Cloud-Based Driver Monitoring and Vehicle Diagnostic with OBD2 Telematics

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Proposed Solution



Features:

- Detecting reckless driving
- Identifying driving patterns and anomalies of drivers
- Trip analysis
- Fault analysis on vehicular data

On Board Diagnostics (OBD)

- Modern vehicles consist of lots of sensors
 - Speed, RPM, Oxygen, Mass Air Flow (MAF)
- OBD2 detects stats and failures of those sensors
- Predecessors
 - o ALDL 1980
 - o OBD 1 1989
 - o OBD 2 1994
- Most popular manufacturers have OBD2 after 2005





Data Transmission

- 2 possible approaches
 - Via smartphone as intermediator
 - Through a dedicated hardware





Data Processing

- Data should be processed both in
 Real time
 - o Long term
- Data should be processed at
 - $\circ~$ Device / smart phone
 - o Cloud
- Complex Event Processing (CEP)
 - $\circ~$ CEP on the phone/device
 - $\circ~$ CEP on the cloud
- Business Activity Monitoring (BAM)

Mobile App	Back End	
Dashboard showing real time OBD2 data	Driver anomaly detection	
Trip logs	Reckless driving detection	
Coolant temperature monitoring	O2 sensor failure detection	
Fuel economy monitoring	MAF sensor failure detection	

Related Work

- Plainly displays data with little or no processing at edge or cloud
- A driver can't be expected to carry a PC/laptop
- In car navigation system^[1] requires driver to look at navigation pane frequently
- Y. Yang et al.'s system^[2] performs remote monitoring, but analysis not supported
- None of them have the ability to identify impending sensor failures

[1] M.J. Kim, J. W. Jang and Y. S. Yu, —A Study on In-Vehicle System using OBD-II with Navigation.

[2] Y. Yang et al., —Research and Development of Hybrid Electric Vehicles CAN-Bus Data Monitor and Diagnostic System through OBD-II and Android-Based Smartphones

Solution Architecture



Android App





🖬 🌲 🛒 ↔ 🌠 🐼 🔹 😽 - 🐼 PIDs	: 📶 36% 📕 19:21
Distance Traveled Since Codes Cleared	Log
Mode:01 PID:0x04 Engine Load Calculated	Log
Mode:01 PID:0x5C Engine Oil Temperature	Log
Mode:01 PID:0x0C Engine RPM	Log 🖌
Mode : 01 PID : 0x1F Engine Run Time Since Start	Log
Mode : 01 PID : 0x05 Coolant Temp.	Log 🖌
Mode : 01 PID : 0x52 Ethanol Fuel Percentage	Log
Mode:01 PID:0x2F Fuel Level Input	Log
Ok	Cancel

Fuel Economy & Coolant Temperature Monitoring





Trip Logs



♀ ⊒ "⊾ ≪ «				
Trip Description				
Start				
Place	Time			
Moratuwa	14/01/2015 09:08:54			
End Place ^{Colombo}	Time 14/01/2015 10:11:23			
Trip Distance 18.562 km				
Fuel Efficiency 12.945 km/liters				

Monitoring Reckless Driving

- Based on hard accelerations and decelerations
- Calculate acceleration count and deceleration per time unit beyond a predefined threshold^[1]
- Classification of above count depend on average speed of vehicle in last t seconds
 - Implemented using Siddhi library
- Summarize periodically and store the data in a relational database
- Show an average rapid acceleration and deceleration count per hour

[1] MA.Z. Zeeman and M.J. Booysen - Measuring recklessness using speed and acceleration.

Reckless Driving Interface

KAMPANA					JE My Vehicles	💽 asiri 🗸
<>	Home / Reckless Driving Detection				Start	Searching Q
A Home	Rockless Driving					
Real Time Speed	Reckless Driving Detection overview & stats					
Reckless Driving Detection >	Showing Reckless Dri	ving Analysis for Vehicle - RGS2	3DE43234TH33			
Ltd Driving Anomaly Detection	This graph shows how many rapid accelerations and decelerations are made by the driver for an hour. Using all the data received to the server an average is calculated.				lculated.	
O2 Sensor Failure Detection						
MAF Sensor Failure Detection	Rapid Acceleration and Deceleration	on Average Table				√ ×
	Class - Road Type	Rapid Acceleration Count per ar	hour	Rapid Deceleration Count	per an hour	
	Class - A	0		0		
	Rapid Acceleration and Deceleration Count - class B (20 km/h - 80 km/h) This graph shows rapid acceleration and deceleration count for class B type.					
	Pause reset					seleration Count seleration Count
	0.5					

