SDMAY20-27 : Gauss Sensor for Magnet Array Filter

Team : sdmay20-27

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Client : Magnet Array Company, Dennis O'neel

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 <u>amount of iron contaminants</u> collected, accurately determine when this threshold is reached, and alert the user that it is time to change the filter.



Figure 3.1: Magnetic Array Filter (MAF)

Solutions:

Multiple sensors Change positioning within the collar Collect lots of data

Non-functional requirements:

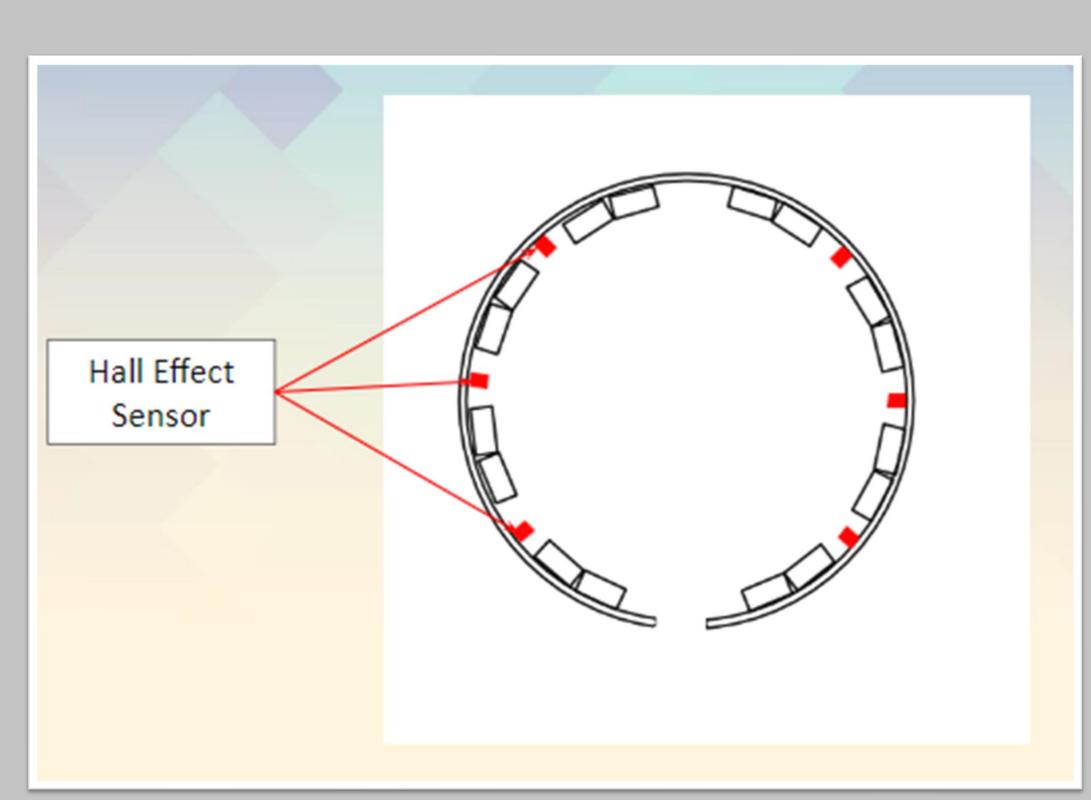
- Reduce time and money on gradually checking, changing, and replacing filter.
- Make sure iron particle is not going through system
- Increasing engine life
- Improve efficiency of overall maintenance process

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



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)

Challenges:

- Not able to test the field with increasing temperatures accurately
- Does not have direct access

Autodesk Eagle

GitLab

Diagram	2:	Position	of	sensors on	magnetic	collar
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Parduino_to_PC_serial Processing 3.5.4 – 🗌 🗙	📀 Arduino_Input Arduino 1.8.12 (Windows Store 1.8.33.0) — [
e Edit Sketch Debug Tools Help	File Edit Sketch Tools Help	
arduino_to_PC_serial	Arduino_Input	i
<pre>import processing.serial.*; import java.io.FileNotFoundException; Serial port; Table hallData = new Table(); int writeInterval = 500; int counter = 1; File chkFile; String filePath = "/Users/aimnzulkefli/Desktop/HallData/"; //change this path to where you String outputFile = "hallEffectData"; PrintWriter outputWriter; void setup(){ try{ int checkFile = 0; String filePath = filePath = new filePat</pre>	<pre>int sensorPinA = 13; //drv5057 int sensorPinB = 12; //drv5056 int sensorPinC = A0; //drv5053 int sensorPinD = A1; int sensorPinE = A2; int sensorPinF = A3; String command = ""; float highValue[] = {0,0,0,0,0,0}; float lowValue[] = {0,0,0,0,0,0}; float serialValue[] = {0,0,0,0,0,0}; float serialValue[] = {0,0,0,0,0,0}; float cycleValue; void setup() { // put your setup code here, to run once:</pre>	
<pre>14 String toCheck = filePath + outputFile + str(checkFile)+ ".csv"; 15 //System.out.println(toCheck); 16 chkFile = new File(toCheck); 17 while(chkFile.exists()){ 18 checkFile++; 19 toCheck = filePath + outputFile + str(checkFile)+ ".csv"; 20 chkFile = new File(toCheck); 21 } 22 } 23 catch(NullPointerException e){ 24 e.printStackIrace();</pre>	<pre>Serial.begin(9600); pinMode(sensorPinA, INPUT); pinMode(sensorPinB, INPUT); } void loop() { if(Serial.available() > 0){ command = Serial.readStringUntil('\n'); if(command.equals("CLEARFUNC")){ } }</pre>	
<pre>25 } 26 outputWriter = createWriter(chkFile); 27 28 29</pre>	} String sendViaSerial = ""; /* To read digital Hall Effect Sensor	
<pre>30 port = new Serial(this, Serial.list()[3], 9600); //set to portnumber of arduino 31 String initialOut = "Count, Sensor 1, Sensor 2, Sensor 3, Sensor 4, Sensor 5, Sensor 6, Ti 32 33 outputWriter.println(initialOut); 34 outputWriter.flush();</pre>	<pre>highValue[0] = pulseIn(sensorPinA, HIGH); lowValue[0] = pulseIn(sensorPinA, LOW); This returns time in microseconds for PWM HIGH and LOW Then calculate DutyCycle: float cycleValue = highValue[0] + lowValue[0];</pre>	
<pre>35 } 36 37 void draw(){ 38 if(port.available() > 0){ 39 String value = port.readStringUntil('\n'); 40 String counterStr = str(counter) + ", "; 41</pre>	<pre>dutyValue[0] = highValue[0]/cycleValue; */ highValue[0] = pulseIn(sensorPinA, HIGH); lowValue[0] = pulseIn(sensorPinA, LOW); highValue[1] = pulseIn(sensorPinB, HIGH); lowValue[1] = pulseIn(sensorPinB, LOW);</pre>	

