Amelio-rater: Detection of Driving Abnormal Behavior for Automated Ratings

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Abstract

Real time Monitoring and observing of abnormal driving behavior is the bedrock to enhance driving evaluation systems. The rating systems of the drivers' should mainly aim to provide consumers with trustworthy feedback; which also assists the business owner gain high accuracy overview of the performance quality of the hired professional drivers. We propose a system that performs detection and identification of driving abnormal behavior using sensors fusion found in smart phones. We will be focusing further improvement in the quality of the current rating systems found in most of transportation companies. Our system will consist of a mobile application that will handle the real time data that will be collected from sensors (accelerometer, gyroscope, and GPS), this data will be analyzed to create automatically generated ratings that would be used by the business owner to keep track of the drivers' performances and location. The business owner will be provided an interface through which he could monitor each driver's and trip's generated data.

1 Introduction

1.1 Background

The accelerometer sensor has become of extreme benefit when it comes to activity recognition[11]. Activity recognition is widely used in everyday applications due to the increase of the availability of accelerometer sensors in consumer products. There are some activities that are very critical and needs to be recognized in order to avoid dangerous situations. Most traffic accidents are caused by human factors such as driving behavior[14]. Driving abnormal behavior needs immediate attention as drivers will not be always aware of them and may lead to accidents. Such behaviors could be classified into different types: drivers' condition[15][5], road anomalies[3] or the driving activity itself[4]. In this project we will be focusing on detecting and classifying the abnormal behavior in the drivers' driving activity. Our proposed solution focuses on collecting each trip's data needed for analysis of the driver's performance as this will be the data used to initiate the ratings. Most of the recently available rating systems have obstacles when it comes to the reason behind the given rate to the driver by the consumer[16]. Our system seeks to deliver the consumers with credible rating data, thus aiding the business to gain better reputation.

1.2 Motivation

This project takes into consideration arising complains about malicious ratings from private transportation users; therefore, companies need to have a good and accurate rating and monitoring system of their drivers. Some of the already implemented similar systems to our proposed project have faced challenges while the ongoing implementation process. Some difficulties were faced when identifying the driving behavior patterns[4], identifying and classifying the detected abnormal behavior[4] removing the noise from the sensors' readings [4][18], making the solution lightweight and computational feasible on smart phones[4][18], the orientation of the smart phone inside the car [8]

According to a survey we have made, 70.7 percent of the people rate the drivers after a ride according to how the driver treats them, 14.4 percent rate because they don't want to cost the driver his job and 10.4 percent rate by random. Also a lot of the users think abnormal behaviors in driving causes accidents. 58.7 percent thinks speeding is a cause, 48.3 percent think car weaving is a cause, and 40 percent think sudden braking is a cause.