Detecting Driving Pattern Anomalies

- Detection of anomalies
 - o Markov Model
 - Model implemented in BAM
 - Validator implemented in CEP



Driving Pattern Anomalies Interface



Sensor Failures - O2 Sensor

 Good sensor should fluctuate between 0.2V and 0.8V in lean and rich conditions respectively^[1]



[1] U. I. Toyota Motor Sales, "OXYGEN / AIR FUEL SENSORS," [Online]. Available: oto.teknik.ummgl.ac.id/wp-content/uploads/2013/.../h37-oxigen-sensor.pdf

Impending O2 Sensor Failure Detection



Impending O2 Sensor Failure Detection (Cont.)



O2 Sensor Failure Detection Interface

KAMPANA		🗲 My Vehicles 🛛 🕅 asiri		
<>	Home / O2 Sensor Fallure Detection	Start Searching		
Home	O2 Sensor Failure Detection	overview & stats		
Real Time Speed				
Reckless Driving Detection	O2 Sensor Analysis for Vehicle - WDE23DEC	T34TH33		
III Driving Anomaly Detection	Following table show the details like o2 sensor wear level and the health state of the o2 sensor. Graph shows raw data related to o2 sensor.			
O2 Sensor Failure Detection >	i olowing table show the details into uz sensor wear level and the health sta	re un ne uz sensur. Uraph shuwa raw uara telareu lu uz sensur.		
MAF Sensor Failure	Sensor Name	O2 Sensor Bank 1 Sensor 1		
Detection	Last Updated	8 / 2 / 2015		
	Health Status	Weak		
	Wear Level (%)	90		
	Estimated Failure In (weeks)	6		
	Pause reset	Serie		
	0.7	Max Voltage (V) Min Voltage (V)		
	0.4			
		· · · · · · · · · · · · · · · · · · ·		
	0.0 23711000 23712000 23713000 23714000 23	715000 23716000 23717000 23718000 23719000 23720000 23721000 23722000 23722000		

MAF Sensor Failure Detection

- Mass air flow value has a linear relationship with rpm^[1]
- When sensor fails, gradient between MAF and RPM reduces with time



 [1] "Volumetric Efficiency and Engine Airflow," EPI Inc., 18 11 2011. [Online]. Available: http:// www.epi- eng.com/piston_engine_technology/volumetric_efficiency.htm

MAF Sensor Failure Detection (Cont.)

- Use regression analysis to detect MAF sensor failure
- Then get the gradient of each line



MAF Sensor Failure Detection Interface

			Start Saarahing
<>	□ Home / MAF Sensro Failure Detection		Start Searching
A Home	MAF Sensro Failure Det	raction	
Real Time Speed	IVIAI SEIISIOT AIIULE DEI	CCLIOI 1 overview & stats	
Reckless Driving Detection	MAF Sensor Analysis for Vehicle - R	GS23DE43234TH33	
III Driving Anomaly Detection			
O2 Sensor Failure Detection	Following table show the details like mat sensor wear level an	d the health state of the maf sensor. Graph shows gradient between rpm and mass ai	r flow rate.
MAF Sensor Failure	Last Updated	9 / 2 / 2015	
Detection >	Health Status	Good	
	Wear Level (%)	63	
	Pause reset		Series
	0.0090		Gradien
	0.0080		
	0.0070		
	0.0060		
	0.0050		
	0.0040		

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Achievements

- Kampana Android app available on Google Play
- 1,000+ downloads and counting!
- In the process of commercializing

/	Updated	Size	Installs
	February 8, 2015	2.5M	1,000 - 5,000
	Current Version	Requires Android	Content Rating
	1.1	4.0 and up	Unrated
			Warning – content not yet been rated.
			Unrated apps may potentially contain
	As of Au	g 2015	content appropriate mature audiences of Learn more



Limitations And Future Work

- Black box hardware device that can be plugged directly to OBD2 port
 - $\circ~$ Required for fleet vehicles
 - OBD2 + GPRS (M2M)
- Support extended PIDs
- Integration with other sensors
- ELM327 adapter doesn't support certain vehicle models
- Comprehensive performance analysis and tuning
 - Thresholds for Reckless driving, MAF failure and Driver anomaly detection
 - Collection of large datasets
- Vehicular data analytics platform

THANK YOU !