Middle East Technical University

Department of
Electrical and Electronics Engineering

EE493 ENGINEERING DESIGN I

Car Chasing Robot
Proposal Report

Supervisor: Assoc. Prof. Emre Özkan
ADDDRESSS

Project Start: 4/10/2018
Project End: 26/5/2019
Project Budget: $450

Company Name : Duayenler Ltd. Şti.

Members	Title	ID	Phone
Sarper Sertel	Electronics Engineer	2094449	0542 515 6039
Enes Taştan	Hardware Design Engineer	2068989	0543 683 4336
Erdem Tuna	Embedded Systems Engineer	2617419	0535 256 3320
Halil Temurtaş	Control Engineer	2094522	0531 632 2194
İlker Sağlık	Software Engineer	2094423	0541 722 9573

November 9, 2018

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Contents

1 notes

1.1 specific requirements and objectives of the project

1.2 approach to the solution of the problem

1.3 outline of the requirements for any standards that the product would need to comply with,

1.4 deliverables and expected outcomes of the project,

1.5 tentative cost-budget analysis,

2 Executive Summary

3 Introduction

Driving is a common event that many people experience in their daily life. As time passes, human reflexes started to become insufficient for driving compared to fast pace of daily life in modern world. Together with the developments in the technology, new solutions are proposed to assist the driver such as lane tracking and emergency breaking systems. The ultimate version of such solutions are considered to be fully autonomous self-driving cars.

Self-driving vehicles are presented to the society as a solution that can facilitate people's life in many ways. Fast operation of the electronics system allows faster response than humans can. A fast and reliable operation of self-driving action can prevent many accidents and increase the safety of the roads in heavy traffics since the system is immune to human defects such as distraction and panic. As a result, autonomous vehicles can open doors to a safer and more conventional future.

DUAYENLER Ltd. Şti. is launched with the aim of innovating automation technologies. In that context, a device that can detect the road and other vehicles on them will be built. It autonomously track the lane and stay on the road while trying to as fast as possible.

This report includes;

- organization of the company by explaining of the qualifications of the members.
- Requirements for physically realizing the intended vehicle
- Possible solutions in system and subsystem levels by explaining their operations
- Timeline and cost of the project
- Expected deliverables from the project

4 Our Team

DUAYENLER Ltd. Şti. (DUAYENLER) was founded in September 2018 by five electrical and electronics engineering students from Middle East Technical University. The company structure is shown in *Figure 1.* The team is composed of variously skilled visionary members. The leader of the team is Halil Temurtaş, a control engineer. Being the team leader, Halil manages the organization of the members as well as drawing an outline for the future calendar. He is experienced in using microcontrollers, device testing and project scheduling. He will be working on the development of the subsystems computation, motion and driving in parallel with his experiences. Sarper Sertel, electronics engineer, has a wide understanding of microelectronics circuits and their design as well as analog lumped circuits. He is also interested in mechanical systems. He will be working on structure, driving and sensing subsystems. Enes Taştan, hardware design engineer, is interested in several topics such as electronics and mechanics. He can also design PCBs. He will be participating to development of driving, motion and structure subsystems. Erdem Tuna, embedded systems engineer, is experienced in use of microcontrollers with sensors and likes programming. He will be contributing in computation and sensing subsystems. Lastly İlker Sağlık, software engineer, is also interested in programming and microcontrollers. He will be working on sensing and driving subsystems.

5 Requirement Analysis

5.1 Pairwise Comparisons for Project Selection

Pairwise comparisons technique can be use to assess objectives of the project. Then, these objectives can be very useful as the desired project is selected out of all potential

