SDMAY20-27 : Gauss Sensor for Magnet Array Filter

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Figure 3.1: Magnetic Array Filter (MAF)

Problem statement: Closed engine systems have contaminants that can build within a mechanical system. The filter for a vehicle helps to try and trap these particles but is not very effective for small contaminants where magnetic array filter used to help trap smaller contaminants in the filter. However, when the filter reaches a certain threshold, it will fail to capture more contaminants. Currently, there is no way of telling when the filter has reached the threshold

Solution: Design a sensor that is able to give interpretation of the amount of iron contaminants collected, accurately determine when this threshold is reached, and alert the user that it is time to change the filter.

Non-functional requirements:

- Reduce time and money on gradually checking, changing, and replacing filter.
- Make sure iron particle is not going through system
- Increasing engine life
- Improve efficiency of overall maintenance process

Functional Requirement:

- Detect magnetic particles, iron (sensitivity **0.05 µm**)
- Detect when then buildups reach the threshold
- Indicate the time to change the filter
- Indicate when there is a significant change in the buildups of particle

Hardware and Software:

For hardware, we are using the following:
Arduino UNO REV3
Standard Computer
DRV5053, DRV5056, DRV5057 Hall Effect Sensor
Magnet Array Filter
For software, we are using the following:
Arduino Programming Tool
Processing
PyCharm
AutoCAD
Autodesk Eagle
GitLab

