Individual Practical Assignment

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Project: Retrofit Automotive Rain Sensing Wipers

Project Summary:

Before explaining the project, we must define the term “automotive rain sensing wipers”. Rain sensing wipers is a system incorporated into a cars wiper system that will, as the name suggests, automatically activate the wipers to wipe the water off the windscreen when rain has been detected. Additionally, it will vary the speed of the wipers depending on the intensity of the rain detected. Due to this being quite a complicated technology, rain sensing wipers have only in the last 20 years become a more common feature on cars but are still not widespread. Amazingly, the rain-sensing wiper system most used today was originally invented in 1978 by Australian, Raymond J. Noack, displaying its difficulties to be properly implemented into mainstream automotive.

Many older cars, some that are not even 10 years old, lack this very useful feature. Hence, my goal was to create a system that could retrofit a rain-sensing wiper system into an older car with minimal cost and effort. For my design, I based it off my own car, a 1987 Alfa Romeo 90, which like many other cars at the time, only had 3 wiper speed settings. These included intermittent (with no way to change the intermittent time gap), slow and fast. From research, I have discovered that the older the car, the easier this system is to install as older cars generally have less wiper settings and hence need less programming to determine what wiper speed should be set at what rain intensity. But this doesn’t mean it can’t be installed on newer vehicles, would just be a bit more work. Also, an important implementation note is that the car must already have electronically driven wipers for this system to work.

Description of System:

Overall, the system is controlled by an Arduino UNO board connected to an Edge server. Rain/water is detected using a rain sensor module that consists of a flat board with two visible connections running atop the board that are effectively ‘short circuited’ when water is on the board as the water droplets are big enough to touch both ends of the connection i.e., the positive and negative. By short circuiting the connections the water lowers the resistance of the connection, with more water lowering the resistance even more. This resistance reading can be read and consists of a value between 0 and 700 but generally never reaches 0 or 700 in actual practice. A separate driver board connected by red and blue wires processes the resistance reading and is the connection point for reading this value to the Arduino. The rain sensor board and driver are separate so the driver board can remain moisture free and therefore, not damage its circuits.

The Arduino reads the analogue value from the rain sensor module and through multiple if statements with range conditions, will power a relay that in implementation, would activate the cars wipers at the selected speed. How these relays connect to the car and activate the wipers depends on the wiper system wiring but relays are definitely needed as the Arduino alone, wouldn't have the voltage to power the cars wiper system as usually they are operating at 12V.

The fan system is a design of my own implementation and wasn't originally planned but was needed as an obvious problem arose in testing. From testing an original system which was identical except for the fan relay and the DC motor itself, an issue arose where the wiper system would get stuck on one wiper setting after rain had been emulated (using a spray bottle) as the water would get stuck and sit on the rain sensor. This would not stop until I would manually wipe off the water which wouldn't be easily possible in a real implantation and defeats the whole purpose of the system. Hence, the idea of the fan was used to 'push' the remaining stuck water droplets off the rain sensor and prevent it from triggering when there was not any rain. Before this though, I had used a servo motor with an arm with a rubber blade (like a cars wiper blade) to wipe off the water every so often when it had been raining. This idea was scrapped, as it was too difficult to implement and needed extra maintenance of looking after the rubber as it would deteriorate over time. Unfortunately, I do not have a picture of the entire system together, but figure 1 shows the servo wiper I created for it.

