotics.com/shop/weather-meters/

Other parts needed:

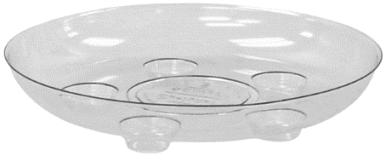
Wood frame	~$50.00
Junction Box (plastic 6"x6"x4")	~$30.00
Two piece dryer vent (Dundas Jafine Provent)	~$6.00
Extension power cord (length dependent)	~$20.00
Stainless steel rod (1/8" x 3') for sun shield	~$8.00
Carpet savers (6") 7 @ ~$2 ea.	~$15.00
Plastic 1" conduit 90 degree	~$2.00
Galvanized conduit for the mast (1" x 10')	~$15.00
TOTAL	**~$140.00**

There are directions below on how to build the:

- Sun shield
- Enclosure
- Mast and support frame

Building the Sun Shield

The Carpet Savers typically go under potted plants to prevent leakage onto carpets:



They are available at your local Canadian Tire store or other home store, and work very well for constructing a sun shield for the temperature sensor. The other pieces needed are the ⅛" stainless rod (~3' long) and a ~4" diameter clear plastic piece. This piece forms the bottom of the sun shield onto which the temperature sensor is mounted (through a ~¼" hole); see the picture.

The ⅛" stainless rod is cut into pieces: 2 pieces at 4.5" and one at ~8" long (see the pictures below).

Cut 1½" hole in the centre of six of the carpet savers. This creates the space for the temperature sensor. The seventh untouched carpet saver forms the top of the sun shield. Now drill ⅛" holes in the centre of three of the “feet” as shown in the picture below.

Cut a flat piece of plastic or wood about 4" in diameter to form the bottom of the sun shield a shown in the picture below. There is a centre hole in this piece, into which the temperature sensor is glued later.

Now spray paint all seven carpet shields white prior to assembly. Spray paint the plastic 90° conduit at the same time.

Assemble the sun shield starting at the bottom. Place nuts at one end of the short stainless rods, and one at the same distance from the end of the rod on the longer one, as shown above. Slide on the bottom piece, and then slide the first carpet shield onto these rods followed by one of the ¾" tube spacers on each rod. Repeat this process five more times, except on the las one add a nut to secure the six carpet shields together before adding the spacers. Now thread the temperature sensor wire through the hole in the bottom piece and add some glue if desired to hold it in alignment with the center holes in the carpet shields.

Now place the last painted, but otherwise unmodified carpet shield, on a flat surface, and then add some glue (like Marine Goop) in the three appropriate “feet”. Place the assembled shield on top with the glue lined up with the three rods and spacers. Leave it to cure overnight and you are done!

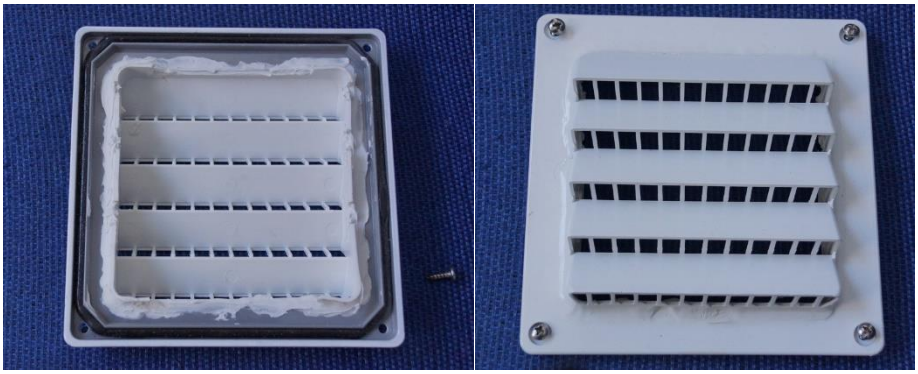
The extra long rod in used to mount this assembly onto the plastic 90° conduit, as shown in the picture below. It is then strapped onto the mast during final assembly.