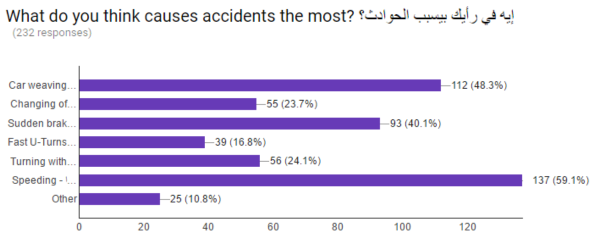


Figure 1 :Survey Results 1

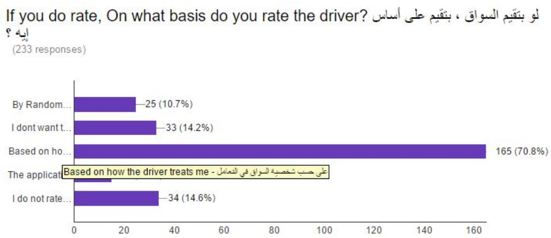


Figure 2 :Survey Results 2

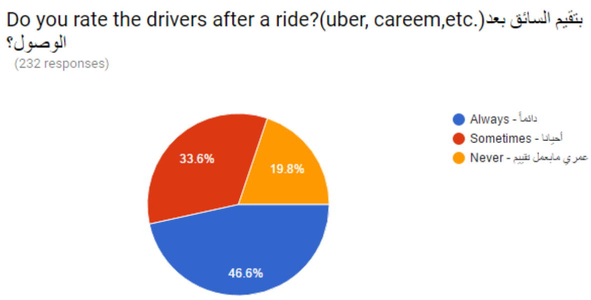


Figure : Survey Results 3

1.3 Problem Definitions

Several challenges have been faced by systems aiming to contribute to collect sensors' readings and use them to detect activities including the abnormal behavior in driving. We aim to ameliorate the accuracy rates of the detection of a driving abnormal behavior and road conditions in the real time; and accordingly correctly and accurately classify them into the category each falls into. Our target is to replace the malicious rating data by more trustworthy rates generated using technologies rather than human entries.

2 Project Description

Detecting driving abnormal behaviors and assisting technologies using smart phone based on sensor-fusion.

2.1 Objectives

Our system is designed to become a smart rating system to drivers. Systems that use manual rating systems may deal with unfairness in the recorded rates. Also the system offers a real-time monitoring to the business owner, along side with a notification system to alert the driver when abnormal behaviors occur repeatedly. There are multiple types of abnormal behaviors in driving like weaving, sudden changing of lanes, sudden braking, speeding, fast u-turns, turning with wide radius[4]. Our main objective is to detect an abnormal behavior and classify it to know which abnormal behavior it classifies as. After those classifications are done, ratings and statistics are generated using the resulting data. Several proposed algorithms could be used in these processes such as KNN, DTW, HMM, SVM, and ANN algorithms[1].

