

**“WRESTLING ROBOTS”**

**PROJECT PROPOSAL**

Prepared for

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| --- | --- | --- |
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# EXECUTIVE SUMMARY

As the technology develops further, challenges in the robotics area become more complex and human-imitating. The best way to accomplish this imitation resides in sports area. Today, people are already working on developing robots which will compete against humans. We are also trying the same thing, but in a different sport, namely wrestling.

As Umbrella Corporation we will design an automated platform which will compete with an opponent in a way that both of them will have two bumpers, namely offensive and defensive bumpers. The one which hits opponent's defense bumper with its own offense bumper will get a point. As simple as it sounds the whole concept requires a fast, agile, sturdy, light and intelligent robot in order to compete in high level. All these features force us, Umbrella Corp. to be the best among the bests.

Even though combining all these features may seem impossible at first, a correct division of labor creates smaller problems and solving these smaller problems make the completion of the project and a competitive product within our grasp.

As more detailed information about problem division we have created three sub-problems and possible solutions. These sub-problems are;

* Detection of the position and orientation of the opponent
* Designing a fast and agile actuator system
* Control of the combination of the first two solutions according to a strategy

Our approach to these problems may be summarized as;

* A possible list for the solutions of the *detection* problem
  + Implementation of an overviewing camera and color coded caps
  + Combination of proximity and solar sensors
  + Using different kinds of wireless transmitters such as infrared or RF type
* A possible list for the solutions of the *motion* problem
  + Design and implementation of a four wheel omni-wheel system
  + Design and implementation of two parallel bidirectional wheels and single caster wheel
* A possible list for the solutions of the *control* problem
  + Integrated control system which will reside in the platform
  + A third party control system which will overview both (if applicable) the camera and strategy generation

This document is a proposal for the mentioned product, and contains detailed information on how the product will be developed, and why our product will be the best.

# INTRODUCTION

Today, many sports are relied on the strategy, even though they require physical strength. Wrestling is one of those sports. Not only the muscles work, but the brain also needs to think to defeat the opponent and win at the end. For instance, a wrestler has to take the opponent’s movements into consideration such that he can choose the right way to attack his opponent before the opponent gets offensive.

Nowadays, our company *Umbrella Corporation* is interested in performing such sports in electronic world via robots. Although wrestling seems like a physical sport, the strategy has great importance in wrestling, and that factor inspired us to implement this sport on robotics area. As a result, we agreed to design an autonomous robot which can “wrestle” with a similar opponent.

For the project mentioned above, one needs to score points in a limited sense rather than professional wrestling. A wrestler robot should have a body such that half of it belongs to the defensive part (the back of the body), and the other half belongs to the offensive part (the front of the body). The wrestler has to attack the other wrestler from behind with its offensive bumper. Meanwhile, the wrestler should secure its rear part and defend it against the attack of the opponent. If one touches or hits the defensive bumper that counts towards score points. Considering dead-lock issue, the project bears some similarities to the professional wrestling. If there is no movement for a certain amount of time, the robot should break the dead-lock; it can retreat and invent another strategy to attack.

Although the project sounds challenging, we, as *Umbrella Corporation,* have much more experience, engineering skills and diligence than the project requires. We are well organized and our members are highly motivated. Our company has leading engineers in their respective areas, such as, telecommunications, control, computer, etc. Thus, every member completes each other by their knowledge on different areas.

# PROJECT GOALS AND OBJECTIVES

The main goal of the project is to implement the real life wrestling sport into robotics world. By doing this so, our aim is not to implement whole wrestling game, due to the physical limitations of the mechanical design, but the implement the term “künde” as a strategy game.

In our game definition, it is defined that there are two regions on the robots, namely; offensive and defensive. If a robot manages to touch the opponent’s defensive region with its own offensive region, this counts as a point to the attacking robot. The winner of the game will be the determined according to the points collected by each opposing robots at the end of the game.

The main objectives of the design are;

* Fast operation
* Clever strategy
* Roboust design
* Determination
* Stand alone operation
* Easy to use
* Instant display of the game state
* Safe operation
* Stability
* Smart design
* Outstanding look

To state the relevant weights of the objectives, we have defined 3 zones by importance;

1. **Essentials**

* Fast operation: robot shall be quick in identifying problem, deciding strategy and moving to target.
* Stability: system shall act in the same in repetitive operations without clashing.