Figure 1 Custom Made Servo Wiper with Rubber Blade

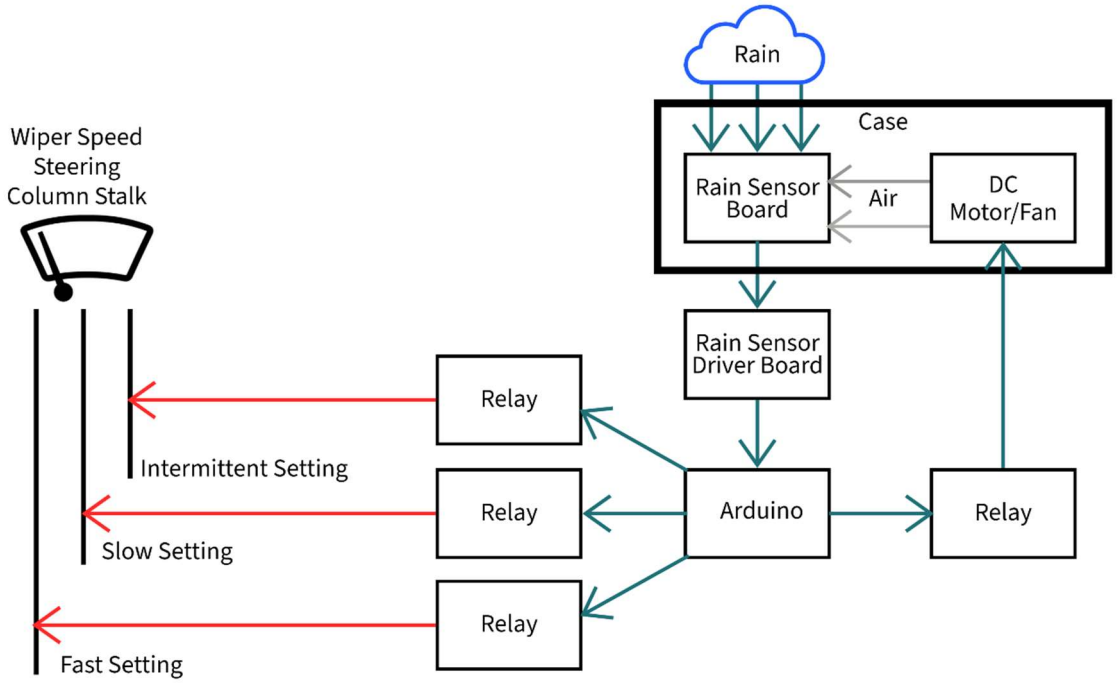
The last consideration for this project was the fact that water and electronics do not go well together. Hence, the Arduino board, driver board for the rain sensor, relays and the DC motor/fan all need to be protected from rain/water to prevent system failure. To prevent the Arduino and rain sensor board from water damage they can be simply separated by distance by extending the length of the wires and placing them inside the vehicle where water shouldn't contact them, like many other automotive electronics. As the DC motor/fan needs to be next to the rain sensor for maximum effectiveness distance will not suffice. Instead, a 'case' was made up for the motor with the rain sensor board attached as well, and while the case has to have openings for the fan to push air, the case will be mounted where the water cannot reach as gravity does not allow the water to travel upwards, i.e., come up through the bottom of the case. Figure 2 shows the ideal case that would achieve this but note that it still is not refined enough to be a final version. Figure 2's design is not used for the test bench implementation as the airflow needed to push the water droplet off the rain sensor board is not acceptable, again, this still needs to be refined and tested more for a final version.

Figure 2 Ideal Case for DC Motor Fan (needs further refinement)

Rain-sensing wiper system consists of:

- Arduino UNO Board [6]
    - USB-B Power Cable to power Arduino UNO board
    - Various connectors and coloured wires to connect Arduino to other components.
- Arduino Compatible Rain Sensor Module [1]
- DC Motor [8]
    - Propeller to stick on the end of the motor to create a fan.
- 4x Relay Modules (Available from Jaycar) [5]
    - 3x for Wiper Speed settings (connect to car wiper steering column stalk)
    - 1x for DC Motor
- Mounting bracket for rain sensor and fan (Custom made/3D Designed and Printed [7][12])

Block Diagram (Hardware):



UML Diagram (Software):

auto_wiper.ino (Arduino IDE [2])
+sensorValue: int +digitalState: int +rain: bool
+setup(): void +loop(): void

Database.py
+device: string +arduino: string +data: string +dbconn: string +cursor:

Testbench Implementation of System:

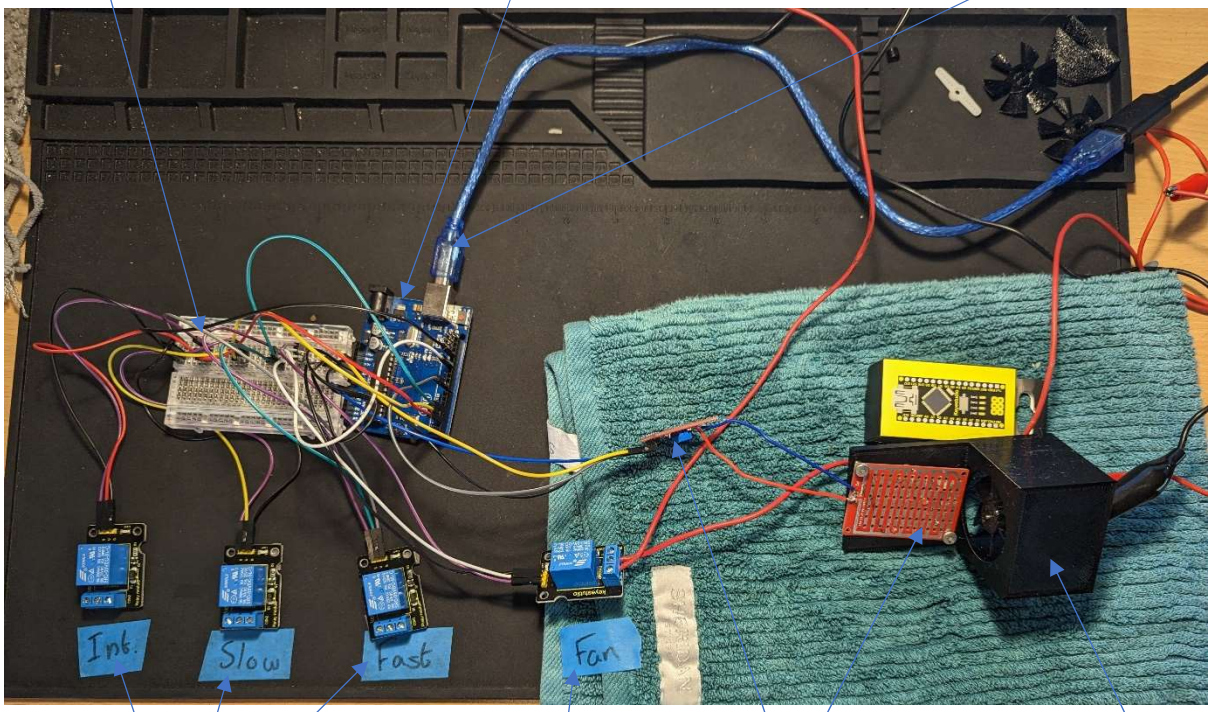


Figure 1 General Overview of System (Testbench Setup)

Temporary Bread Board for Testing

Arduino UNO

USB-B Arduino Power Cable

3x Relays for Selecting Wiper Speed

1x Relay for driving the DC motor/fan.

Arduino Compatible Rain Sensing Module

Note: One on the right is the actual board the rain touches, the other is the control/driver board

