First Notification of Loss (FNOL) Machine Learning Process used for Telematics

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Abstract— Machine Learning (ML) is a subfield of computer science that evolved from the study of pattern recognition and computational learning theory in Artificial Intelligence (AI). Machine learning explores the study and construction of algorithms that can learn from and make predictions on data. Such algorithms operate by building a model from example inputs in order to make data-driven predictions or decisions, rather than following strictly static program instructions. [1]. When a vehicle (car) comes across an accident, telematics device associated with it will send the accident information (crash or the impact data) to a system. This alert notification (FNOL – Fist Notification of Loss alert) will be send to the recipients. Later this data is stored for analysis, reporting and for claiming the insurance. As data from an accident is understood, reconstruction tools will revolutionize fault allocation, with early intervention transforming FNOL activity and situation control; delivering cost reductions throughout the process. This will help the telematics industries to claim the insurance for their vehicle (which is met with an accident)[2]. FNOL ML API (Application Programming Interface) will identify if FNOL message which is received from the device is a genuine accident message and its value is greater than or equal to configured threshold. If so, it will send an email about that incident (impact) to all the email recipients configured in the system with the accident information[2]. In the present investigation, an attempt was made to analyze FNOL ML process. Computer program (code) was written to develop the Machine Learning capability. This is to understand and predict the accident data which is very useful for telematics industry to process the motor insurance claims. The FNOL ML will receive the accident data from the device (fitted to the vehicle), do the calculation for machine learning process and finally send the mail to the respective mail distribution list informing about the accident and the accident data.

Key words: Machine Learning, FNOL, Telematics, Artificial Intelligence, API

I. INTRODUCTION

A. Machine Learning (Ml)

Machine learning is closely related to computational statistics; a discipline that aims at the design of algorithms for implementing statistical methods on computers. It has strong ties to mathematical optimization, which delivers methods, theory and application domains to the field. Machine learning is employed in a range of computing tasks where designing and programming explicit algorithms is infeasible. Example applications include spam filtering, optical character recognition (OCR), search engines and computer vision. Machine learning focuses more on exploratory data analysis. [3]

A ML System will provide an automated First Notification of Loss (FNOL) alert, with a situational analysis. The developed system will produce a suite of accident reports, depending on the severity, recreating the last movements of the vehicle and all the associated attributes. This includes the sequencing of any impacts, allowing claims defense or early settlement.

B. First Notification Of Loss (FNOL)

FNOL solution is designed as an interactive tool, meant to guide customer service representatives through the loss reporting process while obtaining more accurate and relevant facts about the loss of vehicle being reported. FNOL solution intelligently route the reported loss to the appropriate claims handling system based on the policy data. Once all loss of data is gathered, the claim is registered in the appropriate claims processing system. [4]

C. Telematics

Telematics refers to the use of wireless devices and "black box" technologies to transmit data in real time back to an organization. Typically, it's used in the context of automobiles, whereby installed or after-factory boxes collect and transmit data on vehicle use, maintenance requirements or automotive servicing. Telematics is a general term that refers to any device which merges telecommunications and informatics. Telematics includes anything from GPS systems to navigation systems. It is responsible for many features in vehicles from OnStar to hands free mobile calling. [5]

Telematics enables wireless data communication and opens up a huge range of possibilities. It can enable you to have wireless television and internet on your vehicle. Telematics is essentially a range of different features, options and devices that are brought together by a single principle – data and communication. Through telematics we can enjoy many benefits in our vehicle on a daily basis such as roadside assistance and remote unlocking of your vehicle. Telematics is also used heavily in fleet tracking and management. More and more fleet owners are finding huge savings by adopting telematics technology. [6]

