IR Sensor for Snapmaker 2 Glass bed

This is an outline of my solution for replacing the existing inductive proximity sensor with an IR sensor to level on glass. It's not been tested by anybody else so does need some sanity checking and comments welcome.

Disclaimer - you do need to completely dismantle the print head and solder a wire to the circuit board and slightly change the firmware so warranty is probably gone but it's all completely reversible and you can easily go back to the stock print head and firmware but please don't blame me if it all goes wrong.

I did this with the original SM2 printhead and hot end. I don't think anything in the new head will invalidate the design indeed it looks a lot like this solution and as the new slightly wider hot end works with this printhead today I think it will all work with the new one but this needs testing.

In outline I removed the old inductive proximity sensor, hot end fan box and two-sided cooling fan box and replaced them with a one sided cooling fan box, a combined hot end fan box and IR sensor mount and an IR proximity sensor. To give the sensor the best detection conditions I also sprayed the back side of my borosilicate glass plate with high temperature black paint.

Prior to this change I was using an additional blower fan on the front of the print head. I now find that this is not necessary and I am getting very good cooling and bridging without it.

The sensor I used is David Crocker's mini height sensor, it's the only one that gets good reviews in relation to accuracy. The sensor works on 3.3v or 5v power and output and is high when triggered. The sensor output also needs to be pulled up to 3.3v on start-up to enable digital mode. The SM2 inductive sensor works on 24v, logic is 3.3v and output pulls low when triggered. That means the cable between the IR sensor and the socket on the printer board need to incorporate a logic change and a pull up. This can however all be done with cheap as chips transistor, two resistors, some soldering and heat shrink tube.

Parts list:-

1. Mini height IR sensor. (p01 & p02)

https://miscsolutions.wordpress.com/mini-height-sensor-board/

Worldwide suppliers are detailed in a link in the document. I used Ooznest who were very efficient.

2. 2xM3 nuts.

3. 1x100kΩ resistor and 2x47kΩ resistors. One of the 47kΩ resistors is only used for testing the cable once made. The values of the resistors are not crucial. The 100kΩ resistor is just protecting the output of the sensor and the 47kΩ resistor is a pull up. I used 47kΩ as that's what Snapmaker used for the existing sensor.

4. 1xNPN switching diode, I used a 2N2222 – small and very cheap.

5. 1xJST 2 connector with tails or make your own. I used this from eBay which should help identify the actual type.

https://www.ebay.co.uk/itm/265108342987

6. 1xJST 0.1in (or metric 0.0987in equivalent) any JST this size is fine, I made my own.

7. 1x Male and female Dupont or similar connectors for the 3.3v power lead. I made mine from two hook up cables I already had.

Printing replacement parts

You will need to print two new parts.

1. Main-cooling-fan-box.stl. (p03)

2. Hot-end-fan-box-with-sensor-holder.stl. (p04)

The stl's are orientated in the way I printed them. I used Cura 4.9 on default Snapmaker fast settings. I have now printed the parts in PETG though my initial prints were PLA and they worked just fine and didn't melt or deform all all when printing up to PETG. I don't print at ABS temperatures, if you print ABS you should probably print the parts in ABS! Both parts have cooling fans running through or around them.

I printed both parts with tree supports, bed only, 50% support overhang angle so that there are no supports in the slot where the 3mm nuts go. Printed with 30% infill. You may need to tidy up the tongue on the sensor part and the corresponding slot on the fan part.

The fan box needs 2x3mm nuts and the sensor holder 1x3mm nut push fitted into the slots above the screw holes. They need to go in with the hex points in the centre of the slot so the thinnest part of the nut goes into the slot. It's a tight fit and they need to be pushed fully down into the slots to line up with the holes.

The fan box is slightly lower than the original, I find this gives better clearance and just as good cooling that's better than the original split fan design. I have included an STL for a fan box that's the same height as the original if you want to use this.

Cable manufacture

The cable has three connectors, one for the IR sensor, one for the socket on the printer head circuit board and another for the 3.3v power. The connector for the printer head board is a Mini Micro PH 2.0mm JST 3-Pin Male Connector Plug – just buy some with tails. Take out the cable that matches 24v as marked on the circuit board and sort out the colours as you wish. The pins on the IR sensor are 0.1inch, you need to carefully bend them through 90 degrees towards the bottom of the board. To connect I used a compatible JST connector because of its size. I used a 2n2222 transistor, a 100k ohm and a 47k ohm resistor all wired

together up as detailed on the diagram. I put a male Dupont connector on the 3.3v utilising some existing hook up cables. (p05) The cable needs to be about 150mm long and I put the components around the middle so they lie alongside the servo in the print head. This cable is going in a metal box past lots of metal components so make sure all connections are covered by heat shrink and I put another piece over the central part of the cable where it goes past the hot end heat block. I found leaving off the white connector for the control board end until I had this last piece of heat shrink on meant I could use a smaller size. (p06, p07, p08)

Check cable works

It's wise – no essential to check the cable does what it needs to.