1. **Musts**

* Clever strategy: there shall be more than one solution considering all the cases in wrestling with opponent.
* Roboust design: the robot shall endure the extreme impacts caused by the opponent and the environment.
* Determination: the robot shall analyze the environment and the opponent precisely.
* Stand alone: after the start of the operation, the robot shall run without any human interraction
* Safe operation: the robot shall be stopped directly in an emergency case.
* Smart design: the robot shall choose appropriate strategy during the game and change it if the conditions are changed.

1. **Better be**

* Easy to use: the design shall be instinctive so that inexperienced user can use robot.
* Instant display of the game state: the robot shall be displaying game state to audiance.
* Outstanding look: the robot shall look catchy to impress audiance.

# standards

In real world wrestling sports, each person wrestles with an opponent which is in the same weight region with himself/herself. Since our project will be the implementation of the wrestling sport, there shall be some configuration restrictions defined prior to competition.

In order to compete fairly with other teams, there should be some standards defined before the manufacturing of the robots. In standards committee following issues shall be discussed to provide a fair competition.

* **Dimensions of robots**

Robots shall have same dimensions in order to recognize each other.

* **Dimensions of the field**

Field dimensions shall be known for all teams before design process.

* **Bumper design**

Offensive and defensive bumper structure shall be known to identify opponents bumper (i.e. defensive or offensive).

* **Evaluation**

In order to determine the winner, there shall be a scoring scheme defined in standards committee.

* **Timing**

Duration of the game and the deadlock time shall be defined.

* **Score calling**

To inform audiance and the jury for the point taken by a robot, there shall be a system indicating the score.

* **Emergency stop**

There shall be a wireless system in all robots that enables the user to stop the robots.

# team organızatıon structure

Umbrella Corporation, which is going to conduct “wrestling” project, consists of 6 qualified engineers. The specialization areas of the engineers are shown on the Figure 1. Each engineer is equipped with the theoretical knowledge and practical experience on different areas that is related to this project.

**Figure 1:** Organizational Structure

*Tuba Ceren Deveci* serves as the project coordinator throughout the project, because she has sufficient communication skills and she is good at organizing and coordinating people. Her specialization is based on microwave and RF engineering. She is also interested in signal processing. She will be responsible for the theoretical research and financial analysis.

*Mehmet Hakan Doğan* serves in the software engineering section of the company. He is experienced in programming with different software languages, such as C++, Java, Unix and with Verilog, Assembly etc. Relying on his full-time job experience, he is likely to work in collaboration and good at team work. He will be responsible for the theoretical research and conceptual design.

*Mehmet Duran* has specialized in power systems and power electronics area. He has experiences in driving different types of motors and actuators. He plays a great role in visualizing the aspects of the robot, as he is capable of technical drawing with AUTOCAD. He will be also responsible for the conceptual design with Hakan and for the theoretical research.

*Osman Zeki Er* is the system engineer of the company. Having sufficient expertise both on computer and control area, he will contribute to the project by finding possible solutions that require MATLAB/Simulink and image processing. He will be responsible for the theoretical research and, mainly, the technical aspects of the project.

*Alkan Kahraman* is the mechatronics engineer and has expertized in robotics area. As he has a minor degree in mechatronics, he is a domineer of mechanical systems of the robots and embedded systems. He has also experiences with programming in machine codes and software languages. He will be responsible for the technical aspects of the project with Zeki.

*Nazım Önder Orhan* serves as the telecommunications engineer. He is skillful at signal processing. His main areas of interest are including wireless communication protocols and their implementation. He can also help team with his signal processing skills. He will be responsible for theoretical research and the process analysis.

# solutıon procedure

In order to achieve the goals, Umbrella Corporation developed a few alternatives for each subsystem. However, it still remains uncertain that which one of the alternatives will prove to be the optimal solution. There are some examples for some of the alternatives developed.

The closest one so far is a competition for soccer playing robots called “Robocup”. And small size division is very similar in conceptual way for the “Wrestling robot”. As main concerns are aligned with each other it is safe to assume that some of the features used in Robocup small size league may prove useful. Especially the questions about Omni-Wheel system may be answered. One particular video[[1]](#footnote-1) shows the potential of the Omni-Wheel system in great detail. Please note that it also shows the overhead camera is also feasible.

In another video[[2]](#footnote-2), it is possible to determine the location of an opponent with a proximity sensor. Even though how the bumpers will be differentiated is still not determined, this provides a very basic and reliable way to determine at least the location of the opponent.