Mounting Bracket for rain sensor and DC motor/fan inside

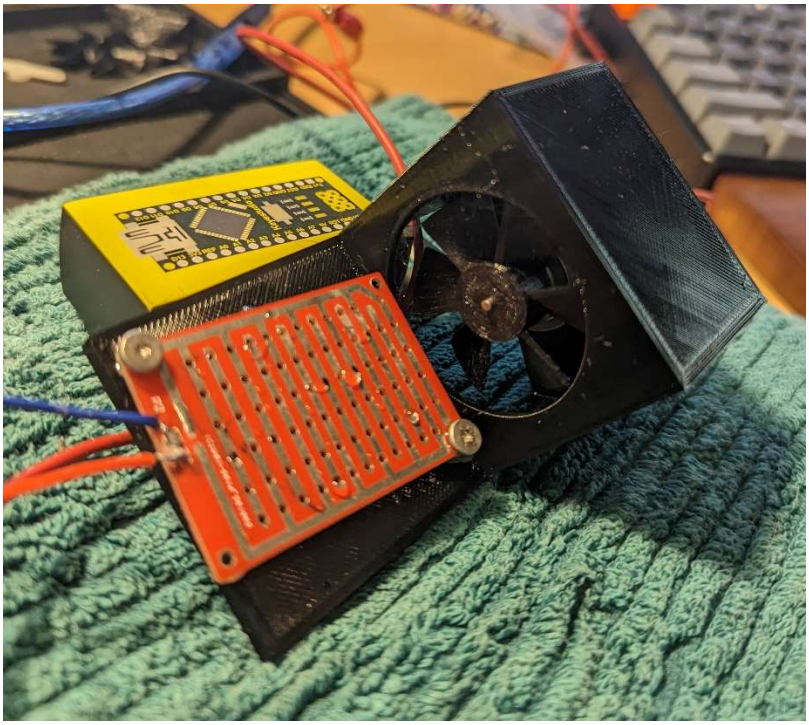


Figure 2 Rain Sensor Board and DC motor/fan

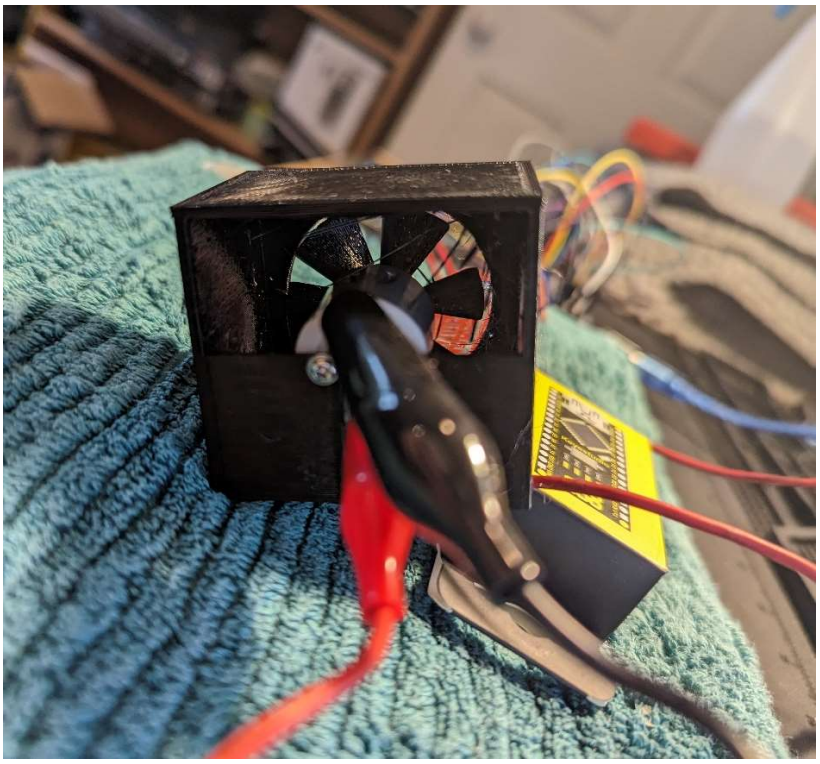