Supply 3.3v to the Dupont connector and ground to the control board connector. There should be 3.3v on both the 3.3v line and sensor "out" line of the IR sensor connector. Next connect "in" on the control board to 3.3v using the spare 47k ohm resistor. Connect the "out" line on the IR sensor to 0v. The control board input (that side of the resistor) should be at 3.3v. Move the "out" line sensor connection to 3.3v to simulate a trigger and the connector board input should go low to around 0.007v. If all this works, power your test rig off, connect the IR sensor to its connector being careful to match the polarity of the cabling and power back on. The IR sensor LED should pulse twice, that means it has recognised the pull up resistor and is in digital mode. Put a piece of white paper or a finger near the capacitor end of the sensor and the LED should light and your meter on the in line of the control board connector should go down to around 0v (~0.007v). Success and your cabling and sensor are working correctly.

Print head dismantle and rebuild (p09)

Take both sides off the print head.

The new power cable needs to be soldered into the circuit board pad called p1. Take the circuit board out by removing the two screws on the back of the print head and sliding it out. Remove all the plugs carefully. Where the plugs go is marked on the board but make sure you know how to put them back again in the same place. Remove the four screws holding the heatsink to the circuit board, remove the plastic washers and separate the heatsink with blue thermal pad from the board. This takes a bit of pressure but should just pull apart. (p10) The removal of the thermal pad should reveal pad p1 on the circuit board, solder the 3.3v wire into the hole (handily marked 3.3v on the other side) going in through the connector side of the board. (p11) I used a female Dupont hookup cable here so that I could put all the old components back and leave this wire still connected. Route the cable behind the screw hole put, the thermal pad and heat sink back on the board using the existing screws and washers and put it to one side. The heat sink material will act as a clamp holding the power cable. (p12)

Take the hot end out by loosening the grub screw below the filament cover and removing it. You need to take the cable apart at the join as the extension will not come out through to the hot end hole. Note how this fits above the mounting for the cooling fan for when you put it back together.

Undo the two screws that hold the cooling fan and it's associated ducting. Also undo the sensor screw, the one that's recessed in the back of the print-head. You should now be able to remove the old probe, ducting and fan.
Note the way the fan cable is orientated with regard to the fan box. (p13) Remove the three screws from the fan and screw the fan onto the replacement main cooling fan box. Put this to one side for now.

Screw the IR sensor to the new printed part with the capacitor facing out and at the top. You can use the supplied screws though they are a little long. I just screwed them through the holes in the mount. They are M2.5, use shorter ones if available.

Put the new sensor assembly onto the printer head but don't screw it in yet. Feed the new cable in through the side of the sensor assembly and through the gap in the hot end heat block alongside the hot end fan cable. It's a bit of a fiddle. Make sure the fan box sits snugly on the top of the fan. Screw the assembly to the print head through the recessed hole in the back using the original cap head screw.

Plug the cable you made into the sensor making sure the polarity is correct and bend the cable so it's close round the bottom of the sensor. (p14 & p15))

Put the cooling fan and new duct box in from the bottom feeding the cable through towards the circuit board alongside the other cables. The tongue of the sensor print should slot between the two rails on the fan box. Secure the fan using the two longer countersunk screws. (p16)

Put the hot end into the hole in the heat block. Make sure the hot end is seated correctly and the cut off round flanges fit into the slot in the heat block. feeding the jumper cable through from the circuit board side and connect with the hot end cable over the cooling box mount as it was originally. Tighten the locking allen screw that's behind the filament door on the front of the print head. (p17)

Plug all the connectors into the circuit board. Connect the new 3.3v wire to the new cabling and carefully put the circuit board back into the head and secure with the original two screws. (p18)

Screw the sides back on the print head and that's it all done.

When you power the printer on the LED on the sensor should flash briefly then pulse twice after a couple of seconds. Holding a piece of white paper near the sensor should trigger it and the LED will come on. If the paper is too near the LED will go out, this is normal. Home the printhead and send a G30 command from something connected via USB (laptop with Luban or Octoprint. Put white paper under the sensor and make sure the head stops, if not, switch off quickly and check all your wiring and connectors.

Firmware update to change the print head to sensor offset.

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Note I am in discussion with Snapmaker over the sensor offset and that their leveling routine is not correct. This issue has now been corrected and the code has been included from releases 1.12.2 onwards.
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The new sensor is in line with the nozzle and 13.5mm to the right. The original sensor was 19.5mm behind and 13.0mm to the right of the nozzle so it's best to update the firmware to change the sensor offset. The new sensor will still work fairly well without this change, especially on glass where the surface is flat and you are just levelling out gradients but it's best to change the firmware. You also get all the latest fixes and hopefully no new bugs!

> A number of people have had trouble with the firmware update so I have written a beginners guide which goes through all the steps needed to successfully make the changes necessary for the IR sensor and upload the changed firmware to the Snapmaker2.
>
> https://docs.google.com/document/d/1T_P_yC-vskAzn-YR6GPWysciVwm7Z7EyAT7IrRCXLJ0/edit?usp=sharing

Shorter version for those that are comfortable updating Snapmaker2 firmware

Go to the GitHub site for the Snapmaker Controller.

https://github.com/Snapmaker/Snapmaker2-Controller

Read the Instructions on how to update the firmware and make sure you understand them.