Telematics is the use of technology to measure the three-dimensional movement of an object. More specifically, vehicle telematics utilize mobile or other devices which access or contain accelerometers, magnetometers, gyroscopes and GPS to measure specific driving actions. The devices gather information from these sensors to accurately calculate driving trends, including factors such as mileage, hard breaking and accelerating, turns, time of day driven, and significantly more in depth information on the vehicle's movement.[7]
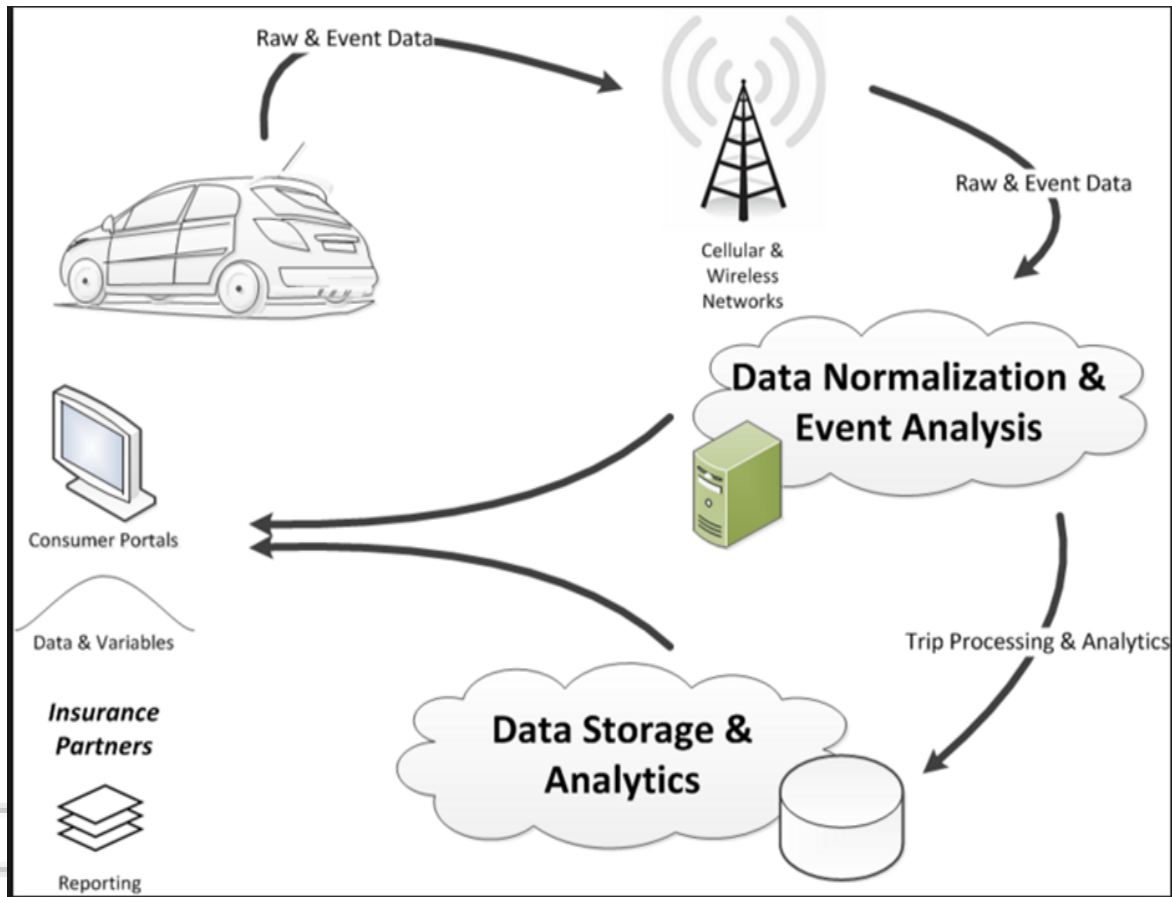
Fig. 1: Telematics data flow.

II. OBJECTIVE OF FNOL ML PROCESS

The main objective of the FNOL ML system (worker role) is to decode the detail acceleration data collected from the device and then analyze data with the help of machine learning to decide if an email must be generated with an FNOL alert.

Once this message is identified as a genuine accident message, the vehicle's acceleration across 3 axes at the time of the accident is retrieved. This information is sent to Machine Learning API which returns a threshold value. If this threshold value is greater than or equal to configured threshold limit, an email will be sent to all configured recipients with the details of this accident.