Figure 3 Back of Rain Sensor Mounting Bracket

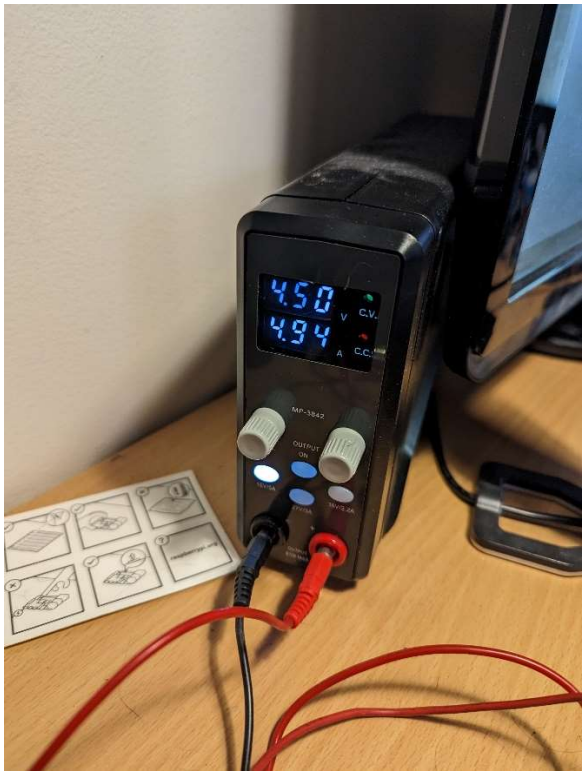


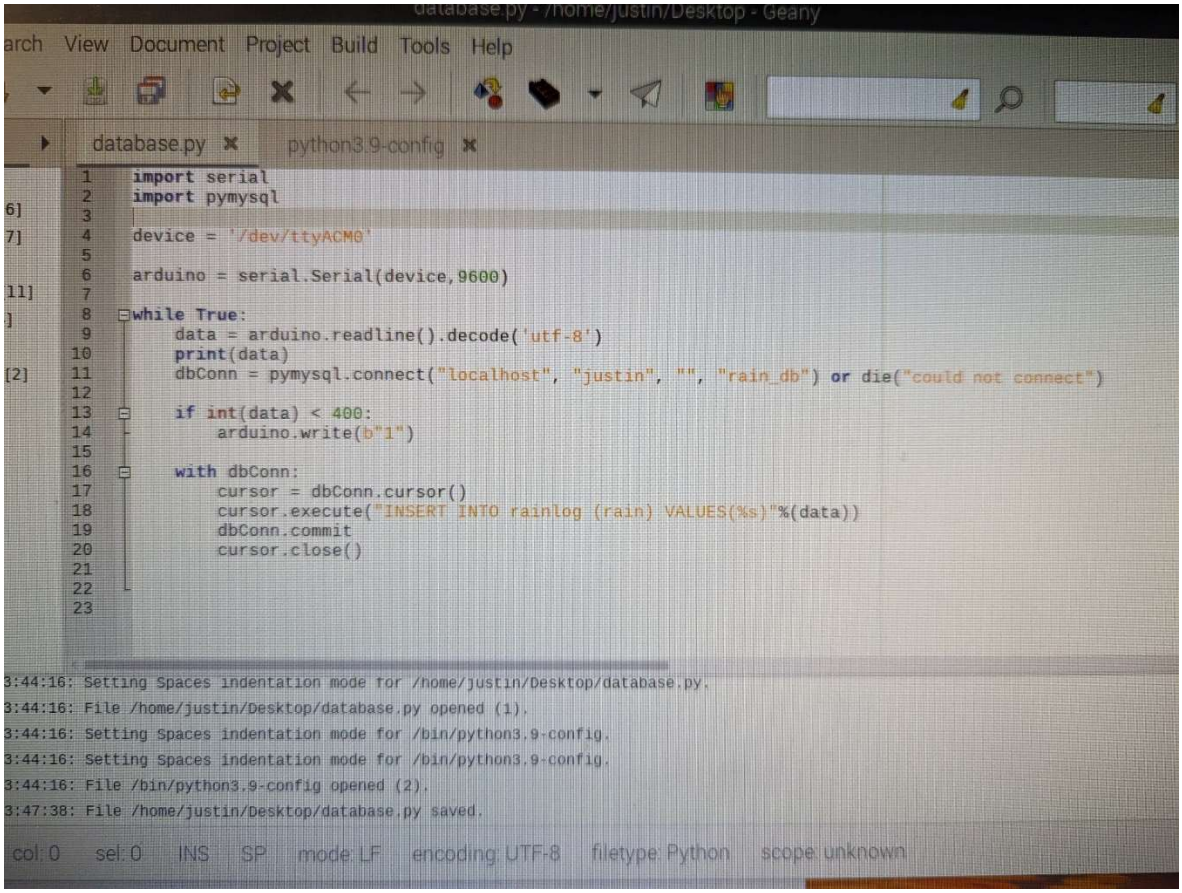
Figure 4 Separate Power Supply used to run DC Motor for test bench setup.