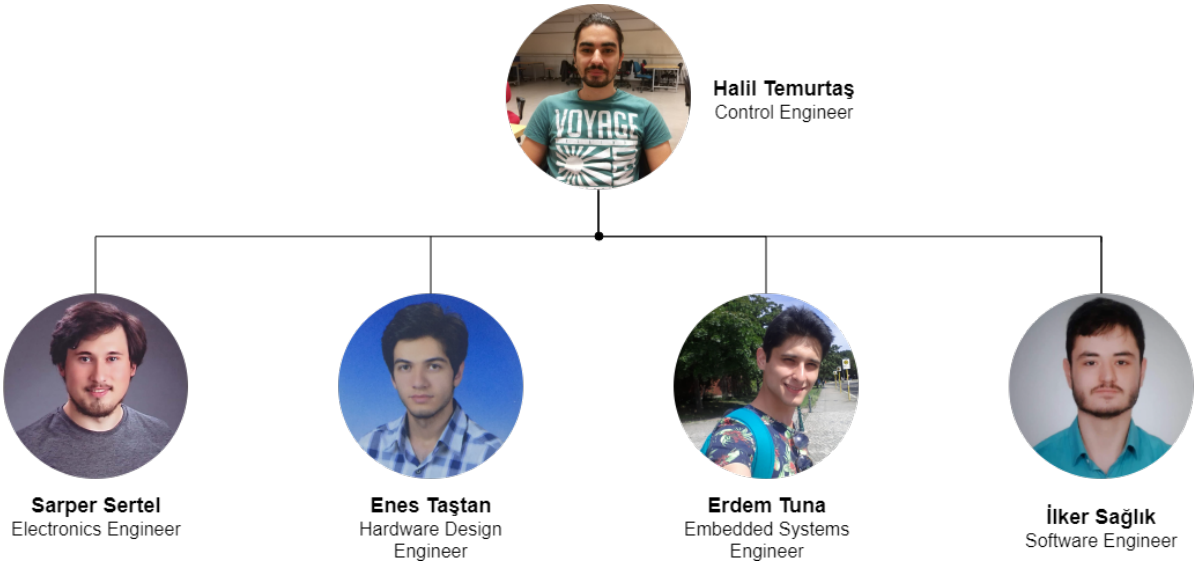

Figure 1: Company Tree of DUAYENLER.

project. For this purpose, tables at *Figures 2,3* is created by consensus of all project-pairs. The weighted objectives are then used to construct the weighted objective tree at *Figure 4*.

	Having Fun	Competition	Original Solution	Budget	Mechanical Challenges	Complexity	Marketability	Total	Weighted Objectives
Having Fun	0	0,5	0,75	0,8	0,9	0,6	0,8	4,35	0,2
Competition	0,5	0	0,7	0,7	0,5	0,75	0,8	3,95	0,2
Original Solution	0,25	0,3	0	0,6	0,7	0,55	0,8	3,2	0,16
Budget	0,2	0,3	0,4	0	0,2	0,3	0,8	2,2	0,1
Mechanical Challenges	0,1	0,3	0,3	0,8	0	0,3	0,8	2,6	0,12
Complexity	0,4	0,25	0,45	0,7	0,7	0	0,8	3,3	0,16
Marketability	0,2	0,2	0,2	0,2	0,2	0,2	0	1,2	0,06
								20,8	1

Figure 2: Pairwise Comparison Charts

	Having Fun (0.2)	Competition (0.2)	Original Solution (0.16)	Budget (0.1)	Mechanical Challenges (0.12)	Complexity (0.16)	Marketability (0.06)	Total
Balloon Catching	8	10	6	4	0	2	6	5,28
	1,6	2	0,96	0,4	0	0,32	0,36	
Air Hockey	8	8	4	8	2	6	8	5,84
	1,6	1,6	0,64	0,8	0,24	0,96	0,48	
Chasing Cars	10	8	8	6	6	8	10	7,48
	2	1,6	1,28	0,6	0,72	1,28	0,6	
Mapping Robot	4	4	8	2	8	0	6	4,04
	0,8	0,8	1,28	0,2	0,96	0	0,36	