The data from a device is collected and it is turn into information and knowledge. The Insurance Information Exchange (iiX) is a device agnostic information platform that collects and analyses data from multiple telematics devices. The information is then shared via the iiX to Insurers, Brokers and the Policy Holder in the form of FNOL alerts which is used for claims process.

III. REQUIREMENT CONSIDERATIONS

A. Select Data Points Around Accident.

The FNOL ML Worker Role needs to determine the point of impact and then for selected 30 points: 5 points before to 25 points after the impact.

B. Determine Force Of Impact

To determine the force of the impact the acceleration peak must be on one side of x–axis for at least 30 ms (3 data points). This statement is true then determines the angle of the impact using Trigonometry.

C. Create ML Data Structure

A specific data structure is used as the input to Azure ML. This structure can be developed using C# code.

D. Send The Email (FNOL Mail Notification)S

The FNOL ML will reply to the request with a probability factor that we can measure against the pre-set parameters.
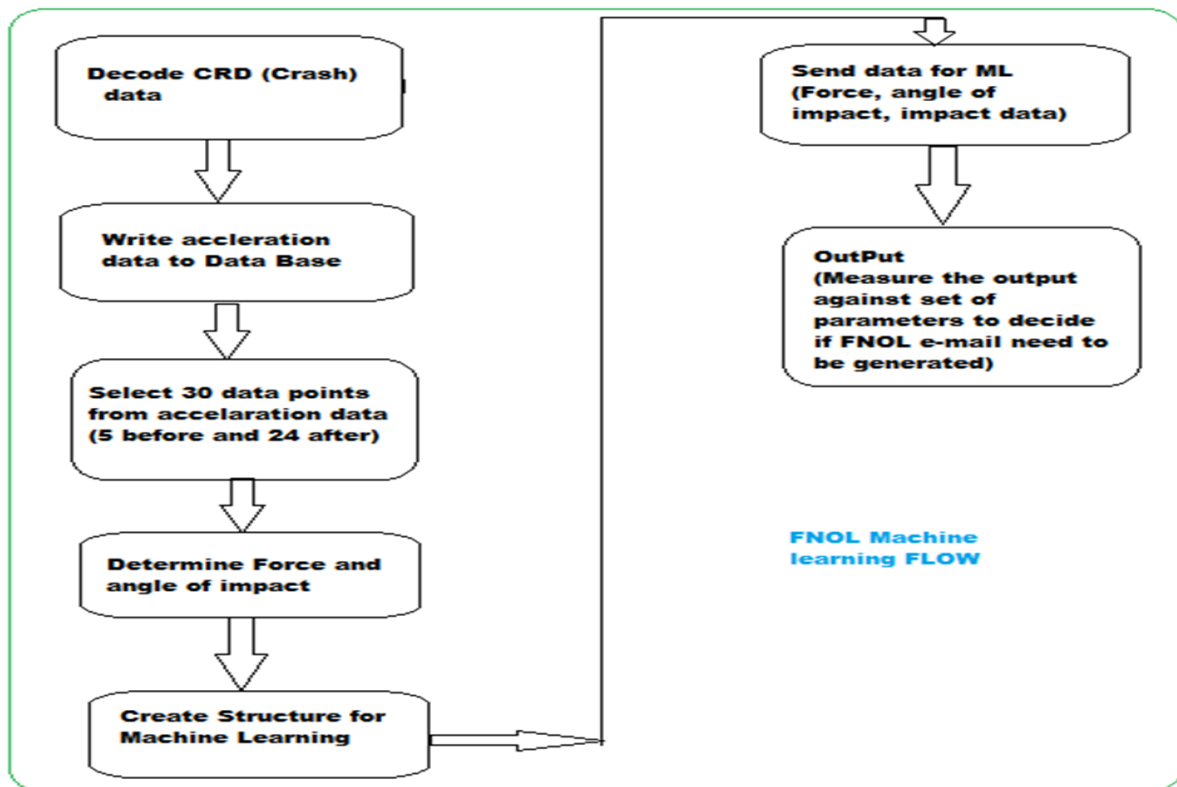
Decode CRD (Crash) data

