

#### 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: 16.16.6227 Project End: 16.16.6227 Project Budget: \$450

Company Name: Duayenler Ltd. Sti.

| Members        |                           |         |                   |
|----------------|---------------------------|---------|-------------------|
| Sarper Sertel  | Electronics Engineer      | 2094449 | 0542 515 6039     |
| Enes Taştan    | Hardware Design Engineer  | 2068989 | $0543\ 63\ 4336$  |
| 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

# Contents

|            | 0.1 problem statement, societal impact of the project,                        | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
|------------|---|----------------|--|--|--|--|--|--|--|--|--|--|--|--|--|
|            | 0.2 company organization (human resources, etc.),                             | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | 0.3 specific requirements and objectives of the project                       | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | 0.4 approach to the solution of the problem                                   | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | 0.5 outline of the requirements for any standards that the product would need |                |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | to comply with,   | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | 0.6 deliverables and expected outcomes of the project,                        | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | 0.7 tentative cost-budget analysis,   | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | 0.8 time plan (Gantt chart),  | $\overline{2}$ |  |  |  |  |  |  |  |  |  |  |  |  |  |
|            | F (   |                |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1          | Executive Summary   |                |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2          | Introduction  |                |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3          | Team Organization   |                |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1          | Requirement Analysis  | 2              |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5          | Standards Section   | 4              |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3          | Solution Procedure  | 4              |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7          | Expected Deliverables   | 4              |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3          | Conclusion  | 5              |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>A</b> 1 | opendix A. Gannt Chart  | 5              |  |  |  |  |  |  |  |  |  |  |  |  |  |

- 0.1 problem statement, societal impact of the project,
- 0.2 company organization (human resources, etc.),
- 0.3 specific requirements and objectives of the project
- 0.4 approach to the solution of the problem
- 0.5 outline of the requirements for any standards that the product would need to comply with,
- 0.6 deliverables and expected outcomes of the project,
- 0.7 tentative cost-budget analysis,
- 0.8 time plan (Gantt chart),
- 1 Executive Summary
- 2 Introduction
- 3 Team Organization

Our team



Figure 1: Company Tree

#### 4 Requirement Analysis

Reqs, soln puanlama

|                          | Having Fun | Competition | Original Solution | Budget | Mechanical<br>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<br>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<br>(0.2) | Competition<br>(0.2) | Original Solution<br>(0.16) | Budget<br>(0.1) | Mechanical<br>Challenges<br>(0.12) | Complexity<br>(0.16) | Marketability<br>(0.06) | Total |
|--------------|---------------------|----------------------|-----------------------------|-----------------|------------------------------------|----------------------|-------------------------|-------|
| Balloon      | 8                   | 10                   | 6                           | 4               | 0                                  | 2                    | 6                       | F 20  |
| Balloon      | 1,6                 | 2                    | 2 0,96 0,4 0                | 0,32            | 0,36                               | 5,28                 |                         |       |
| Air Hockey   | 8                   | 8                    | 4                           | 8               | 2                                  | 6                    | 8                       | F 04  |
| Air Hockey   | 1,6                 | 1,6                  | 0,64                        | 0,8             | 0,24                               | 0,96                 | 0,48                    | 5,84  |
| Charles Care | 10                  | 8                    | 8                           | 6               | 6                                  | 8                    | 10                      | 7.40  |
| Chasing Cars | 2                   | 1,6                  | 1,28                        | 0,6             | 0,72                               | 1,28                 | 0,6                     | 7,48  |
|              | 4                   | 4                    | 8                           | 2               | 8                                  | 0                    | 6                       | 404   |
| Mapping      | 0,8                 | 0,8                  | 1,28                        | 0,2             | 0,96                               | 0                    | 0,36                    | 4,04  |

Figure 3: Project Evaluation Chart

|                              | Performance | Marketability | Environmental Effects | Feasibility | Total | Weighted Objectives |
|------------------------------|-------------|---------------|-----------------------|-------------|-------|---------------------|
| Performance                  | 0           | 1             | 0,8                   | 0,8         | 2,6   | 0,45                |
| Marketability                | 0           | 0             | 0,4                   | 0,35        | 0,75  | 0,12                |
| <b>Environmental Effects</b> | 0,2         | 0,6           | 0                     | 0,5         | 1,3   | 0,23                |
| Feasibility                  | 0,2         | 0,35          | 0,5                   | 0           | 1,05  | 0,2                 |
|                              |             |               |                       |             | 5,7   | 1                   |

Figure 4: Pairwise Comparison Charts for Objectives

|                | 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 5: Pairwise Comparison Charts for Sub-Objectives

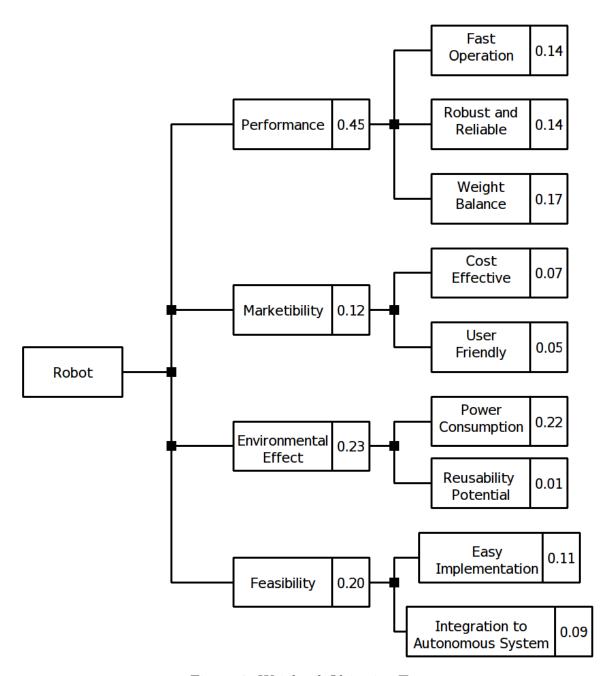


Figure 6: Weighted Objective Tree

- 5 Standards Section
- 6 Solution Procedure
- 7 Expected Deliverables

### 8 Conclusion

### A Gannt Chart

Is
the
project
well
defined
and
realistic?

Have you outlined a sound approach, including your ability to perform the tasks

|         |   | 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                                       |     |   |   |   |   |   |   |     |   |    |    |    |    |    |    |    |    |    |       |    |    |    |    |    |    | پيلا |    |
| 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  |     |   |   |   |   |   |   |     |   |    |    |    |    |    |    |    |    |    |       |    |    |    |    |    |    |      |    |

|         | T                             | 0+ | 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                    | T  |     |   |     |   |   |   |   |    |    |    |    | П  |    |    |    | T  |    | П  |       |    |    |    |       |    |
| 7       | Project Ending                |    |     |   |     |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |       |    |    |    |       |    |