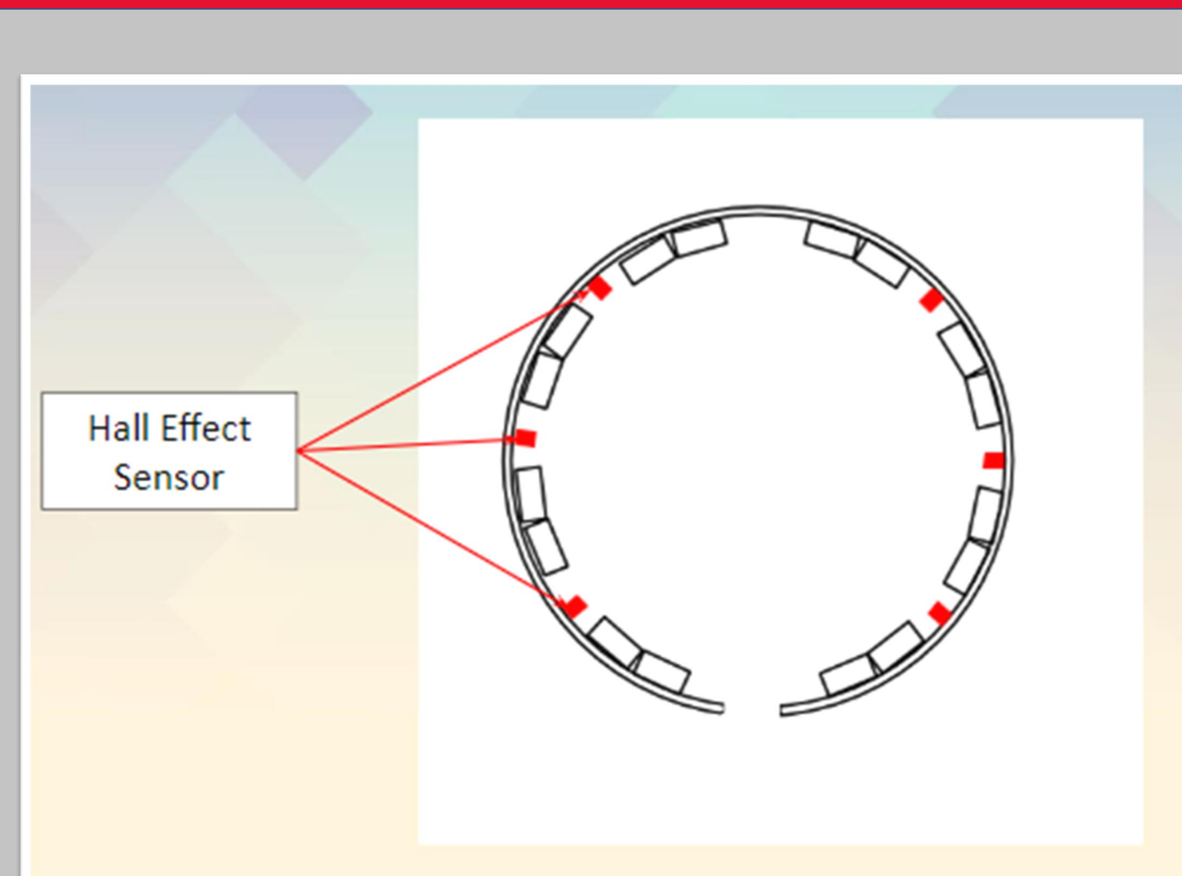


Diagram 2: Position of sensors on magnetic collar

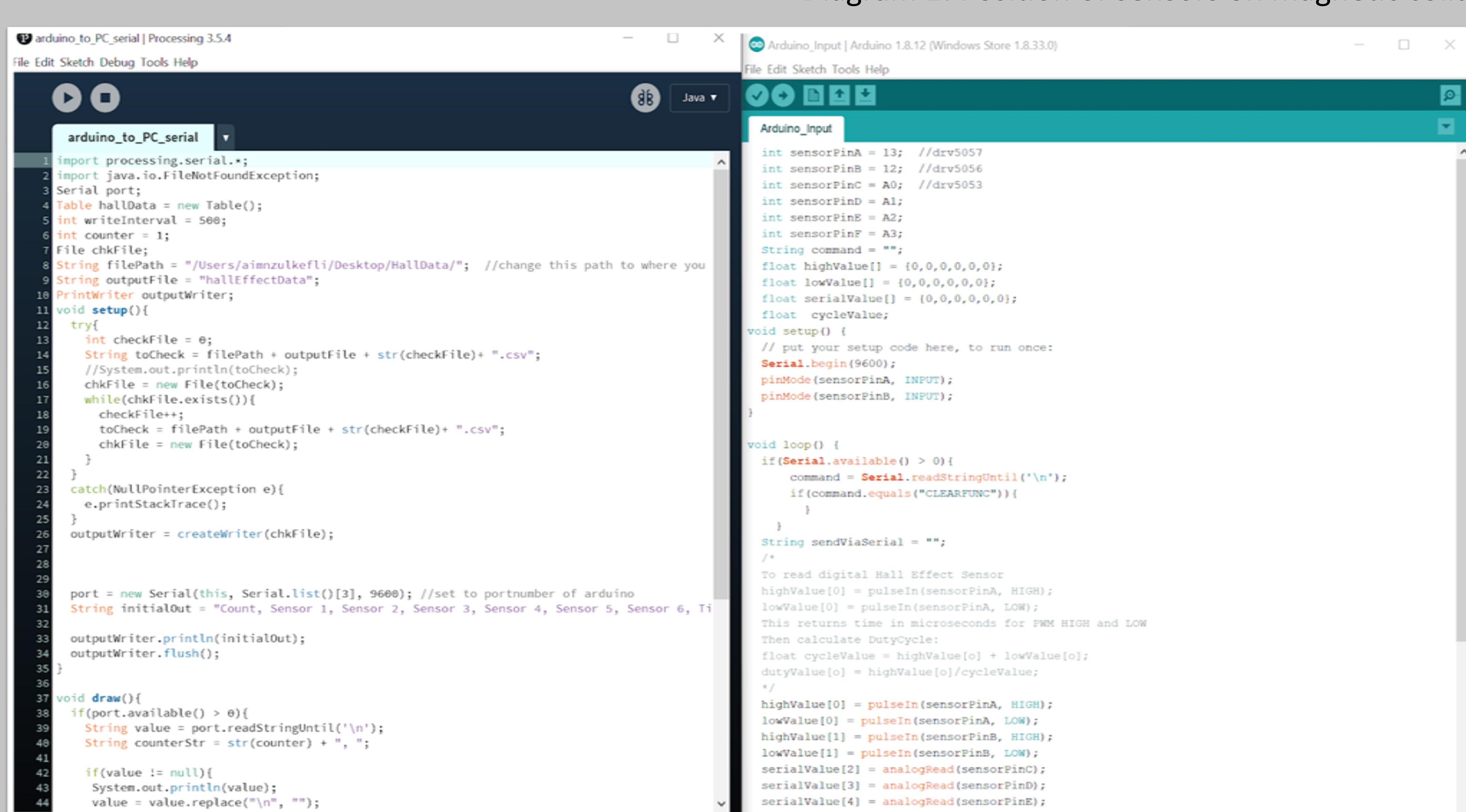
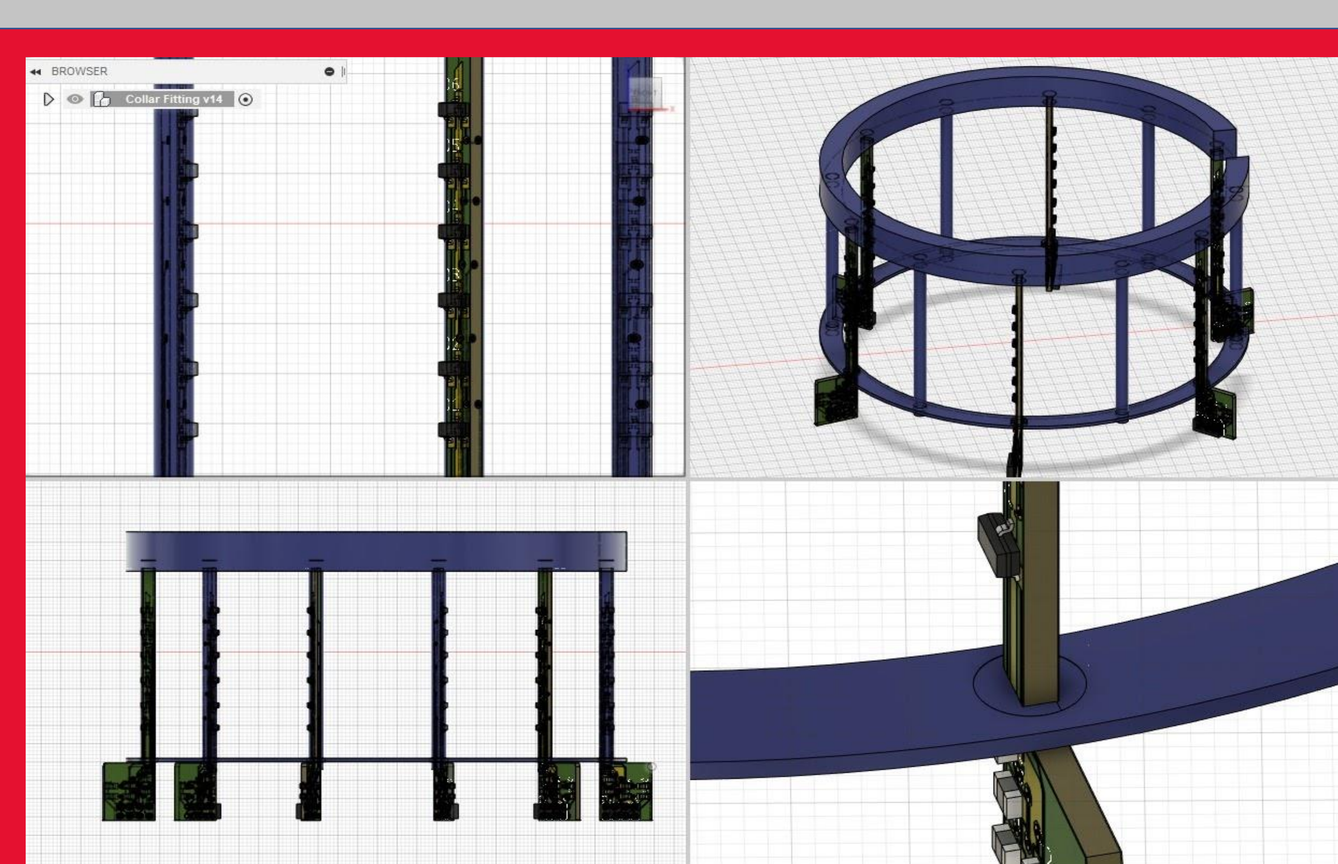


