Project 1 : CoPilot drive statistics

Project Report

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1 Background

The project has been carried out by students in the course DVA313 - Software Engineering 2: Project Teamwork at Mälardalen University in cooperation with Volvo Construction Equipment in Eskilstuna.

The students involved in the project are listed below:

- Leslie Dahlberg (*ldg14001@student.mdh.se*), bachelors 3rd year, Computer Science
- Eric Engtorp (*eep13001@student.mdh.se*), bachelors 3rd year, Computer Science
- Fredrik Frenning (*ffg12002@student.mdh.se*), bachelors 3rd year, Computer Science
- Pooria Ghavamian (*pgn16007@student.mdh.se*), masters 1st year, Software Engineering
- Léa Brunschwig (*lbg16006@student.mdh.se*), masters 1st year, Software Engineering
- Vladimir Djukanovic (*vdc16001@student.mdh.se*), bachelors 3rd year, Computer Science
- Hamza Sabljakovic (*hsc16001@student.mdh.se*), masters 1st year, Software Engineering

The purpose of the project was to design and implement an Android application for Volvos customized tablet called the Volvo Co-Pilot. The Co-Pilot is an Android tablet which can be mounted on Volvos construction machines and connected to their CAN-buses in order to extract information about the machine and help the operator with difficult tasks. Our application is meant to help the operator drive in an eco-friendly manner by providing live-feedback and a sense of gamification to the driving experience. See our design document and our requirements document for more information about specific requirements and design choices.

2 Project Results

2.1 Deliverables

The deliverables can be divided to steering group deliverables and customer deliverables.

Date finished	Name	Description
17/11/2016	Requirements specification	Should include requirements specification, deadline tables, team structure, activities, deliverables, etc.
01/12/2016	Design specification	Should capture important design decisions we have made in the project, and should provide a good basis for understanding the implementation.
12/01/2017	Implementation	Should include complete functionality covered by design and requirements specification.
12/01/2017	Project report	Should summarize the outcomes of the project, both in terms of results produced and experiences from the project work.

Table 1: Steering Group Deliverables

Table 2 refers to deliverables that were specifically asked by Volvo CE which rely mostly on reports and early proofs of concept.

Date finished	Name	Description
16/11/2016	3 concepts for Co Pilot application and web portal	Should include 3 sketches for both Co Pilot application and web portal
16/11/2016	Concepts presentation (report)	Description of presented concepts and covered functionality
12/01/2017	Implementation	Should include complete functionality covered by design and requirements specification.
12/01/2017	Final product	Must include eco driving algorithm, APK, web portal
12/01/2017	Final Report	Should include product description (implemented features and possible improvements for application that may not be implemented)

Table 2: Volvo CE required deliverables

2.2 Key features of product

All key requirements proposed are implemented in the final product. The product has a web portal side and an Android app side. The Android app has 5 main pages, the user starts by selecting a machine, writing their name and picking the duration of their driving. After the preliminary phase is over, the main game screen is provided where the sensory input from the machine is presented both in radial and line charts. The user has the ability to upload their performance after they are finished driving. The data are sent to the web portal where the user can compare their performance with other drivers using the same radial and line charts.

2.3 Acceptance testing

Acceptance testing was carried out on in the Volvo simulation labs at Mlardalen University by the whole development team. Nine test cases were used to verify that the app and web-portal functioned in accordance with the requirements. After final bugfixes were applied 8 test cases passed. The product was then demonstrated to the client and the client was supplied with an executable version of the app and access to the source code to enable them to evaluate the product for themselves. The final test case did not pass, but this was due to a bug in the hardware which we could not do anything about.

2.4 Missing functionality & future improvements

The app demonstrates a proof of concept for eco-driving in the Co-Pilot but the algorithm used to calculate the score is rudimentary at best and would greatly benefit from further customization and use-cases studies specific to the different types of machines that will be used with the Co-Pilot.

Currently the user selects an alias and machine type everytime the game is played. This could be improved by automatically reading the machine type from the machine and letting the user log-in with a user account.

The alias selection does not filter out profanity and inappropriate content and it would be preferable if at least the web portal would hide or reject such aliases.