Raspberry Pi Enclosure

The enclosure is formed from a plastic junction box (6"x6"x4") with a vent glued into a cut-out on the lid.

A vent is required since the HAT includes the pressure and humidity sensors. This vent comes from a dryer replacement vent, the Dundas Jafine Provent 4" vent works best since the louvered portion can be removed (it is a two piece construction):

Remove the inner vent piece and trace its outline onto the centre of the junction box cover. Cut out this square hole (it does not have to be too precise since it will be caulked with weather seal) and insert the vent from the inside of the cover until it is seated properly (there are protrusions). Caulk around the inside and outside of the vent, as shown in the pictures below:



Let the caulk cure overnight, then spray paint the junction box and its cover white. Optionally add a screen to the inside of the cover to keep out spiders.

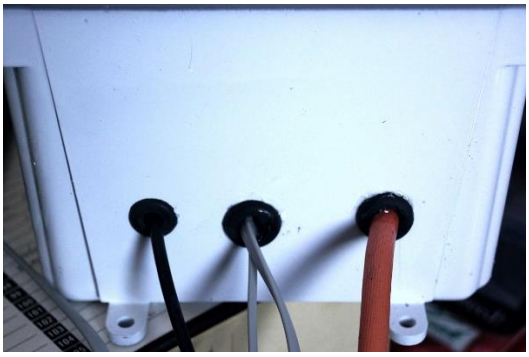
Now we mount the Raspberry Pi inside the box. Mount the Pi on the back/bottom of the junction box using adhesive standoffs: https://www.active123.com/SA120X8-Adhesive-Standoffs-012-Pkg8-Prodview.html. Place the standoffs on the Pi, and then stick it into the box, as shown below.

Place it in the top left portion of the box so that there is room for making connections, and room for the power cube. This also helps to keep it dry. The power cube is Velcroed to the side of the junction box so that it does not move inside the box.

The last step is to drill holes into the bottom of the junction box for the:

- Temperature sensor cable
- Wind and rain sensor cables
- Power cable

The rubber grommets shown in the picture below are optional, but recommended.



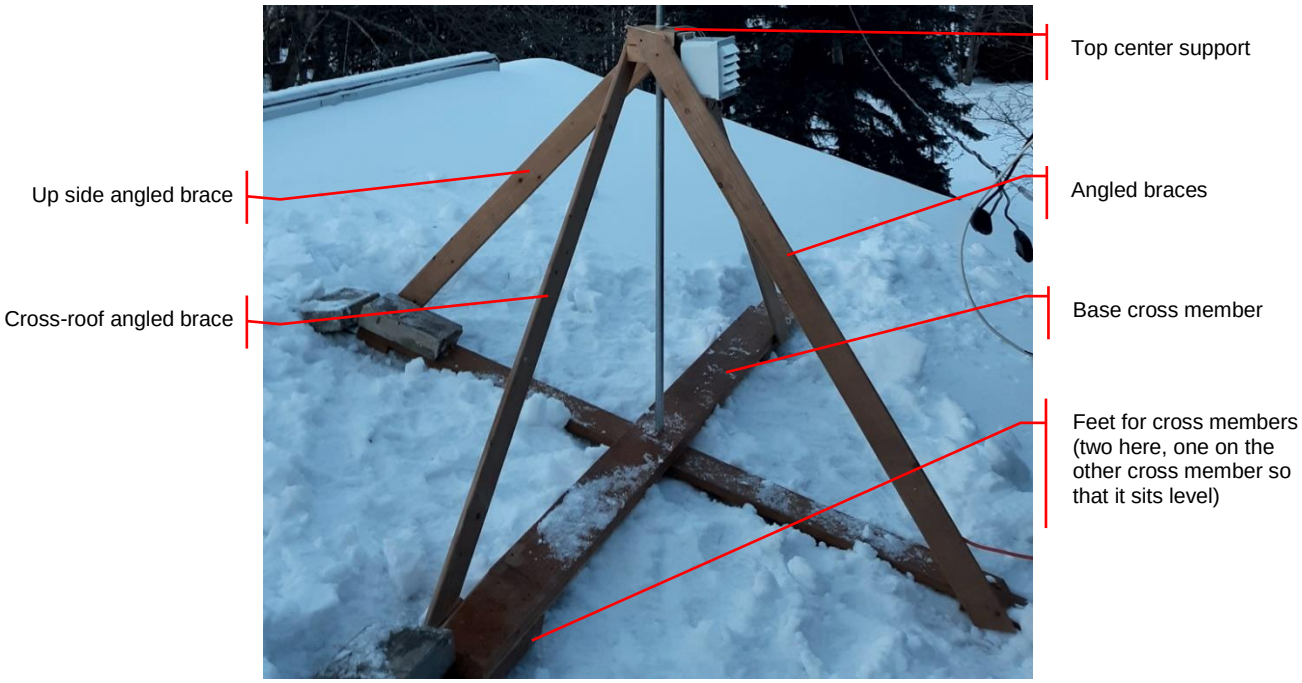
The temperature sensor hole is ¼" and the other two holes are ½".

