Adaptive Driver Alert System

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Abstract

In this project we present an adaptive driver alert system system that uses passive techniques for extracting the alertness of the driver and informing the driver about inalertiveness. The state of the driver is detected through posture analysis from the live video feed through the camera facing the driver and also the analysis of data from the on-board diagonostics attached to the motor vehicle and traffic monitoring through the camera that is facing the road. The model adapts with the driver and improves on the go. The driver is alerted through a visual aid with a heads up display placed at a visble position and through a buzzer fitted in the vehicle. The model is also trained to detect any kind of seizure based on the pre-trained gestures which when detected alerts the nearest hospital to provide ambulance to the spot.

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0.1 Introduction

0.1.1 Purpose

The purpose of the driver alert system is to shift driver's attention back on the road when being shifted away from it by an event, activity that occured inside or outside the vehicle or due to sleep. This alerting is done based on the analysis of the psycho-physiological state of the driver through posture analysis on the live recording of the driver and the vehicle movement pattern based on the on-board diagonostics attached to the vehicle and a camera recording the traffic on the road.

0.1.2 Impact

Distracted driving has been identified as an important risk factor in road traffic injuries.The main causes of distraction are as follows:

- Mobile phone usage has developed into a primary source of driver distraction as it can induce drivers to take their attention off the road, thus making vehicle occupants more vulnerable to road crashes.
- Drowsiness due to lack of sleep or alcohol consumption above the permisible limits. This is one of the main causes for road crashes.

The model has a huge impact on the drivers as well as the commuters travelling in the vehicle. The model reduces the risk of road crash by alerting the driver when it detects inalert state of the driver. The module also has measures to request for help from emergency service providers like ambulance, police and fire department(in case of fire).

0.1.3 Development strategy

The strategy utilized to develop the module is Scrum framework. Scrum framework was selected for the following reasons:

- Scrum framework is fast moving and money efficient.
- It is an improvement on agile methodology. It is perfect for the development of projects with constantly variable requirements.
- Scrum framework is adaptive in nature due to its short sprints. Thus ensuring customer satisfaction.

- As Scrum framework rely on constant feedback therefore the quality of product increases in less amount of time.

Scrum framework is ideal for this project as the requirements may change due to various factors for which a new feedback is generated after each sprint which makes the release ideal for the requirement.

0.1.4 Team size

The teams are broadly classified into three categories:

1. Software Development
2. Testing
3. Review

These are further divided based on the sub-products a person is working. For example the software development comprises of planning, model building, UI or UX design, backend and testing as sub-product and each product comprises of certain people working on them. During each sprint or release the final product is reviewed by certain people who provide a sprint retrospective which specifies the stages at which changes should be made so that the product meets the requirements.

0.2 Requirement Details

The requirements for an effective drowsy and distracted driver detection system are as follows:

- A non-intrusive monitoring system that will not distract the driver.
- A real-time monitoring system, to insure accuracy in detecting drowsiness and distracted behaviour.
- A system that will function in both daytime and nighttime conditions and alert required departments on accident.

0.2.1 Stakeholders

Here is a list of stakeholders who are affected by the module:

- Driver of the vehicle (in which the module is embeded)
- Commuter travelling in the vehicle
- Emergency services (like ambulance, fire dept, police etc.)
- Other vehicles on road

0.2.2 Competetive analysis

There are many existing solution put forward by some of the top automobile manufacturers. Some of such best solutions are as follows:

- **Ford's Driver alert system**
  Ford's Driver Alert System constantly monitors the driving behaviour and is designed to detect any changes that could be caused by fatigue. It uses a forward-looking camera to monitor the vehicle position in the lane and calculate a vigilance level for the driver. If the system identifies the driver becoming less vigilant, a warning icon appears in the display, suggesting you take a break. If the drivers alertness further declines, the message is repeated and combined with a chime.

- **Land Rover's Driver assist**
  It's features are as follows:

  1. Emergency braking (autonomous emergency braking)
  2. Lane keep assist
  3. Driver condition monitor
  4. Traffic sign recognition
  5. Blind spot assist
  6. Adaptive cruise control with queue assist
  7. Park assist etc.