2.2 Scope

1. Business Owner can monitor the drivers' driving behavior.

2. Business Owner can view trips' duration.

3. System rates individual drivers based on their average driving behavior during all their trips.

4. System will detect if there is a road bump.

5. Business Owner can view individual trips' ratings.

6. Business Owner can view individual drivers' ratings.

7. System will have different users.

8. System rates each individual trip.

2.3 Project Overview

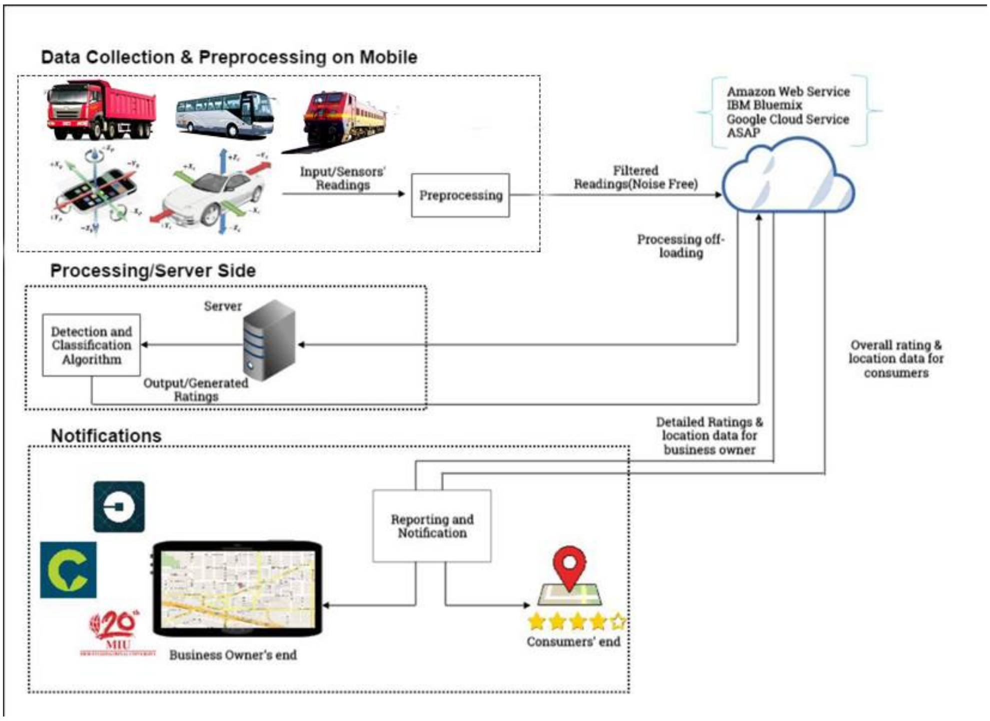


Figure 4:System Overview.

Our proposed system is a mobile application based project that uses the mobile sensors-accelerometer, GPS, and gyroscope- to collect readings from the mentioned sensors. Later on the collected data passes through a pre-processing phase; that supposedly conduct noise cancellation to get a better results. In that moment the filtered data is passed to the used Cloud data storage, which then takes the required data to the server to get the required analysis using a classifier algorithm. After the data has been analyzed the abnormal driving behavior is obtained. Finally the analyzed data takes two paths accordingly,the rating data is always sent to the cloud storage and a warning message is sent to the driver when exceeding a number of abnormal driving behavior in a specific time limit. Furthermore, ratings are retrieved from the cloud storage for the business owner and consumers to have access to viewing it.

3 Similar System Information

D3 [4] is a system proposed to not only detect that an abnormal driving behavior took place; but to also identify it's type and classify it. They used sensors in smart phones to detect and identify six types of abnormal driving behaviors by extracting the sensors' readings. They contributed by using machine learning method (SVM) to train driving features and obtain a classifier model. In total, they obtained 4029 samples of abnormal driving behaviors from the collected data by 20 drivers from different communities with different commute routes using 20 smart phones of 5 different types. They reached an accuracy of 95.36 percent for their system.

Jennifer R. Kwapisz, Gary M. Weiss, Samuel A. Moore [11] proposed WISDM project and introduced technologies that are slimier to some of the technologies in our system, they collect data from their android based data collection platform and send it to internet server to Recognize 6 daily activities (Sitting , walking , jogging ,Stairs up , Stairs down), when they tested their project they had very accurate result for walking and jogging but they had challenges in detecting the stairs up and stairs down as their readings are almost the same.

Derick A. Johnson and Mohan M. Trivedi in [10] uses smart phone based sensor-fusion and DTW in a completely mobile, effective and inexpensive manner to detect, recognize and record the driving actions to categorize the driving style as non-aggressive or aggressive. They contribute by fusing related inter-axial data from multiple sensors into a single classifier. They have found among with others[9] that drivers' behaviors become a lot safer when they are being monitored and have provided feedback. The classical DTW algorithm was used on three different signal sets used: A, G, and T; nearly 97 percent of all the aggressive events were identified accurately using a sensor set T they have created.

MyDrive [2] introduced a robust approach to assess the driving pattern hitherto called Skills Aggression Quantifier(SAQ). This system has an analytic portal which is web based UI and Smartphones to collect data using mobile data; afterwards the data that was collected is sent to cloud based storage. The analytic in this system is structured into three modules peer group, individual analysis, and trip level analysis.

This Project [13] Proposed a system that detect the user transportation method (walking, biking, motor Vehicle, etc) via the data collected through smartphones; they have reached that using DT classification algorithm (Decision Tree) and HMM classification algorithm (Hidden Markov Model) combined gives the most accurate results when tested on their datasets while the mobile in different orientations.

Mohamed Fazeen, Brandon Gozick, Ram Dantu, Moiz Bhukhiya, and Marta C. González in [7] discuss means by which they can increase the drivers' overall awareness to maximize safety using smart phone sensors(accelerometer, GPS, magnetoemter, microphones, and cameras). Smart phones have been embedded with such sensors in the recent years[5][12]. This project determines road conditions(bumps for example) with an overall accuracy of 85.6 percent. Pothole Patrol[6] is a system that uses external accelerometer, this was tested in taxis.