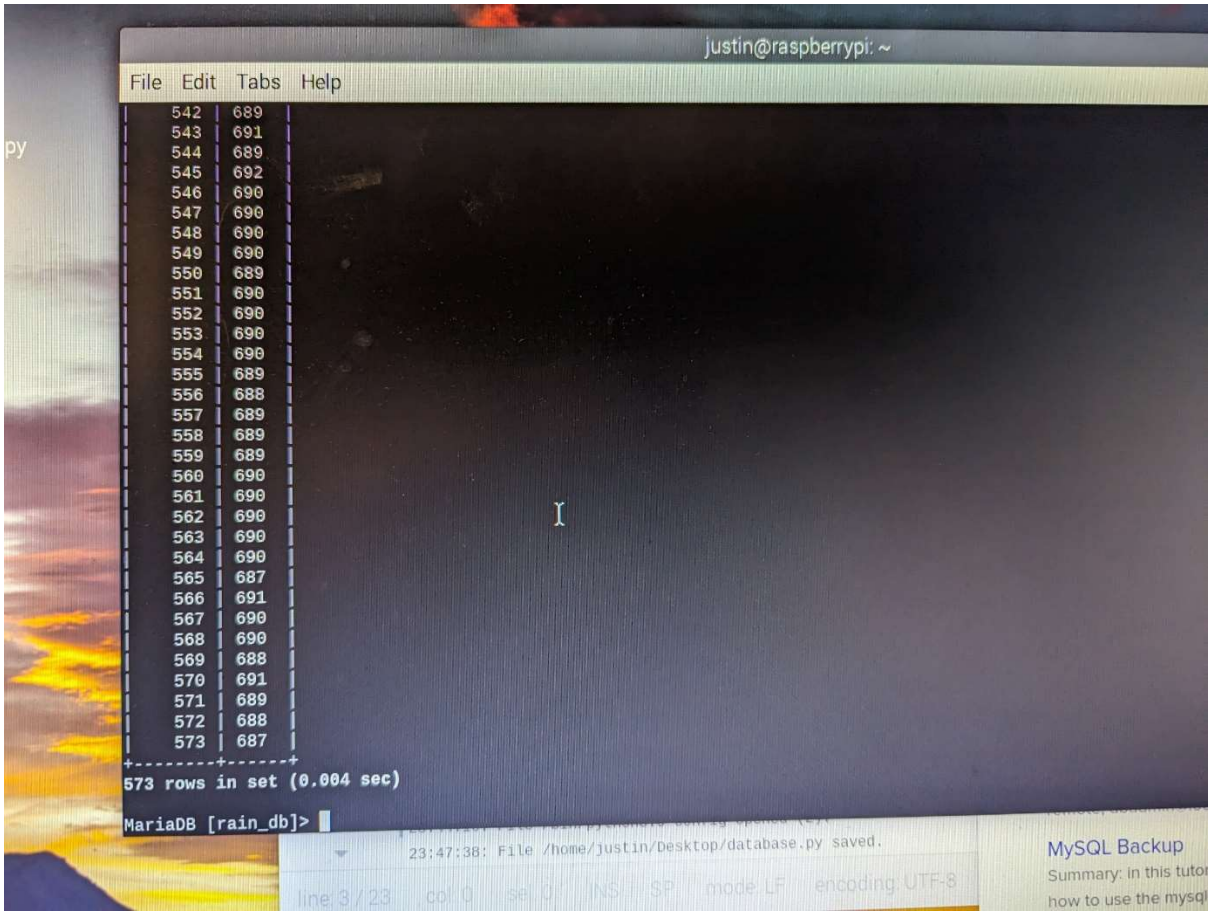
Notes on Test Bench Setup Above:

- Breadboard wouldn't be used in actual implementation, is a waste of space and wires can easily come out. Wires would instead be soldered or crimped in actual system.
- The mounting bracket for the rain sensor and DC motor would be screwed in at an angle like seen in the photo, wouldn't be leaning against a box.
    - Additionally, the shroud that covers the motor needs to be redesigned to save more space for fitting into a tight space in a car (will explain why later).
- The DC motor is powered by a separate workbench power supply running at 4.5V due to the Arduino not having enough voltage to run the relays, rain sensor module and fan simultaneously. Hence, there is a separate relay for the fan so it can be switched electronically on and off by the Arduino.
    - In an actual implementation this would be run off the car's battery.

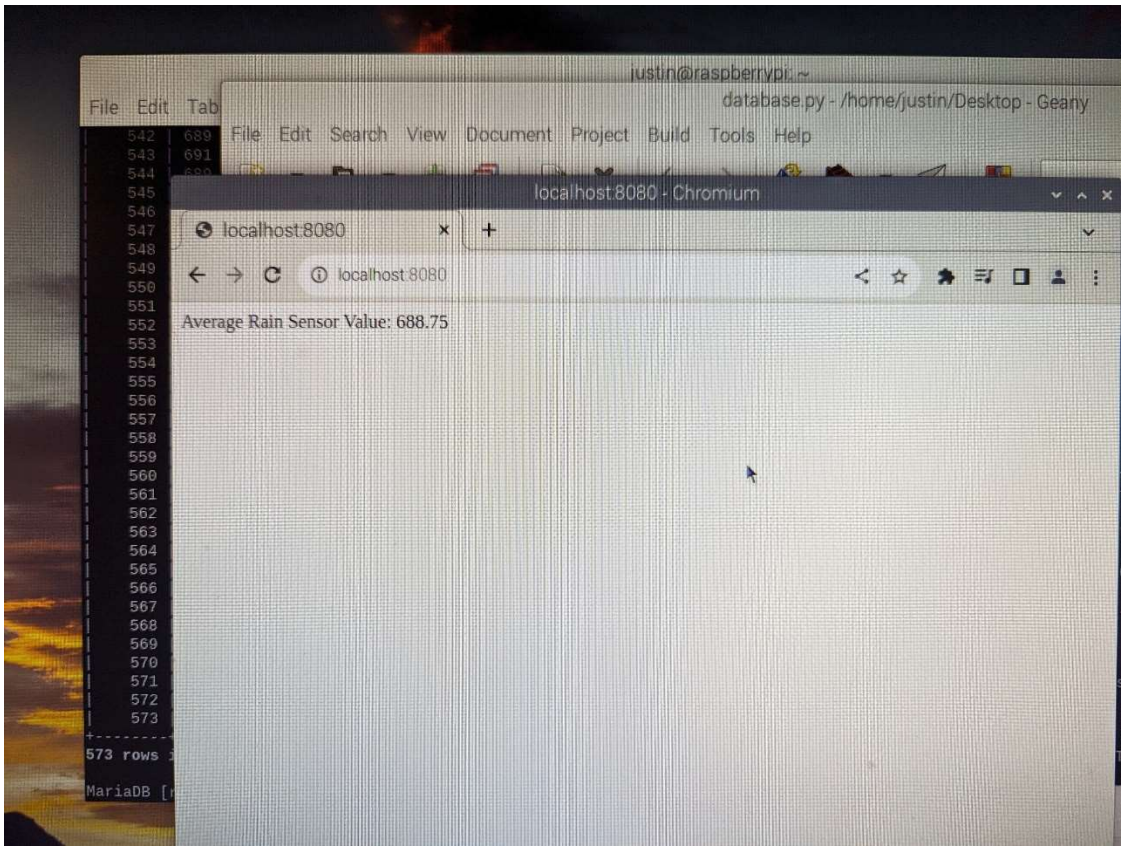
Rain Sensor Data being uploaded to database (with conditional rule):