Write acceleration data to Data Base

Select 30 data points from acceleration data (5 before and 24 after)

Determine Force and angle of impact

Create Structure for Machine Learning

Send data for ML (Force, angle of impact, impact data)

OutPut (Measure the output against set of parameters to decide if FNOL e-mail need to be generated)

FNOL Machine learning FLOW

Fig. 2: FNOL Machine Learning flow.

IV. FNOL MAIL GENERATION WORK FLOW

WORKER ROLE : 1

1) Create Accident_Table (with Structure: AccidentId, DeviceIMEI, MessageType, AccelX, AccelY, AccelZ, AccidentCounter, AccidentDataType, LMTime, AccidentFrameNumber)
2) Create Accident_Process_Table (with structure ID, DeviceIMEI, Accident Couner, RecordCount, Flag)

Decode +CRD messages from Queue

Insert decoded messages in to the Accident_Table

Insert Accident_Process_Table with a flag (Flag= 40, for 1000 count of records)

Select 1000 records from Accident_Table

Select maximum acceleration points in between 1000 records (Accident ID)

From Accident ID, take 30 data points (5 before and 24 after)

From the impact points determine the area under the curve (impact points until it reaches zero)

Determine the Force (Area under the curve) Deterimine angle of impact

Check the device calibration

WORKER ROLE : 2

Parameters (calibrated, audit, Angle of impact, energy, Maximum G, Azure ML value, Accident flag) will be instered to DB with XYZ value parameters (30 data points) for Azure ML Analysis)

Generate and send email if
1) Force calculated > Threshold Force
2) Accident counter flag=1
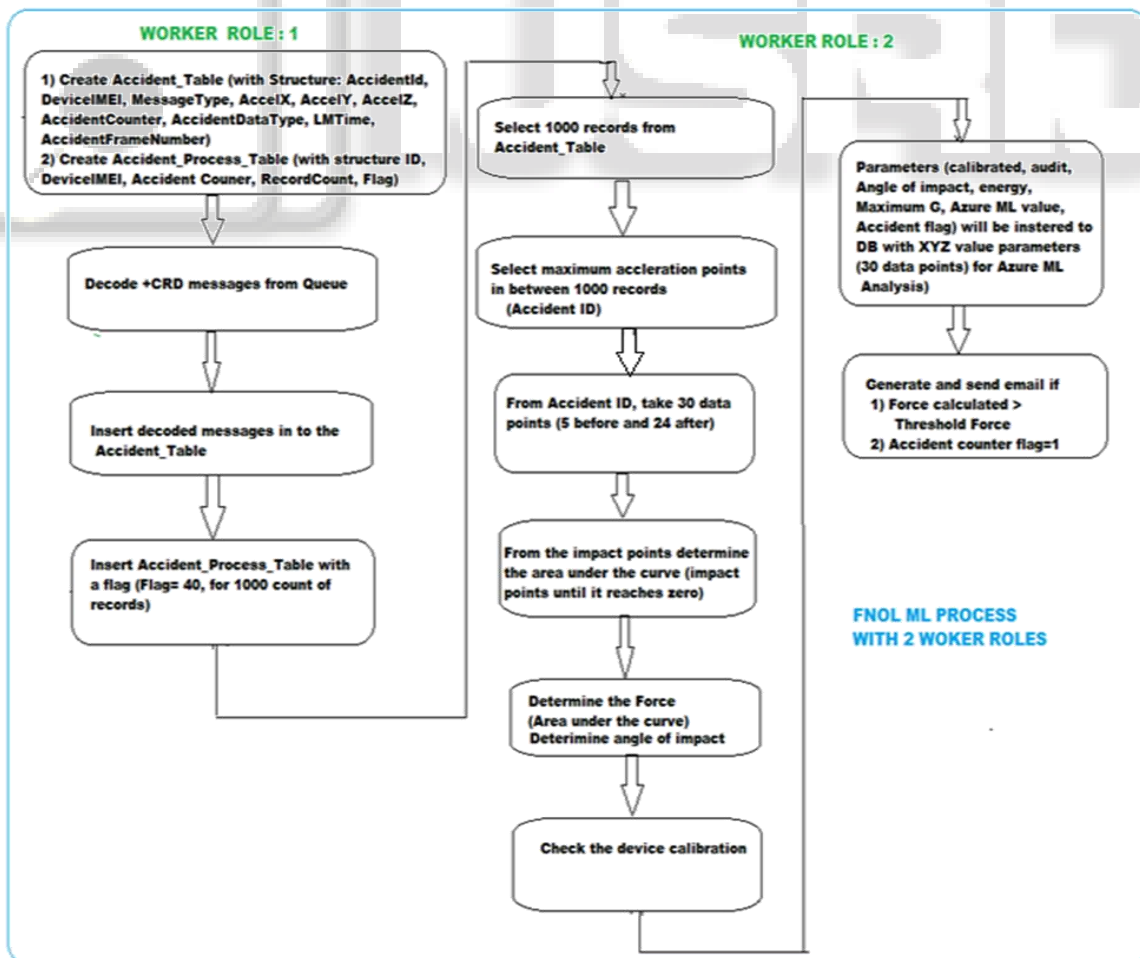
FNOL ML PROCESS WITH 2 WOKER ROLES