Haofu Han, Jiadi Yu, Hongzi Zhu, Yingying Chen, Jie Yang, Yanmin Zhu, Guangtao Xue and Minglu Li in [18] estimate the vehicles' speeds using sensors found in the smart phones in urban environments where GPS is inaccurate or unavailable. The process integrates the accelerometer's readings over time to rule out the acceleration errors from the real ones.

This project[8] uses the sensor readings and GPS that is embedded in the smart phones of the users and transmit it to a remote server where the analysis of the data occur,they have faced some challenges in the accelerometer data as it contains noise and also induced jerks and shocks of the phone, they have used an algorithm which is a great help in our project that calibrate the accelerometer sensor data collected by any orientation of the phone and convert it to the vehicle orientation to get the desired accelerometer values regardless the position of the phone, their experiments gave a positive feedback in estimation of the velocity of the vehicles.

This project [1] Compares between classifiers which identify different gestures (KNN , ANN , SVM , HMM , DTW) in order to observe which classifier gives the highest accuracy , they collect data from mobile accelerometer and then analyses it to detect the required gestures, they have experimented this data in both user-independent and user-dependent recognition ; the experiments showed that both DTW and KNN achieved the best recognition accuracy for both user-dependent and user-independent recognition.

3.1 Similar System Description

In the past years, the rating systems mainly relied on manual ratings recorded by individuals regardless of whether the driver deserves the rate whether it is good or bad. D3[4] did develop a system to aid in reducing accidents by detecting a driving abnormal behavior taking place by the driver regardless of other works [15][17] based on pre-deployed infrastructure. This project found that already existing works[7][5] only detects an abnormal behavior and due to the sensors' sensitivity and different car types the threshold is affected therefore identification of the abnormal behavior could not be provided. Our system strives to accentuate the accuracy rates reached by D3 system after proposing the classification techniques alongside the detection. The main sensor that can not be let go of under any circumstances in such systems is the accelerometer. As mentioned by Jennifer R. Kwapisz, Gary M. Weiss, and Samuel A. Moore in [11] the importance of the accelerometer in recognizing an ongoing activity is crucial n processes such as data collection for example. They used an application with an interface that allowed them to get users' permissions to get some of their details and sensors' data along with the frequency of the data collection occurrence. Such proven and accurate experiments assists us in our system as the accelerometer is one of the sensors on which most of our readings and data depend. MyDrive [2] is a system that works only on the speed of the moving car; however, our proposed system will be working on other driving behaviors alongside the acceleration of the car. They use an analytic web based UI portal to analyze the data, an smart phone sensors to collect the required data.

3.2 Comparison with Proposed Project

Points of Comparison	Algorithm Used	Accuracy Achieved (%)	Gesture Types	Smart Phone Orientation	Real Time	Training Samples
D3	SVM	95.36	6 driving patterns	Horizontal	Online	Up to 4029
MyDrive	Skill-Aggression Quantifier(SAQ)	Not Mentioned	Velocity only	-	Offline	-
A Comparative Study for Accelerometer Based Gesture Recognition Algorithm	KNN,DTW	99.7,99.8	Human Gestures	Horizontal	Offline	At least 1
Our Proposed System	**KNN+DTW**	-	**Driving Behaviors + Road Condition**	**-**	**Online**	**At least 1**

Figure 5 : Similar Systems Comparisons.