Figure 3: Project Evaluation Chart

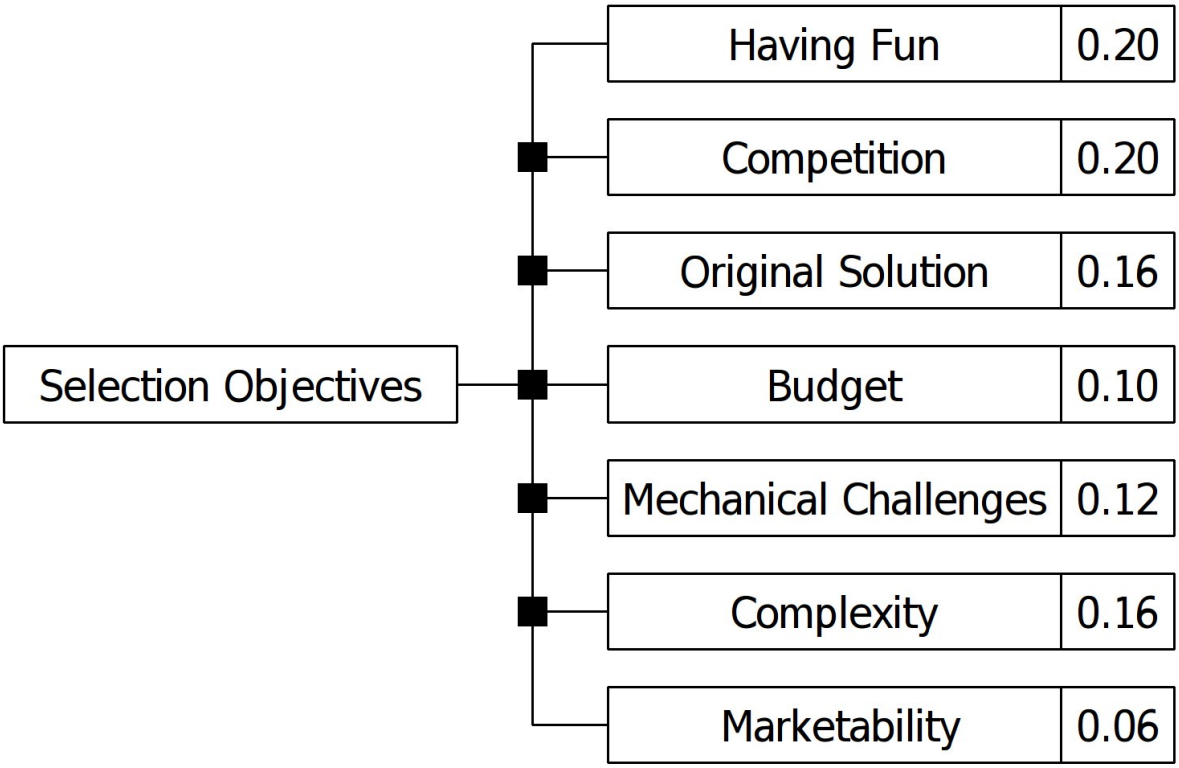

Figure 4: Weighted Objective Tree

5.2 Systems & Subsystems of Chosen Project

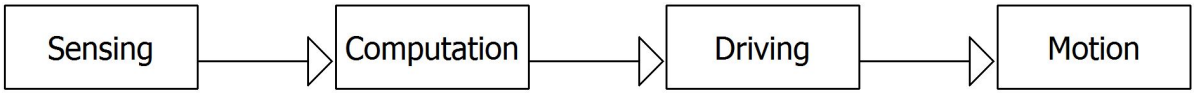

Figure 5: System Diagram for the Chosen Project

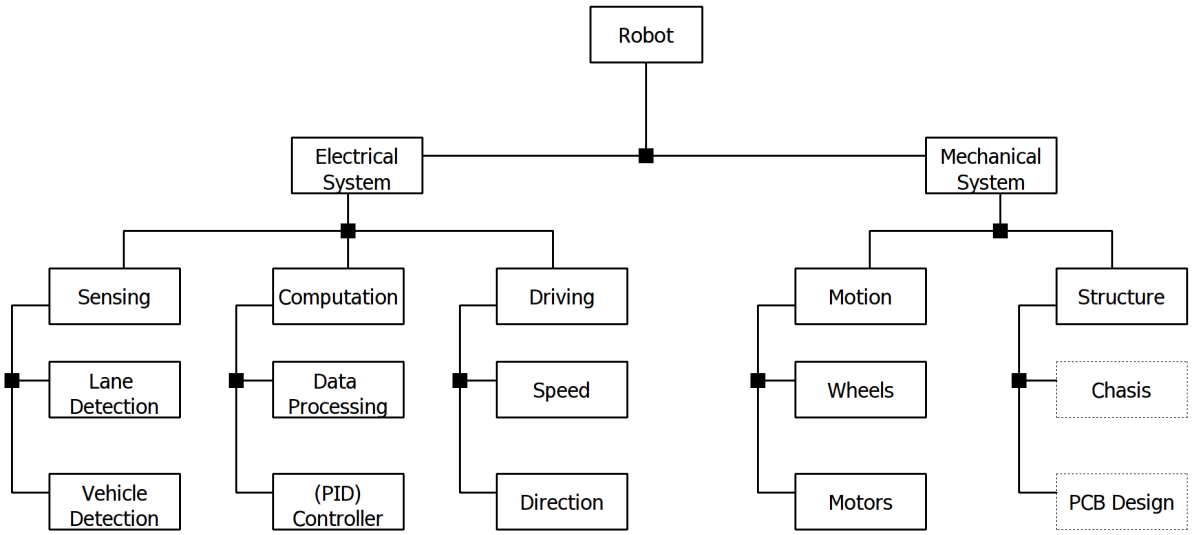

Figure 6: Systems & Subsystems of Chosen Project

5.3 Solution Alternatives for Systems & Subsystems

5.3.1 Possible Solutions for Lane Detection Unit

5.3.2 Possible Solutions for Vehicle Detection Unit

5.3.3 Possible Solutions for Data Processing Unit

5.3.4 Possible Solutions for Controller Unit

5.3.5 Possible Solutions for Motors Unit

5.3.6 Possible Solutions for Wheels Unit

5.3.7 Possible Solutions for Speed Unit

5.3.8 Possible Solutions for Direction Unit

5.4 Design Option 1

5.5 Design Option 2

5.6 Design Option 3

5.7 Pairwise Comparisons for Solution Selection

	Fast Operation	Robust	Weight Balance	Total	Weighted Objectives	Weighted Objectives
Fast Operation	0	0,55	0,4	0,95	0,32	0,144
Robust	0,45	0	0,5	0,95	0,32	0,144
Weight Balance	0,6	0,5	0	1,1	0,36	0,162
				3	1	0,45