While the examples provide a justification to some extent, it is required to have made a certain amount of progress in the design in order to fully analyze the compatibility. Umbrella Corporation does not want to close all the doors before that point comes. Therefore, every possible solution so far has its own procedure.

One common procedure is the testing of the components. Every component will be tested before using both to ensure it is working properly and to get familiar with that component.

As for different procedures, each solution has milestones to track the progress and to provide a sense of success to boost the morale of the employees. These milestones are;

* **MILESTONES OF DETECTION**
* **Overhead Camera**
  + Identification of single point
  + Identification of orientation using multiple points
  + Identification of motion using multiple points at different times
* **Sensors**
  + Identification of the relative location of the opponent by using proximity sensor
  + Identification of the motion of the opponent
  + Identification of the orientation by using solar sensors
* **Transmitters**
  + Differentiation of the transmitters
* **MILESTONES OF MOTION**
* **Omni-Wheel**
  + Control of a single motor
  + Control of four motors
  + To be able to move in a straight line
  + To be able to move sideways
  + To be able to move in crossways
  + To be able to turn around
  + Combinations of multiple movement patterns
* **Caster Wheel**
  + Control of a single motor
  + Control of two motors
  + To be able to move in a straight line
  + To be able to turn around
  + Combinations of multiple movement patterns
* **MILESTONES OF CONTROL**
* **Integrated Control System**
  + Follow the opponent
  + Escape from opponent
  + Artificial intelligence and strategy generation
  + Execution of the generated strategies
* **Third Party Control**
  + Sending and receiving a single data
  + Building a permanent data stream
  + Follow the opponent
  + Escape from opponent
  + Artificial intelligence and strategy generation
  + Execution of the generated strategies

Depending on the design details for every milestone a test bench will be designed and checked to see if it has been accomplished before going any further.

Please keep in mind that more alternative solutions may appear in the design phase. Should such a thing happens they too will have their milestones and go though the same procedure.

# delıverables

## Equipment

* **Vehicle (Robot)**

The user will be provided with a device which can compete with similar opponent in a platform.

* **Platform**

The user will be provided with a platform which the robots can compete with each other on.

* **Chargeable Battery (2 items)**

The user will be provided with two chargeable batteries in order to run/drive the robot. Chargeable batteries help the user to get rid of extra payments and efforts.

* **Battery Charge Machine**

The user will be provided with a battery charge in order to charge the batteries.

## Documents

* **Warranty**

Umbrella Corp. provides two (2) years warranty in both hardware and software components' breakdowns of the vehicle except the user faults.

* **Manual**

The user will be provided with a manual which contains information about the vehicle components usage, software component usage etc. This manual will be helpful for the users in the usage of the vehicle at first stage.

## Software

* **Documents and videos containing tutorials on a CD**

The user will be provided with a CD which contains documents and videos containing tutorials. This will be useful for the users as a software manual.

* **Robcomsoft**

The user will be provided with a special computer program (Robcomsoft) which provides the communication between the device and computers (or similar components e.g. smart phones). The users can use this software in competitions in order to get a score table on its interface.

# Summary and Closing

Umbrella Corporation will design a “wrestler” robot which collects points by touching or hitting the opponent’s defensive bumper with its offensive bumper. Performing and implementing sports are becoming more and more popular in robotics area, because it is getting easier and more challenging at the same time to design a strategy as the technology goes further. Wrestling, as one of these sports, has drawn our attention, because it requires both physical strength, agility and strategy. That’s why we want to get into this business.

Although some specifications are going to be clear according to the standards, the problems to be solved are quite accurate. These problems are: analyzing the environment, determining the location of the opponent, choosing the correct strategy to attack, preventing the opponent from scoring a point, re-choosing a different strategy in case of a dead-lock. Considering the solutions of these topics, we will work, make research and design individually and together on parts and subsystems of the project.

When the project is finished, this will bring a new approach to wrestler robots. The agility, the determination and the robustness of the wrestler robot will be a long-lasting example for the “sporter” robots.

We, as Umbrella Corporation, guarantee that we will provide you the best solution with most definite specifications according to the standards.