Fig. 3: FNOL Machine Learning worker role calculation.

V. SOLUTION IMPLEMENTATION DETAILS

The solution for FNOL ML Worker role will be implemented as follows:

A. Create Worker Role: 1

This worker Role will decode the accident/crash messages from the queue, decode these messages, and insert to Accident Table. Also create Accident process table to take a count of 1000 records for processing the crash data.

1) Accident_Table Structure As Follows
- AccidentID,
- DeviceIMEI,
- MessageType,
- AccelX,
- AccelY,
- AccelZ,
- AccidentCounter, //[Crash counter]
- AccidentDataType,
- AccidentFrameNumber,
- LMTime

2) Accident_Process_Table Structure As Follows
- ID,
- DeviceIMEI,
- AccidentCounter, //[Crash counter]
- RecordCount, // Total Count per device Combined with Accident Counter
- Flag //(if record count is 1000 then set 40 [sent for process])

a) Steps:
1) Decode the +CRD (crash) data from queue.
2) Insert the decoded +CRD data into Accident_Table.

While decoding the +CRD messages there are 2 important parameters to look at.
- Crash Counter – this is a unique counter that will link the +CRD and +CRA data.
- Send Time – this is the time that the +CRD message was send from the unit.

When looking at these 2 parameters, we will be able to tie each 1000 record block to a specific accident/incident message.
3) Insert Accident_Process_Table with a flag (with a value 40 for 1000 count of records)
4) Determine the record count with the Device IMEI, Accident Counter and update the total count on it.

3) Create Worker Role: 2
This Worker Role will take 1000 records and process them for sending mails.
1) Check Accident_Process_Table flag value is 40.
2) Select 1000 records from Accident_Table if Accident_Process_Table flag value is 40.
3) Select maximum acceleration point in between 1000 records (i.e., Accident ID - define impact point).

4) From that Accident ID take 30 data points: 5 before and 24 points after.
5) In that 30 data points, determine the curve (from the before impact point [+ve or –ve] to till it reaches 0)
6) Determine the Force (this up to 2 to 24) – This must be the area under the curve

Determine force and angle of impact based on impact point (X,Y and Z).