Diagram 3: SW designs using Processing and Arduino

Market / Literature Survey:

- Currently on the market, there is no way of knowing when the filter has reached a certain threshold to where particles will not be caught.
- This is because as more of the wear debris metal particles are trapped by the magnetic array filter, the particle build ups causes a deterioration in the ability to attract any more of the wear particles inside the oil system.



Solutions:

Multiple sensors
Change positioning within the collar
Collect lots of data
Acquired dirty oil samples from CyRide to be used for sampling and data set for threshold
Change temperature during testing

	Sensitivity
Honeywell (SS39ET)	1 ~1.75 (mV/Gauss)
Texas Instrument (DRV5053)	-11 ~ +45 (mV/mT)
Texas Instrument (DRV5055)	-100 ~ 100 (mV/mT)
Texas Instrument (DRV5056)	25 ~200 (mV/mT)

Diagram 1: List of options of different model of Hall Effect sensor

Challenges:

- Not able to test the field with increasing temperatures accurately
- Does not have direct access to a vehicle
- Time consumption on data acquisition
- Choosing the right hall effect sensors

Possible Risks and Risk Management:

1. Accuracy
   Largest risk is accuracy of the sensors. The environment has large fluctuation in temperature and also repetitive mechanical vibration.
2. Equipment
   Risk in using hydraulic test bench. It is used extensively for data collection. Despite training, there is still high risk in using it. (Eg: oil spills, high temperature oil leaks)
3. Knowledge of Area
   Knowledge on Hall Effect sensors. We are taught how they work but do not have in depth hands-on experience with them. This can cause some delays in reaching milestones for the project.

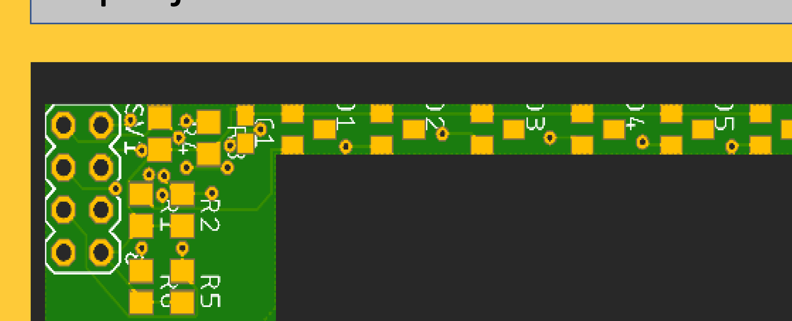


Diagram 4: Final Board design