(Sorry for quality drop, was unsure how to get files from my physical raspberry pi to my main computer so used my phone camera)





Basic User Interface Displaying Calculated Average Rain Sensor Value:



Resources:

1. *Arduino Compatible Rain Sensor Module | Jaycar Electronics* n.d., <https://www.jaycar.com.au/arduino-compatible-rain-sensor-module/p/XC4603?pos=1&queryId=23f1c6e54728a01257a6ccb3a0f4e3ec>.
2. *Arduino Software* n.d., <https://www.arduino.cc/en/software>.
3. 'Arduino UNO digital output voltage (5V) - how it gets the 5V from USB power?' 2016, *Arduino Forum*, <https://forum.arduino.cc/t/arduino-uno-digital-output-voltage-5v-how-it-gets-the-5v-from-usb-power/394009/3>.
4. 'Can you use both the 3.3V and 5V simultaneously?' 2016, *Arduino Forum*, <https://forum.arduino.cc/t/can-you-use-both-the-3-3v-and-5v-simultaneously/378565>.
5. *Duinotech Arduino Compatible 5V Relay | Jaycar Electronics* n.d., <https://www.jaycar.com.au/duinotech-arduino-compatible-5v-relay/p/XC4419>.
6. *Duinotech UNO r3 Main Board | Jaycar Electronics* n.d., <https://www.jaycar.com.au/duinotech-uno-r3-main-board/p/XC4410?pos=7&queryId=bcfec9cf81851ef97e236aad15f6d266&sort=relevance&searchText=arduino%20uno>.
7. *Fusion 360 | Free Software for Students and Educators | Autodesk* n.d., <https://www.autodesk.com/campaigns/education/fusion-360>.
8. *Hobby Motor - Medium Torque | Jaycar Electronics* n.d, <https://www.jaycar.com.au/hobby-motor-medium-torque/p/YM2707?pos=1&queryId=e67a503bfe8df1b2746a375fb5ef7894&sort=relevance&searchText=hobby%20motor>.
9. *Oracle VM VirtualBox* n.d., <https://www.virtualbox.org/>.
10. 'Rain Sensing Wiper using Arduino and Servo Motor' 2017, *Electronic Circuits and Diagrams-Electronic Projects and Design*, <https://www.circuitstoday.com/rain-sensing-wiper-project>.
11. *Rain Sensor with Arduino for making Automatic Car Windshield Wiper. – MYTECTUTOR* n.d., <https://mytectutor.com/rain-sensor-with-arduino-for-making-automatic-car-windshield-wiper/>.
12. 'UltiMaker Cura: Powerful, easy-to-use 3D printing software' n.d., *https://ultimaker.com*, <https://ultimaker.com/software/ultimaker-cura>.

Appendix:

All source code, sketches, scripts, etc, used are uploaded as separate files on Canvas.