4) Force Determination Logic As Follows:
- Area under the curve of the impact is used for calculation of force.
- Calculate the area under the x and y axis separately
- Take the value times gravity to get the acceleration and then times by the interval which is 0.01(10 ms).
- The equation for a single value is (value*9.81*0.01)
- Add all the areas to get the total area

5) Determine Angle Of Impact As Follows:
- If ForceX or ForceY value is '0' then set degree to '0' else set degree = 270 + DEGREES(ATAN(ForceX/ForceY))
- If ForceX > 0 and ForceY < 0 then set degree = 90 − DEGREES(ATAN(-ForceX/ForceY))
- If ForceX < 0 and ForceY < 0 then set degree = 90 + DEGREES(ATAN(ForceX/ForceY))
- If ForceX < 0 and ForceY > 0 then set degree = 270 − DEGREES(ATAN(ForceX/-ForceY))
- Finally, If degree > 180 the set degree = degree − 180 else degree = degree + 180

1) Check the device calibration: If the deviceIMEI has entry in the 'DeviceCalibration' table then device is Calibrated else not calibrated.
2) Audit device or now: If the deviceIMEI status is '1' in the 'AuditDevices' table then Audit Device else not audit.
3) Following parameters need to be calculated:
- Total Energy/Force (Total Area * 1300)
- Maximum Gravity: SQRT[SQR(ForceX) + SQR(ForceY)]
- ML probability value (when returned from system)
- Accident confirmation flag (true/false) – this will be updated manually when we confirm if it was an actual accident.

All of these parameters must be inserted into a database with the XYZ value parameters (30 data points) for the ML analysis
4) Generate and send FNOL email

Generate FNOL email and send to distribution list if below conditions are satisfied
- If the Force determined is > Threshold value
- Accident counter flag is '1' (Mail Send)

VI. MACHINE LEARNING DATA AND ML CALCULATION

	AccelX	AccelY	AccelZ			
01	0.000000000	0.024390244	1.048780488			
02	0.000000000	0.036585366	1.024390244			
03	0.024390244	0.024390244	1.012195122	SQUARE (AccelX)	SQUARE (AccelY)	SQRT(X + Y)
04	0.012195122	0.024390244	1.097560976	X	Y	Cforce
05	0.000000000	0.024390244	1.073170732	0.000000000	0.000594884	1.15169542
06	0.219512195	-3.012195122	0.121951220	0.048185604	9.073319453	3.020182951
07	-0.060975610	-0.743902439	0.951219512	0.003718025	0.553390839	0.746397256
08	-0.231707317	-0.548780488	0.926829268	0.053688281	0.301160024	0.859012492
09	-0.097560976	0.768292683	1.353658537			
10	-0.073170732	0.243902439	1.109756098		Average (Cforce)	1.44432203
11	0.024390244	0.195121951	1.024390244			
12	0.000000000	0.073170732	1.060975610			
13	0.000000000	0.036585366	1.060975610			
14	0.000000000	0.012195122	1.048780488			
15	0.048780488	0.024390244	1.048780488			
16	0.012195122	0.000000000	1.036585366			
17	0.000000000	0.024390244	1.036585366			
18	0.012195122	0.024390244	1.048780488			
19	0.000000000	0.012195122	1.060975610			