4 Project Management and Deliverable

4.1 Tasks and Time Plan

Task Name	Start Date	End Date
Enter your deadline as start and end date	09/04/16	05/30/17
Information Gathering	09/04/16	09/15/16
Survey and Proposal	09/16/16	09/27/16
Designing Application	09/28/16	10/04/16
Implemneting Prototype	09/28/16	10/17/16
Proposal Presentation	09/28/16	10/18/16
Data Set Collection	10/20/16	11/01/16
Implementing GUI Design	11/02/16	11/12/16
Designing Database	11/13/16	11/25/16
Data Classification	11/26/16	01/17/17
SRS Presentation	01/18/17	01/18/17
Implementing Application	01/19/17	05/10/17
Validating and Testing	05/11/17	05/29/17
Final Presentation	05/30/17	05/30/17

Figure 6: Time Plan Table

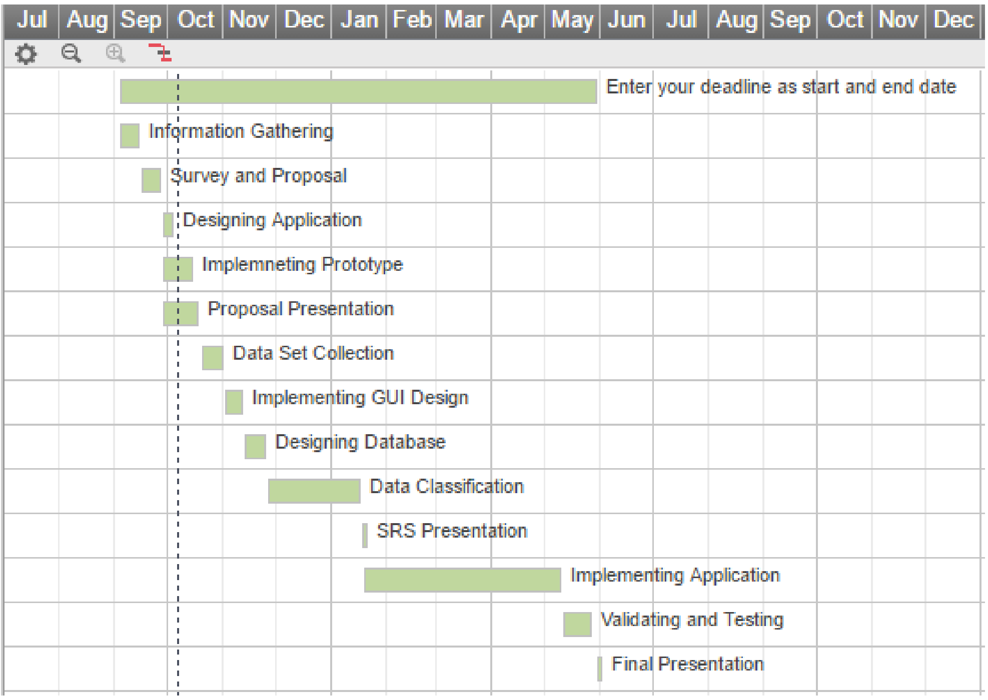


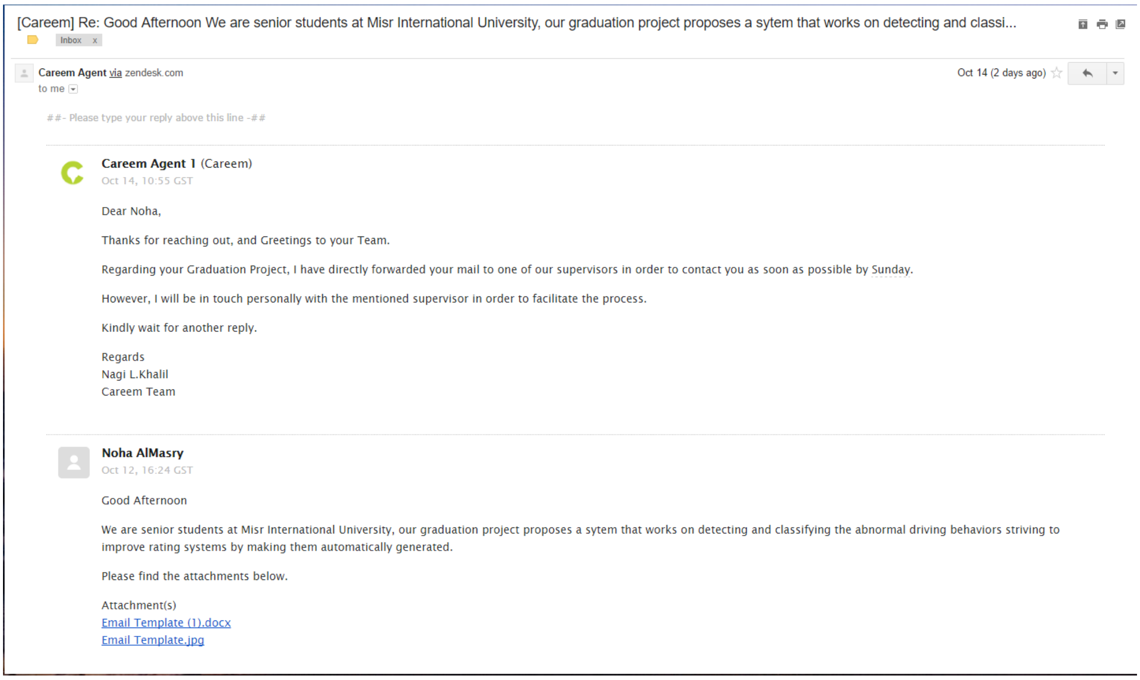
Figure 7: Gantt Chart for Time Plan

4.2 Budget and Resource Costs

Item	Quantity	Cost
Huawei Ascend X (U9000)	1	5607 EGP
Accelerometer Sensors	1	1000 EGP
Camera	1	2000 EGP

Figure 8: Budget

4.3 Supportive Documents



[Careem] Re: Good Afternoon We are senior students at Misr International University, our graduation project proposes a sytem that works on detecting and classi...

Inbox x

Careem Agent via zendesk.com
to me

Oct 14 (2 days ago)

##- Please type your reply above this line -##

Careem Agent 1 (Careem)
Oct 14, 10:55 GST

Dear Noha,

Thanks for reaching out, and Greetings to your Team.

Regarding your Graduation Project, I have directly forwarded your mail to one of our supervisors in order to contact you as soon as possible by Sunday.

However, I will be in touch personally with the mentioned supervisor in order to facilitate the process.

Kindly wait for another reply.