The game screen provides live feedback in the form of line graphs, a radial graph and two score values. Good scores during a longer period of time result in notifications which tell the player that he/she is doing a good job. Good scores also change the color of the score to green. In order to improve the feeling of the game one could add more gamification features and more interactive responsivness.

3 Project Work

3.1 Changes to organization and routines

In an overall vision, the work realised and the product delivered correspond to the predictions issued in the document Project Plan. The objectives fixed have been efficiently achieved, indeed, the project has been finished earlier than planned, that is implying an amount of planned-hour-work which is not respected because it was overestimated.

We can note that there is a tiny modification in the requirements: the achievements feedback, that were optionnal, have not been implemented and the Android application is available only in portrait format.

Other changes have occurred regarding the organization of the work, in particularly concerning the responsibles of the different tasks : Pooria was the responsible of testing instead of Fredrik, Léa was dedicated for all the documentation (Project Plan, Design Description and Project Report) and Leslie for the product.

Finally, we could not test the application as we wished at Volvo's lab, and simulators of Mlardalens were not providing the expected values to do real simulation with our application.

3.2 Total Project effort

This table table sum up the hours spend on different parts of the project. The project meetings includes those done with the steering group, Volvo or between the team members. The documentation includes the preparation for the project meetings or the project presentation.

Activity	**Actual effort (person days)**
Project Meetings	$\simeq$ 12.8
Project Presentation	$\simeq$ 2.8
Testing	$\simeq$ 1.4
Documentation	$\simeq$ 7.3
Web Portal	$\simeq$ 5.1
Android App	$\simeq$ 6.8
Total	$\simeq$ 36,2

Table 3: Project effort

3.3 Worked hours

We can note that we are far from the 150 hours per person fixed at the beginning but we can also see that most of the work has been done during the first 6 weeks, followed by some refactoring, tests and documentation work.

Member / Week	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**	**W10**	**Total**
Leslie Dahlberg	15	20	20	22 (+2)	17 (-3)	18 (-2)	6 (-9)	0	0 (-10)	3,5 (-6,5)	121,5 (-28.5)
Pooria Ghavamian	15	20	20	20	15 (-5)	12.5 (-7.5)	0(L) (-15)	0	3 (-7)	4,5 (-5,5)	110 (-40)
Léa Brunschwig	15	15	0(L)	20 (-5)	21.5 (-3.5)	15.5 (-9.5)	6 (-4)	2 (-8)	6 (-9)	8.5 (-1.5)	109.5 (-40.5)
Hamza Sabljakovic	15	15	27 (+7)	21.5 (+1.5)	15 (-10)	14 (-6)	6 (-9)	0	0 (-10)	4,5 (-5,5)	118 (-32)
Frederik Frenning	15	20	20	19 (-1)	18 (-2)	14 (-6)	6 (-9)	0	0 (-10)	3,5 (-6,5)	115,5 (-34.5)
Vladimir Djukanovic	15	15	27 (+7)	21 (+1)	16 (-9)	14.5 (-5.5)	6 (-9)	0	0 (-10)	3,5 (-6,5)	118 (-32)
Eric Engtorp	15	20	20	18 (-2)	10 (-10)	12.5 (-7.5)	6 (-9)	0	0 (-10)	3,5 (-6,5)	105 (-45)
Total	105	125	134 (+14)	141.5 (-3.5)	112.5 (-42.5)	101 (-44)	36 (-64)	2 (-8)	8 (-67)	30 (-40)	795 (-255)

Table 4: Worked hours

3.4 Distribution of work and responsibilities

With this table, we can see that the work has often been divided in two groups to provide the most efficient result. The two main areas were the Web Application and then the Android Application.

Sketch Android App	Hamza, **Fredrik**, Eric, Pooria
Sketch Web Portal	Leslie, **Vladimir**, Léa
Concepts presentation (report to Volvo)	**Pooria**
Android App	**Leslie**, Eric, Fredrik, Pooria, Léa
Web Portal	**Hamza**, Vladimir
Project Plan	Vladimir, Fredrik, Pooria, **Léa**
Design Description	Hamza, Vladimir, Pooria, Leslie, Fredrik, **Léa**
Project Report	Pooria, Leslie, **Léa**

Table 5: Distribution of work

Legend : **Responsible**

3.5 Positive experiences

The successful accomplishment of this project is a showcase of several positive points. To begin, a weekly routine consisting of team meetings with the steering group was quite effective in putting the project development in check. These meetings provided an opportunity to distribute the tasks and assure that everyone is busy during the week and keeping track of the deadlines.