There are many other vendors providing a variety of features that assist the driver. Although the module presented by the report is unique as it monitors the behaviour of the driver directly and analyzes the psycho-physiological state of the driver thus ensuring greater safety.

0.3 Detailed Design

0.3.1 System Design

The system comprises of following sub-systems:

1. Camera module
2. On-board diagonostics
3. Alcohol and eye lid detection sensors
4. Alerting module
5. Database to store data from all components
6. GSM module to alert emergency services
7. Posenet model for posture monitoring

The Usecase diagram for the above requirement is as follows:

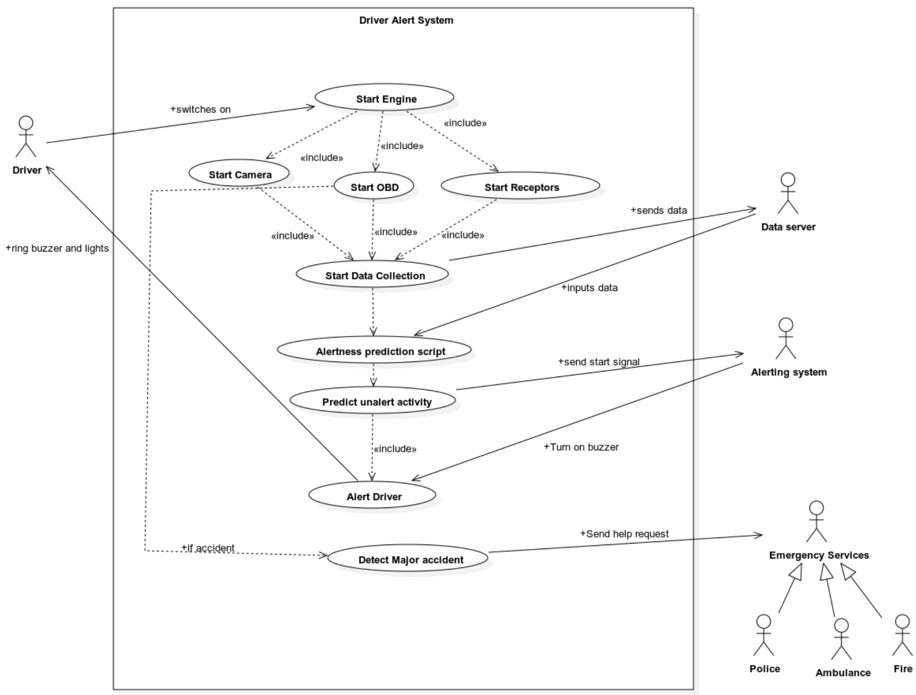

Figure 1: UseCase diagram for the driver alert system

0.3.2 Sequence model

This section talks about the sequence in which all the processes take place. The sequence diagram for adaptive driver alert system is as follows:

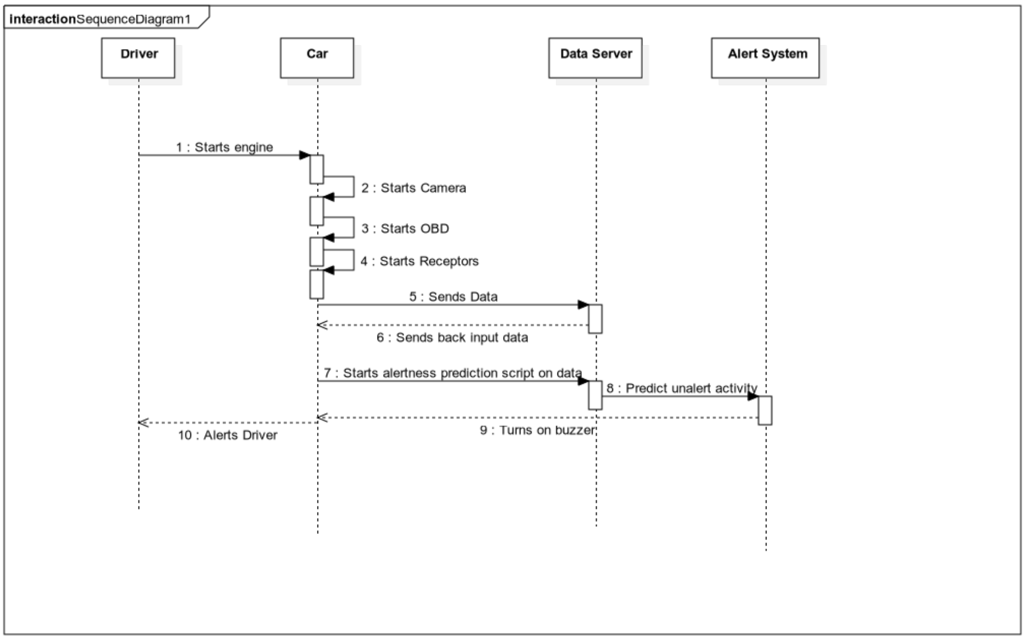

Figure 2: Sequence diagram for the driver alert system

The diagram mainly comprises of the following actors and the interactions between them:

- Driver
- Car (it is a compilation of all the modules with the car)
- Data server (compilation of data from OBD and all other sensors embeded in the car)
- Alert system (buzzers and alarms that alert the driver when something is about to go wrong)

0.3.3 Data Flow in the system

This section talks about the dataflow in the system at various levels of abstractions.