Regards
Nagi L.Khalil
Careem Team

Noha AlMasry
Oct 12, 16:24 GST

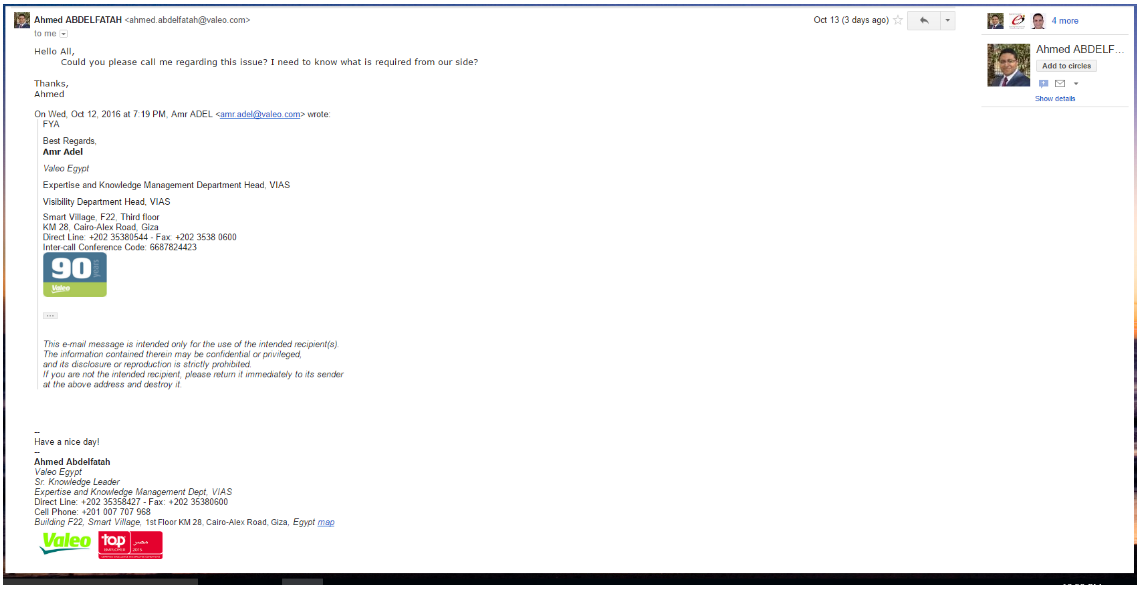
Good Afternoon

We are senior students at Misr International University, our graduation project proposes a sytem that works on detecting and classifying the abnormal driving behaviors striving to improve rating systems by making them automatically generated.

Please find the attachments below.

Attachment(s)
Email Template (1).docx
Email Template.jpg

Figure 9: Careem Reply.



Ahmed ABDELFATAH <ahmed.abdelfatah@valeo.com>
to me

Oct 13 (3 days ago)

Hello All,
Could you please call me regarding this issue? I need to know what is required from our side?

Thanks,
Ahmed

On Wed, Oct 12, 2016 at 7:19 PM, Amr ADEL <amr.adel@valeo.com> wrote:
FYA

Best Regards,
Amr Adel

Valeo Egypt

Expertise and Knowledge Management Department Head, VIAS

Visibility Department Head, VIAS

Smart Village, F22, Third floor
KM 28, Cairo-Alex Road, Giza
Direct Line: +202 35380544 - Fax: +202 3538 0600
Inter-call Conference Code: 6687824423

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Have a nice day!
--
Ahmed Abdelfatah
Valeo Egypt
Sr. Knowledge Leader
Expertise and Knowledge Management Dept, VIAS
Direct Line: +202 35358427 - Fax: +202 35380600
Cell Phone: +201 007 707 968
Building F22, Smart Village, 1st Floor KM 28, Cairo-Alex Road, Giza, *Egypt* map

Ahmed ABDELF...
Add to circles
Show details

Figure 10: Valeo Reply.

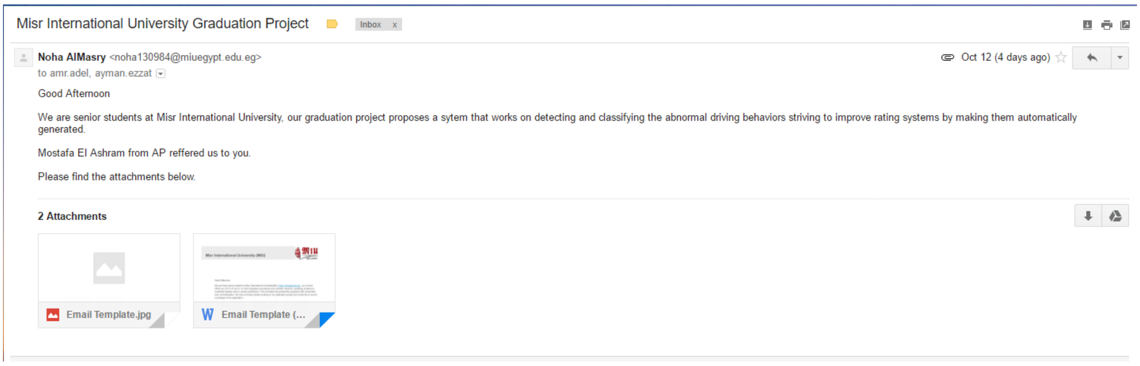

Figure 11: Valeo Sent.

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