# APPENDICES

## Gantt chart

## Analysıs of all projects

Project selection is done after evaluation of each project by each group member. Team members considered same criterias to evaluate the projects. These criterias are;

**Original solution:** how original is our solution on project

**Dependence on standards:** how much dependent our solutions to changing standards

**Mechanical challenges:** how much efford is required on mechanical parts

**Cost:** the cost of all components and services needed

**Marketability:** the need for this product in the market

Table 2 shows evaluation of these criterias by each team member out of 10 and Table 3. shows the ranking according to the data in Table 2.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| CEREN | Original Solution | Dependence on Standards | Mechanical Challenges | Cost | Marketability | Overall Score |
| Curling | 8 | 6 | 5 | 6 | 7 | 6,4 |
| Wrestling | 9 | 7 | 7 | 7 | 7 | 7,4 |
| Light | 8 | 6 | 6 | 7 | 8 | 7 |
| Relay race | 7 | 7 | 4 | 6 | 5 | 5,8 |
| Tetrisoid | 7 | 6 | 4 | 6 | 7 | 6 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ZEKİ | Original Solution | Dependence on Standards | Mechanical Challenges | Cost | Marketability | Overall Score |
| Curling | 9 | 7 | 6 | 7 | 6 | 7 |
| Wrestling | 10 | 8 | 6 | 7 | 7 | 7,6 |
| Light | 8 | 5 | 7 | 6 | 7 | 6,6 |
| Relay race | 7 | 7 | 5 | 7 | 5 | 6,2 |
| Tetrisoid | 8 | 6 | 4 | 5 | 6 | 5,8 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| HAKAN | Original Solution | Dependence on Standards | Mechanical Challenges | Cost | Marketability | Overall Score |
| Curling | 7 | 7 | 7 | 5 | 7 | 6,6 |
| Wrestling | 9 | 6 | 7 | 8 | 8 | 7,6 |
| Light | 8 | 8 | 8 | 6 | 6 | 7,2 |
| Relay race | 7 | 7 | 6 | 6 | 5 | 6,2 |
| Tetrisoid | 7 | 6 | 5 | 4 | 7 | 5,8 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| ALKAN | Original Solution | Dependence on Standards | Mechanical Challenges | Cost | Marketability | Overall Score |
| Curling | 8 | 5 | 6 | 5 | 7 | 6,2 |
| Wrestling | 10 | 6 | 6 | 6 | 7 | 7 |
| Light | 9 | 7 | 7 | 7 | 8 | 7,6 |
| Relay race | 7 | 7 | 4 | 6 | 6 | 6 |
| Tetrisoid | 7 | 6 | 4 | 6 | 5 | 5,6 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| MEHMET | Original Solution | Dependence on Standards | Mechanical Challenges | Cost | Marketability | Overall Score |
| Curling | 8 | 7 | 5 | 6 | 7 | 6,6 |
| Wrestling | 9 | 8 | 7 | 7 | 8 | 7,8 |
| Light | 8 | 7 | 6 | 7 | 8 | 7,2 |
| Relay race | 7 | 8 | 5 | 6 | 6 | 6,4 |
| Tetrisoid | 7 | 7 | 4 | 6 | 7 | 6,2 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| NAZIM | Original Solution | Dependence on Standards | Mechanical Challenges | Cost | Marketability | Overall Score |
| Curling | 8 | 6 | 6 | 6 | 7 | 6,6 |
| Wrestling | 9 | 7 | 8 | 8 | 7 | 7,8 |
| Light | 8 | 6 | 7 | 7 | 8 | 7,2 |
| Relay race | 7 | 7 | 5 | 7 | 5 | 6,2 |
| Tetrisoid | 7 | 6 | 4 | 6 | 7 | 6 |

Table 2. Evaluation of each project

According to table 2. ranking of the projects is shown in table 3. and team decided on “wrestling” project.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Ceren | Zeki | Hakan | Alkan | Mehmet | Nazım | Overall |
| Curling | 3 | 2 | 3 | 3 | 3 | 3 | 17 |
| Wrestling | 1 | 1 | 1 | 2 | 1 | 1 | 7 |
| Light | 2 | 3 | 2 | 1 | 2 | 2 | 12 |
| Relay race | 5 | 4 | 4 | 4 | 4 | 4 | 25 |
| Tetrisoid | 4 | 5 | 5 | 5 | 5 | 5 | 29 |

Table 3. Ranking of projects

1. http://www.youtube.com/watch?v=nl9YupK0Y7U [↑](#footnote-ref-1)
2. http://www.youtube.com/watch?v=gIYMAymGzdI [↑](#footnote-ref-2)