CONSTRUCTION INSTRUCTIONS: LED PLANT SHELF

**Materials**

* 1 PVC pipe section, unmodified
* 2 PVC pipe sections with front cut into a U shape
* 6 warm white LEDs (8mm diameter)
* 6 220 ohm resistors
* 1 IR range sensor
* 1 Arduino Uno
* 1 9V battery
* 1 battery cover/port
* Dense paperboard
* Wire in yellow, white, black, and red

**Equipment**

* Hand drill
* Clamp
* Wire cutters
* Wire strippers
* Hot glue gun
* X-acto knife
* Dry erase marker
* Large flat file
* Triangular needle file
* Soldering iron (with solder)
* Hacksaw
* Deburring tool
* Scrap wire (optional/maybe helpful to apply hot glue)
* Electrical tape (optional/makes things tidier)

**Steps**

* **Such solder much solder**
  + Cut wire:
    - 6 pieces of yellow wire and 6 pieces of white, each about 9.5” long.
    - 8 pieces of black wire about 3” long.
    - 1 piece of yellow wire and 1 piece of red wire, each about 3” long.
    - Strip the last ¼-inch or so of all wires.
  + Solder a yellow wire to the positive (longer) terminal of each LED and a white wire to the negative terminal.
  + Solder a 220 ohm resistor to the end of each yellow wire.
  + Solder a black wire piece to the other end of each resistor. You’ll have 2 black wires left over.
  + Construct the solder spider:
    - The point of the spider is to connect all of the white ground wires together so they can use just one wire to connect to the Arduino.
    - Solder the white wires together, with three pointing left and three pointing right.
    - Solder the remaining black wire to the huge solder blob in the middle.
    - Diagram:
  + Solder the small red wire to the red wire on the IR sensor, yellow to yellow, and black to black.
* **Prepare the plant pots**
  + Make dry-erase marker marks on the pots where you will want to cut/drill:
    - 2 drill marks in the middle of the back of the unmodified PVC pipe (for wires).
    - 1 slot in the bottom center of the front of the unmodified PVC pipe (for IR sensor).
    - 3 drill marks in each U-shaped PVC pipe: one on each side, then one offset near the middle. The mark in the middle should be offset to the outside; see picture/video to make this make sense. (for LEDs)
  + Drill 5/16” holes on each of the 3 marks in each u-shaped PVC pipe. It may be useful to drill a 3/16” pilot hole.
  + Drill 7/16” or larger holes in the back of the unmodified pipe. You may need several pilot holes.
  + Clean up edges of holes with deburring tool.
  + Use needle file to make two notches in each of the 7/16” holes.
  + Use hacksaw to cut sides of slot and chip away at center of slot.
  + Finish slot using file(s).
  + Prepare top/base:
    - Draw two circles with the circumference of the INNER circumference of the PVC pipe on the paperboard.
    - Cut circles out using x-acto knife.
    - Cut notches in paperboard circles for finger handle, IR sensor, and wall mounting screw.
  + Use a few dots of hot glue on the bottom inside of the unmodified PVC pipe to attach the bottom paperboard circle (with the square holes). Scrap wire can be used as a hot glue applicator.
  + Use a lot of hot glue on the sides of the PVC pipes to attach the three sections together.
* **Arduino time**
  + Load FadeThreeLEDs code onto the Arduino.
  + Once it’s disconnected from computer, plug the round end of the battery cap into the power supply port on the Arduino.
* **Finish this shelf**
  + Place LEDs:
    - Put the spider in the center pipe and send the LEDs through the large holes to the back of the shelf.
    - Wedge one LED into each circular hole on the side PVC pipe pots.
    - Use a dot or two of hot glue on the back of each LED to hold it in place.
  + Place IR sensor:
    - Place IR sensor, looking out, in the slot in the center pipe pot.
    - Hot glue sensor carefully in place.
  + Finish wiring:
    - Connect spider-ground wire to digital ground pin.
    - Connect yellow LED wires to digital pins 9, 10, 11, 3, 5, and 6.
    - Connect yellow IR sensor wire to analog pin A1.
    - Connect red IR sensor wire to 5v pin.
    - Connect black IR sensor wire to analog ground pin.
    - Tidy up all wires and tape as necessary.
  + Plug 9v battery into battery cap and test system.
  + Congratulations, you’re done!