1. **Level-0 DFD**

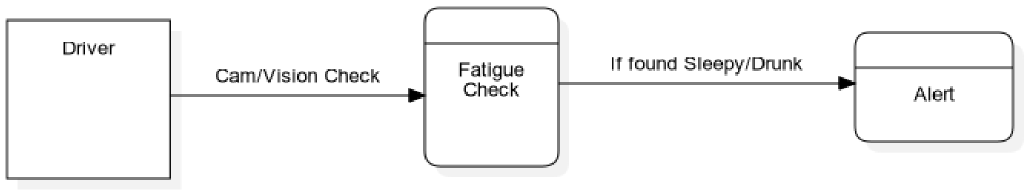

Figure 3: Level-0 DFD for the driver alert system

2. **Level-1 DFD**

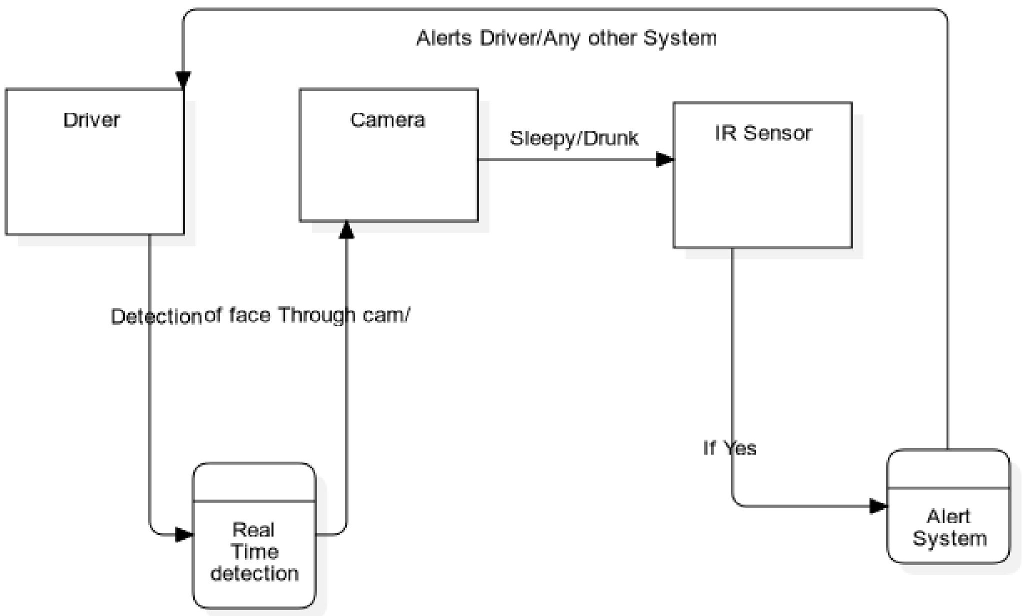

Figure 4: Level-1 DFD for the driver alert system

3. **Level-2 DFD**

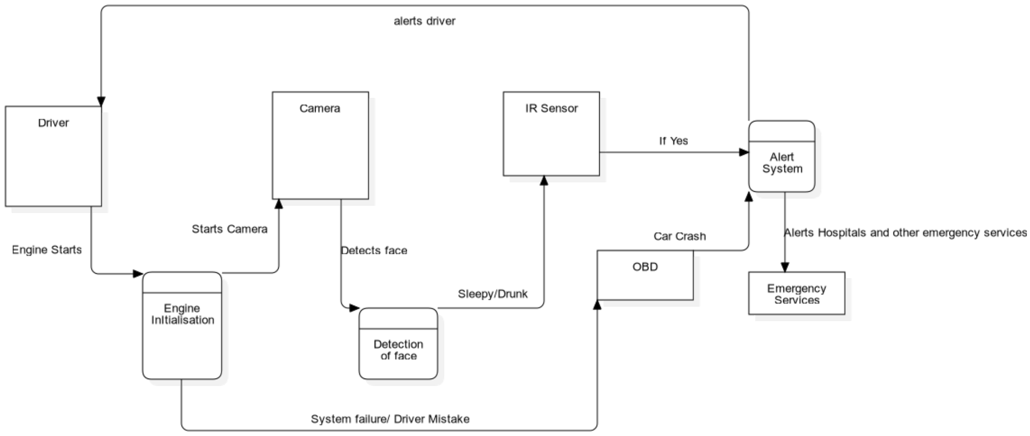

Figure 5: Level-2 DFD for the driver alert system

The data flow among the various modules takes place as shown in the above diagrams.

0.4 Test Plan

The purpose of this section is to provide the test cases of the Adaptive Driver Alert System. It defines the objective, scenario, expected outcomes and procedural requirements for each test case.

0.4.1 Test items and their identifiers

Since the system consist of three subsystems which can be identified as components or levels, each subsystem is an object of tests. Integration of these components shall be included to tests as well. There are currently three subsystems which need to be tested: Eye Detection System, Crash Detection and alerting mechanism.

- Eye Detection uses front camera for getting input frames and processing them.

- Crash Detection uses OBD's built-in accelerometer sensor. It detects extra forces and duration of that force on the device.

- Alerting mechanism mainly through buzzer, lights in the vehicle and alerting of emergency services.

0.4.2 Test's Pass/Fail Criteria

Crash Detection: if it detects the crash correctly ($> 90\%$) and asks for feedback from the driver based on that feedback acts correctly then it passes the test. In the other case it fails.

Eye Detection: if it detects closed eyes correctly ($> 85\%$) then it passes the test. In other case it fails.(constrainted due to the limitations of Posenet model)

0.4.3 Test's and thier expected outcomes

Test Case Identifier	CRASH DETECTION-TEST-01
Objective	Feature should not work if not enabled
Scenario	• User start the application and opens application settings • Under the *Crash Detection* section, *Shake Detect* button is toggled.
Input	Shaking the device while feature is turned off
Outcome	Not output received
Requirements	None

Test Case Identifier	CRASH DETECTION-TEST-02
Objective	Only Crash detection should work if Location sender is not enabled.
Scenario	Enabling Shake Detection switch and testing the feature
Input	Shaking the device while only Shake Detection switch is enabled
Outcome	Feature works concurrently. Application only asks status of driver
Requirements	Crash detection is enabled

Test Case Identifier	Enabling and disabling the Eye Detection System by means physical contact
Objective	Triggering Eye Detection System
Scenario	User clicks "EYE DETECTION" button in the main screen Pressing this button is enough to start the Driver Drowsiness Detection. After pressing that button system opens the front camera and start EDS activity. Pressing Android back button is enough to exit from EDS.
Input	Frames captured by front camera
Outcome	Starting the EDS and detection of the closed eyes
Requirements	Device should have working front camera and should

0.5 Change Management

The change management in the project can be monitored by the following activity diagram. The following activity diagram represents various changes and actions performed to mange such changes.