The organisation was also managed intelligently through forming sub-groups within the project, which in return allowed the team to be efficient and coordinated. Product followed an iterative pattern, starting with a design, GUI, and then connecting it to the backend and finally hooking it up to the simulator. This simplified the development process significantly by letting us develop without the co-pilot hardware.

Moreover, using modern tools for software development teams (i.e. Github, Trello, Slack, etc.), has shown to enhance communication, collaboration and other aspects of software development process. Slack was probably the single most important platform for the project since communication would not be possible in such an efficient manner without it. Trello, helped us to track queued tasks and their responsible individuals. It was remarkable in providing an eagle-eye view of the entire project. Finally, Google Doc and Google Draw helped us to work together on reports and sketches at the same time.

The best experience, however, was the teamwork and the collaboration between each members. By helping each others to solve problems or by exchanging knowledge we managed to produce a better product than originally planned. Moreover, by getting to know the members in the group first and keeping the communication up even outside of meetings and regular working hours, the experience became much more enjoyable and productive.

3.6 Improvement possibilities

All in All, the project is finished successfully and the objectives reached. The methods we incorporated is exhaustively reviewed, and the product is a good contender for commercial use. In hindsight, creating two sub-groups in charge of GUI and App backend under the android sub-group could have been beneficial. Nonetheless, there was much to learn in terms of managing a large group of people and working passionately on producing a product that could one day help diminish our carbon footprint, even if in trace amounts.

4 Test Cases: Appendix

Test Case 1 - Select machine type

- Steps
  - Start App
  - Touch button representing desired machine
- Outcomes
  - App switches to alias selection view

Test Case 2 - Select alias

- Steps
  - Perform test case 1
  - Enter desired alias in text field
  - Touch button "Next"
- Outcomes
  - App switches to time selection view

Test Case 3 - Select time

- Steps
  - Perform test case 2
  - Select desired time
  - Touch button "Play"
- Outcomes
  - App switches to game screen and game starts

Test Case 4 - Toggle between line graphs

- Steps
  - Perform test case 3
  - Touch button "Fuel", "RPM", "Acceleration", "Load" or "Distance"
- Outcomes
  - Line graph at the top of the app switches to selected data and the color changes to the same color as the button that was pressed

Test Case 5 - Store score locally

- Steps
  - Perform test case 3
  - Let app read bus data for a while
  - Wait for timeout or press stop button
  - Touch button "Stats"
- Outcomes
  - The app switches to the Statistics screen
  - An entry at the top of the statistics tables is added with the selected alias and the overall score from the game screen

Test Case 6 - Upload score to cloud

- Steps
  - Perform test case 5
  - Open web portal
  - Select appropriate machine in left sidebar
- Outcomes
  - Web portal will list an entry with your score if the score is higher than the 20 highest on the portal

Test Case 7 - Different machine types on web portal

- Steps
  - Open web portal
  - Select a machine in left sidebar
- Outcomes
  - The highscore list if filtered to only show score from the select machine type

Test Case 8 - Timeout

- Steps
  - Perform test case 3
  - Wait
- Outcomes
  - The app will stop the game after the time selected in the time selection screen
  - The progress bar at the bottom of the screen will indicate how much time is left

Test Case 9 - CAN

- Steps
  - Perform test case 3
  - Wait
- Outcomes
  - The will show real CAN data from the simulators in the line and radial charts

Date	Test Case	Result
12-12-2016	1	**Pass**
12-12-2016	2	**Pass**
12-12-2016	3	**Pass**
12-12-2016	4	**Pass**
12-12-2016	5	**Pass**
12-12-2016	6	**Pass**
12-12-2016	7	**Pass**
12-12-2016	8	**Pass**
12-12-2016	9	**Fail**

Table 6: Performed tests