Figure 7: Pairwise Comparison Charts for Sub-Objectives

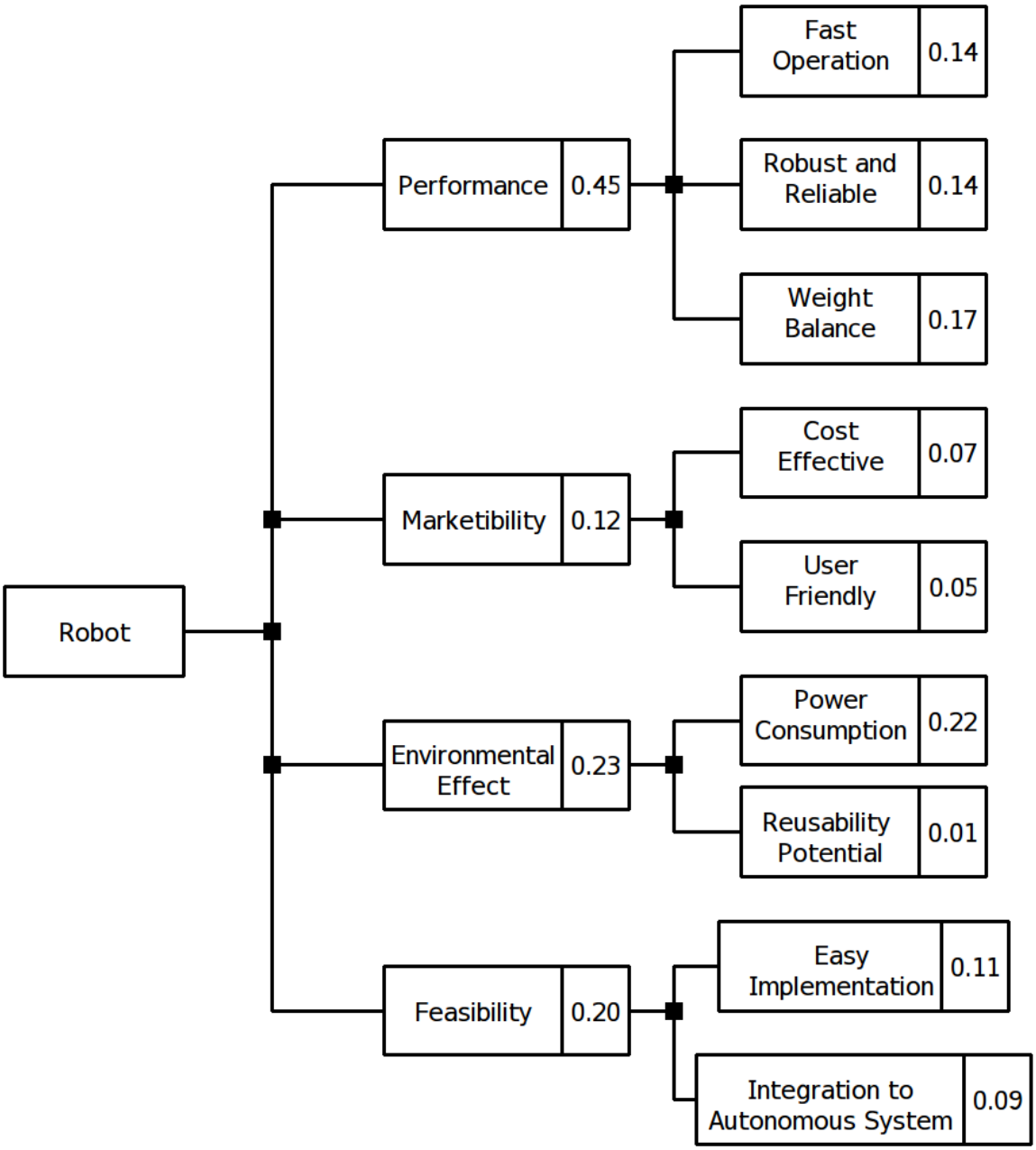

Figure 8: Weighted Objective Tree

	Fast Operation (0.14)	Robust and Reliable Operation (0.14)	Weight Balance (0.17)	Cost Effective (0.07)	User Friendly (0.05)	Power Consumption (0.22)	Reusability Potential (0.01)	Easy Implementation (0.11)	Integration to Autonomous Systems (0.09)	Total
Design 1	8	4	4	10	6	8	6	8	4	58
	1,12	0,56	0,68	0,7	0,3	1,76	0,06	0,88	0,36	6,42
Design 2	10	6	6	8	8	6	6	6	6	62
	1,4	0,84	1,02	0,56	0,4	1,32	0,06	0,66	0,54	6,8
Design 3	8	10	8	6	8	4	6	4	10	64
	1,12	1,4	1,36	0,42	0,4	0,88	0,06	0,44	0,9	6,98

Figure 9: Pairwise Comparison Charts for Solution Selection

6 Standards Section

7 Solution Procedure

8 Expected Deliverables

9 Conclusion

A Gantt Chart

	T0+	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	**Concept Development Phase (3 Weeks)**																												
2	**Assessment of System Requirement Phase (3 Week)**																												
3	**Conceptual Design and Preliminary Design Phase (4 Weeks)**																												
4	**Critical Design Phase (18 Weeks)**																												
5	**Test & Evaluation Phase (19 Weeks)**																												
6	**Implementation & Finalization Phase**																												
7	**Project Ending (T0+28 Weeks)**																												
1	**Concept Development Phase**																												
1.1	**Activities**																												
1.1.1	Literature Research and Determination and Similar Platform Specifications																												
1.1.2	Feasibility Works																												
2	**Assessment of System Requirement Phase**																												
2.1	**Activities**																												
2.1.1	Determination of Team Logo and Vision & Mission																												
2.1.2	Problem Define State for All Projects																												
2.1.3	Solve Defined Problem State for All Projects																												
2.1.4	General Component Research																												
2.2	**Outcomes**																												
2.2.1	Business Statement Report																												
3	**Conceptual Design and Preliminary Design Phase**																												
3.1	**Activities**																												
3.1.1	Preliminary Electrical System Design																												
3.1.1.1	Preliminary Sensing Unit Design																												