to a vehicle

- Time consumption on data acquisition
- Choosing the right hall effect sensors

Possible Risks and Risk

Management:

Accuracy

Largest risk is accuracy of the sensors. The environment has large fluctuation in temperature and also repetitive mechanical vibration.

Equipment 2.

3.

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)

value = value.replace("\n", "");

System.out.println(value);

f(value != null){

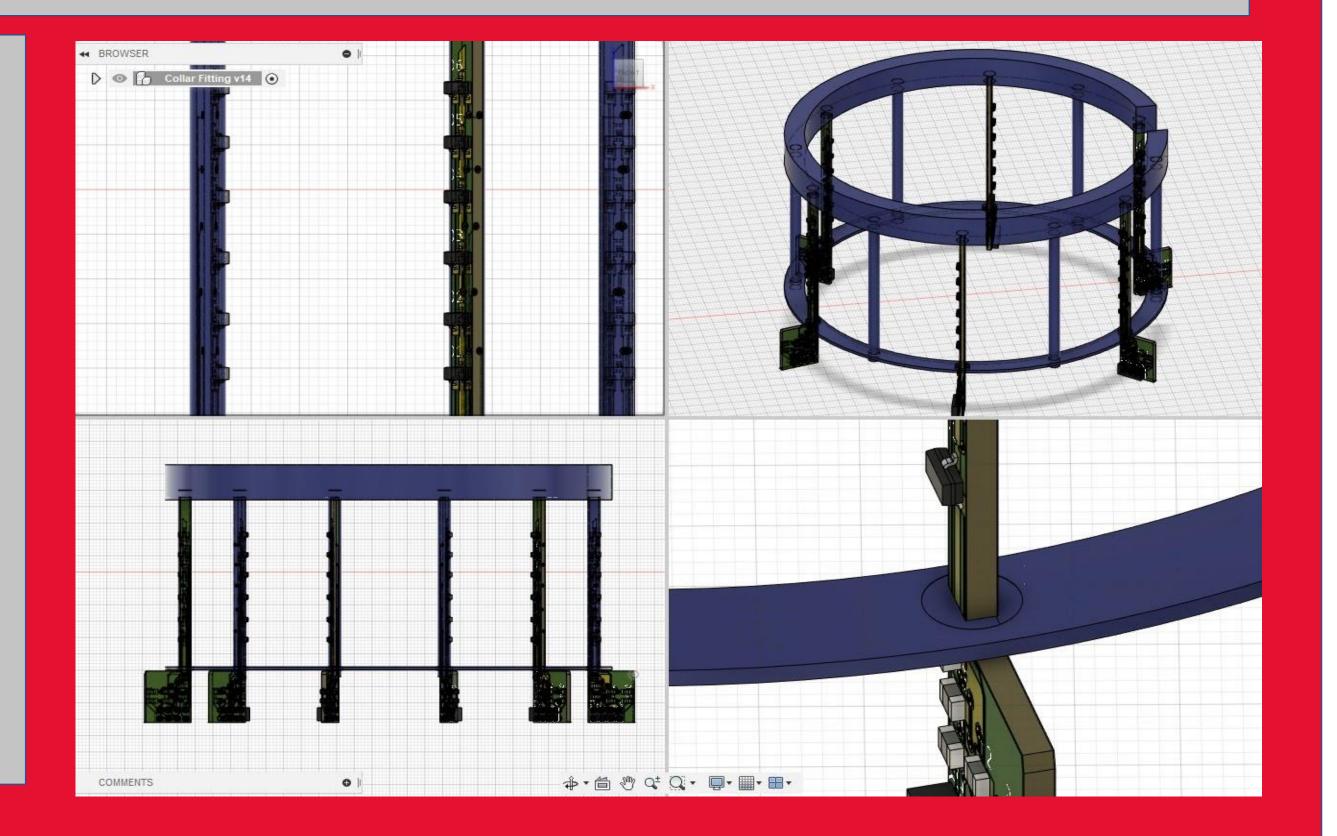
erialValue[5] = analogRead(sensorPinF);

serialValue[3] = analogRead(sensorPinD);

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.



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