Mast and Support Frame

The mast is made from a standard ten-foot length of 1" galvanized conduit, commonly available at any hardware store. The support structure is made of wood—suggested pieces (all pressure treated):

- **Cross members**– two pieces 2" x 6" by ten feet
- **Feet for cross members** – one piece 2" x 6" by eight feet (cut into 6 pieces 1' long)
- **Top center support** – two 6" pieces from the above (square same size as cross members)
- **Angled braces** – four pieces 1" x 4" by six feet

A close-up of the support frame:



Start by nailing or screwing one of the 1' length feet to each end of a cross member. This will be the bottom cross member in the photo above. Do the same to the other cross member but there are two feet needed on each end so that this top cross member sits level.

If your support frame will be located on the roof, as in the photo, drill a 1" hole in the middle of the top cross member (the one with two feet on either end). ***However***, note that this hole need to be *angled* so that when installed on the roof the mast aligns vertically.

Make the top center support by screwing the two square pieces together to form a block the same size as the width of the cross members. Drill a vertical 1" hole through the middle of this block (i.e., it does not need to be angled to suit the roof pitch; this is dealt with later).

Now screw the two cross members together, ensuring that the top piece is on top and that they are centered on each other.

Position the top center support about three to four feet above the center of the cross members. Trim the ends of the angled supports as shown in the picture. The cross-roof pieces are the same length so do these pieces first. This is not critical since this can be fine-tuned during final assemble—just get the lengths and angles on the ends roughly correct. Note that the angled members on the up and down side of the cross members are very different lengths and dependent on the slope of the roof!

Now you need some help. Move the pieces to its final location. Place the cross members first. Put one screw into the end of a cross-roof piece and into the top center support. Do the same for the other cross-roof piece and then roughly position the top center support. Get you helper to hold it into place while you place the mast in position. Now, using a level, ensure that the mast is vertical in the cross-roof direction, and then screw the ends of the cross-roof pieces into the cross member foot. One direction of bracing is done. Now do the same for the up and down roof-angled braces, ensuring that the mast is vertical in both directions. Add some screws where necessary to finish the job.

Now on to the mast. Remove it from the support frame and drill a small (⅛-¼") hole about a foot from the top. This will be used to fasten the wind instruments to the mast.

Make a small cut into the end of the wind mounting mast (or if possible drill a ⅛" hole, but it is good quality stainless, which is difficult to drill) so that the screw placed through the hole in the mast will grab

the wind mounting mast. Now fasten the assembled wind instruments to the top of galvanized mast using the drilled holes.

Now do the final assembly by dropping the mast into the support frame, and adding the rain and temperature assemblies as shown in the photo above. Fasten the junction box in a convenient location, attach the sensors, and power cable.

Plug in the power and check the results!