3.1.1.2	Preliminary Computational Unit Design																												
3.1.1.3	Preliminary Driving Unit Design																												
3.1.2	Preliminary Mechanical System Design																												
3.1.2.1	Preliminary Motion Unit Design																												
3.1.2.2	Preliminary Structure Design																												
3.2	**Outcomes**																												
3.2.1	Preliminary Report																												

	T0+	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
4	**Critical Design Phase**																												
4.1	**First Semester**																												
4.1.1	Electrical System Design																												
4.1.1.1	Sensing Unit Design																												
4.1.1.2	Computational Unit Design																												
4.1.1.3	Driving Unit Design																												
4.1.2	Mechanical System Design																												
4.1.2.1	Motion Unit Design																												
4.1.2.2	Structure Design																												
4.1.3	To be detailed																												
4.2	**First Semester Outcomes**																												
4.2.1	Standards Report																												
4.2.2	Module Test Demo																												
4.2.3	Conceptual Design Report																												
4.2.4	Presentations																												
4.3	**Second Semester**																												
4.3.1	To be detailed																												
4.4	**Second Semester Outcomes**																												
4.4.1	Critical Design Review Report																												
5	**Test & Evalution Phase**																												
5.1	**First Semester Activities**																												
5.1.1	To be detailed																												
5.2	**First Semester Outcomes**																												
5.2.1	To be detailed																												
5.3	**Second Semester Activities**																												
5.3.1	To be detailed																												
5.4	**Second Semester Outcomes**																												
5.4.1	Critical Design Review Report																												
6	**Finalization Phase**																												
6.1	**Activities**																												
6.1.1	To be detailed																												
6.2	**Outcomes**																												
6.2.1	Finalized Product																												
6.2.2	Final Report																												
6.2.3	Final Demo																												
7	**Project Ending**																												