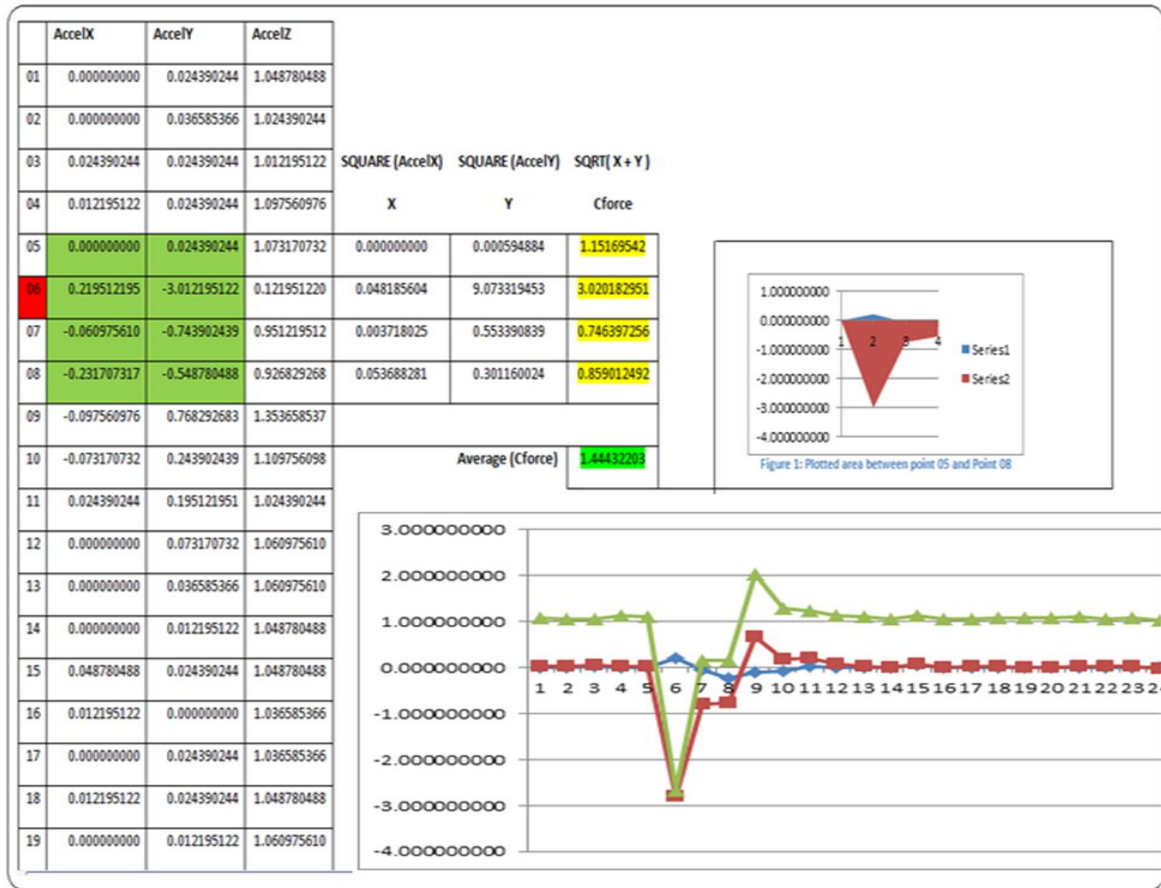Figure 1: Plotted area between point 05 and Point 08

Fig. 4: Machine Learning Data and ML calculation.

- 6th row is the impact of maximum acceleration point, it's because 'AccelY: -3.012195122' value is the maximum Acceleration point.
- Determine the area between point 05 and point 08 for this scenario.

- Finally, determine the Force. This must be area under the curve [Between point 05 and point 08]. This illustration shows for the negative Y till it reaches 0. The same applies for the positive Y till it reaches 0.

Example:

		Gravity	Time(MS)	ABS [(X/y) * Gravity * Time(MS)]
X	0.000000000	9.81	0.01	0
	0.219512195	9.81	0.01	0.021534146
	-0.060975610	9.81	0.01	0.005981707
	-0.231707317	9.81	0.01	0.022730488
Y	0.024390244	9.81	0.01	0.002392683
	-3.012195122	9.81	0.01	0.295496341
	-0.743902439	9.81	0.01	0.072976829
	-0.548780488	9.81	0.01	0.053835366
	Total Area			0.427093902
	Total Force (Total Area * 1300)			555.2220732

Table 1:

- If the calculate force is greater than the threshold force, send the mail to respective distribution list. (In this above example, the average force is more than 500)

VII. CONCLUSION

Accident data from the telematics device was collected when the vehicle was met with an accident. This data was sent to a computer system (ML System) to decode the messages and to store in tables of the database. A computer Machine learning capability was built to analyze accident data and whether it is genuine or not. If this was the real accident, the data was processed for machine learning (ML) to build and send FNOL alerts to the respective mail distribution list informing about the accident and accident data.

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