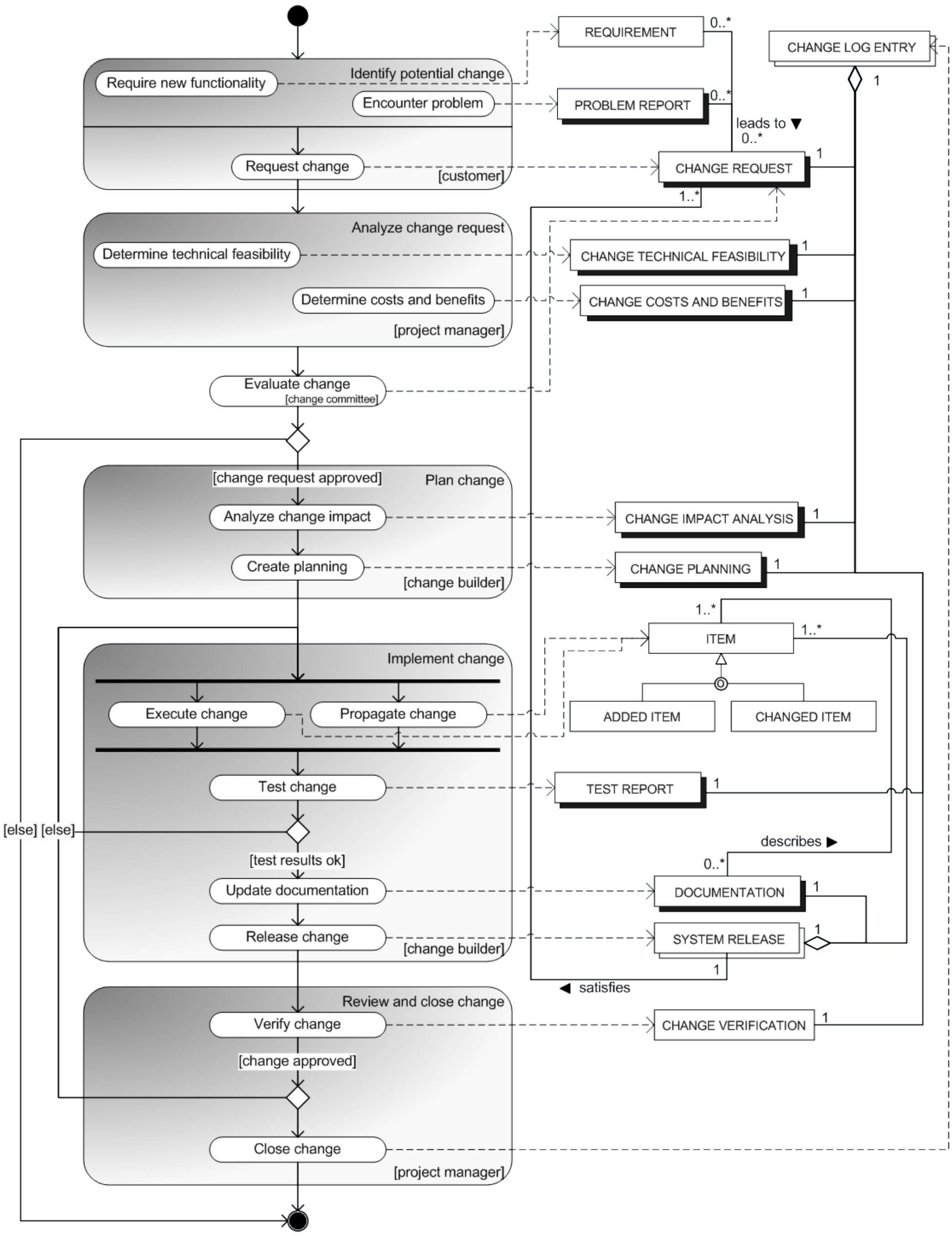

Figure 6: Activity diagram for change management

0.6 Conclusion

0.6.1 Learnings

In this report we presented an adaptive driver alert system making use of passive, camera-based sensor techniques and implicit windshield visualizations. We presented the overall concept of our adaptive loop, hardware solutions to realize an unobtrusive loop on the sensor and the actuator side, and software algorithms that can measure the required features of user inattentiveness.

0.6.2 Challenges faced

- Obtaining ideal blinking time for a variety of people is impossible. So some assumptions were made bases on the information from internet.
- Maintaining and processing real-time data from OBD and sensors was challenging.
- Detecting all car component failures is not possible by OBD alone.
- Alerting the required emergency services might be an issue in cases where the GSM-module is destroyed due to the crash.

Despite of these drawbacks or challenges the proposed solution might reduce the risk of car crash and ensures drivers safety.