Once you have loaded the relevant folder into Visual Studio Code go to the file "Marlin/Configuration.h" and at about line 869 change the values in the three lines to look like this.

#define X_PROBE_OFFSET_FROM_EXTRUDER 13.5 // X offset: -left +right [of the nozzle]
#define Y_PROBE_OFFSET_FROM_EXTRUDER 0 // Y offset: -front +behind [the nozzle]
#define Z_PROBE_OFFSET_FROM_EXTRUDER 1.0 // Z offset: -below +above [the nozzle]

The Z offset seems to be used by Snapmaker and it should be left at the original setting of 1mm. The correct setting should be 2.61mm but that will require Snapmaker to sort out what they do with bed leveling.

Since we are here it's worth stopping the firmware switching off the heaters when you issue a G1029 A leveling command.

Edit Marlin/src/gcode/bedlevel/abl/G1029.cpp
Comment out line 111 so that it looks like this:
// thermalManager.disable_all_heaters();

When doing bed levelling the print head drops straight down from it's home position which is outside the bed to 15mm above where it thinks Z0 should be based on the G28 homing and the sizes of the rails set in the firmware. This is in my view too close to the bed edge both vertically and horizontally before it moves to the first probe point. It should not crash into the bed as it has started using the proximity sensor as an end stop as long as the sensor is over the bed but it's a close run thing. It's less of an issue with the IR sensor but I remove this to save my heart rate as I see the head racing to crash off the edge of the bed! This is a Snapmaker addition to Marlin and I don't like it!
Edit Marlin/src/feature/bedlevel/abl/abl.cpp
Comment out line 467 so it looks like this:
//do_blocking_move_to_z(15, 10);

Save all the files and build the new firmware file and install on your printer per the GitHub instructions.

[Note that if you upload your firmware and then change something and want to upload again you have to change the version string. The upload process compares the existing version string with the one in the new upload and if they are the same it reports a successful upload both on the console and in the log but actually does nothing. I am trying to get them to change this.

To change the version string
Edit Marlin/src/inc/Version.h and change line 41 to something like
#define SHORT_BUILD_VERSION "SM2-4.2.2b"

Setting everything up and automating levelling

You can now use the sensor on glass as you did for the original on the build plate per the standard Snapmaker instructions.

There is a better way in my opinion. This is the levelling set up I use.

1. Heat the bed up to your normal working temperature.
2. Do a calibration as normal.
3. When you manually move the nozzle down to the calibration card make sure you make a careful note of how far you move it down. If you have a USB device connected (e.g. Luban or OctoPrint) the moves will show up on the terminal window.
4. Create a macro as below to use in Luban or OctoPrint with the Sidebar Macros plugin. Change the two temperature commands as required.
5. Change the Z number at G0 Z-3.95 to the minus version of the number you carefully noted down in 3 above.
6. Bed Level Hot 60c Macro

```
;bed level script bed heated to 60c
;bed heat is left on as usually doing a print after this.
G21 ;set units to millimetre
G90 ;set absolute positioning
M425 X0.02 Y0.02 Z0.02 F1 S0 ; set backlash to 0.02mm
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M140 S65 ; set bed temp for bed level, heat while homing
G28 ;do this now, done in G1029 but takes ages
M190 S65 ; wait for bed temp
;Auto Level
G1029 A ;start levelling
G91; relative positioning for Z offset move
;*****************
G0 Z-x.xx ; Device specific Z offset, reduce to bring print closer to the bed
;(bigger minus number).  (equivalent to M851)
;*****************
G1029 S ;save data
G1029 D0 ;end levelling
G90; restore absolute positioning
G28; home all for safety
```

7. Print something small & quick to check height. I just use a 1x20x20mm square. The bottom should be shiny and you should only just feel the filament lines with your nail.
8. Tweak the nozzle height lower or higher by typing the following command at the terminal in USB connected Luban or Octoprint. G1029 D-0.05 to go down or D0.05 if you want the nozzle to go up and test again. This command moves the whole levelling mesh up or down by the value stated.
9. Once happy with your tweak, go back and change the G0 Z value in the macro above by the adjustment you have just made. This means that your adjustment will stay every time you level.

If you CNC or laser, go back to printing you just run the levelling macro and you are back to your optimal level every time.

If you want to increase the height say to print PETG just use G1029 Dx.xx to raise everything up until you next run the macro then you are back to where you started. Change the macro value to get permanent adjustments.

You should only need to go through this process again if you change the nozzle or mess with the sensor.

Conclusion

I find the sensor works extremely well and repeatability is very good. I measured standard deviation against the mean from 5 full bed leveling runs with the bed at 60C to be less than 0.004mm.

Hope people find this useful and happy to take comments or questions on the Snapmaker2 Forum.

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