MIDDLE EAST TECHNICAL UNIVERSITY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

EE-493 SENIOR DESIGN COURSE

VEHICLES CHASING EACH OTHER AROUND A CLOSED COURSE WITH VARYING PROPERTIES PROJECT

STANDARDS REPORT

13.12.2018

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I. INTRODUCTION

Introduction to the report and overview of the report.

This document is an informative document about the standards of the project includes whose name is stated on the title. This document includes the project description, the Standards Committee and the functionality of it, and finally the standards for the project.

In order to define the standards, the Standards Committees were held every Thursday for a month where every company sent a representative to pursue their interests. The standards have been discussed in detail and defined clearly so that every team's work can be regarded and evaluated fairly at the end of the project. Also, the standards are very crucial in order that the teams facilitate the same procedures and rules for the common grounds such as the communication between devices. In addition, the delegates cooperated to define those standards at weekly Standards Committee for a month. There are 19 companies that are currently working on the project. Therefore, there were many creative ideas from various company delegates for the problems that the companies might face during the design process, and creative solutions for those problems at the Standards Committees. The delegates were enfranchised for final decision of every standard. In other words, the standards were discussed to ensure that the devices use the same codes to communicate, have specific qualities for the product in order to avoid any miscommunication and catastrophe, and delegates have reached a consensus on every standard.

Furthermore, the standards are clearly, strictly defined and described. The absence of any standard quality on the product is a violation, such products will not be allowed to participate to the competitions related to the project. Therefore, it is strongly advised to the participating companies to carefully read and make sure that their product satisfies those standards.

Finally, the standards stated in this document cannot be altered. Any request from the companies regarding to this issue will not be taken into consideration.

II. PROJECT DESCRIPTION

In this project each team designs one of the two robots which are self-contained. These robots try to catch and tag each other in an elliptical shaped closed path with

varying width. The area between the two concentric ellipses is the path which is shown in Figure-1 which is taken from Middle East Technical University EE493-494 Engineering Design Courses website. Also, the dimensions of the ellipses are given in Figure-1. The path with varying width must be elevated from the floor by 1-2 cm and it cannot include any marks or signs except its colour to distinguish it from the floor. In addition to them, robots cannot leave the path (cannot touch the floor) and must complete the closed path at most in 20 seconds without affecting from the small disturbances, and robots must run in both directions (cw/ccw). Before the race start robots are placed diametrically opposite sides of the path as in seen in Figure-1 with A and B starting points. Each robot starts to move simultaneously by the command of the team member. To complete the race, one of the robots reaches the other one from the back when the distance between them decreases the 5cm, both robots come to an agreement by a handshake protocol and stop. There are also some restrictions which are that all the instruments must be placed on the robot and the most important precaution is avoiding from collisions.
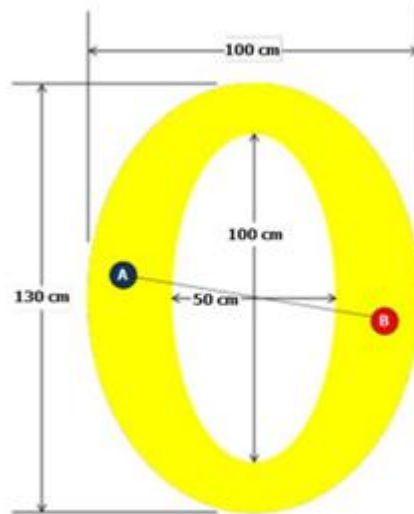

Figure 1: Elliptical race path

III. THE STANDARDS COMMITTEE AND ITS OPERATIONS

The Structure of the Standards Committee

Standards committee consists of 21 people. The standards committee has 2 coordinator faculty members who are Prof. Dr. Arzu Koç and Prof. Dr. Murat Eyüboğlu.

Also, the committee contains representatives of each group choosing the project. The chairperson of the committee is Samet Yıldırım. The scribe of the committee is Alper Bilgiç.

The Operations of the Standards Committee

Standards Committee representatives have participated in total number of 4 meetings in order to decide and clarify topics which are common for all groups. Meetings were held at D-131 every Thursday starting from 8th of November. First week working mechanism and duties of Standards Committee is discussed, chairperson and secretary general is determined and main standards topics are listed. The Committee has listed 3 main topics which are listed below:

- Racetrack properties
- Handshake protocol
- Vehicle Properties

Starting from the 2nd week, the Committee discussed details of these topics. First topic was handshake protocol. Members shared their ideas about the handshake protocol from different perspectives such as its transmission medium, first sender and coding. After the 2nd meeting, members gathered for another meeting that wasn't scheduled as compulsory in order to advance handshake protocol progress. Representatives have discussed race track properties in the 3rd and 4th weeks. Different application examples from representatives have been presented and representatives shared their ideas about the race track properties such as its height, surface material and colour. In the 4th week, Collision avoiding has, also, discussed. To achieve successful handshake protocol, detection of the opponent on the track is must, so topic of detection has discussed to eliminate any interference problem of the sensors which can violate the protocol.

IV. PROJECT STANDARDS

Standards are listed below with clear description:

1. HANDSHAKE PROTOCOL

In this project 2 robots race against each other and after one of them catches the other and is 5 cm away from the other, both robots will stop after a handshake protocol. Standards Committee decided that peer to peer Wi-Fi internet will be used as the communication medium between robots. Robots will be able to run in both client and server mode.

Communication between the robots is hold by peer to peer communication network. Each robot should act as server and client at the same time.

Transmission Control Protocol as known as TCP Three-Way Handshake Protocol is a Transport Layer host-to-host protocol that provides reliable communication over IP networks between two endpoints. TCP provides for the recovery of segments that get lost, are damaged, duplicated or received out of order. Therefore, this protocol is also known as a secure, reliable protocol since it attempts to recover from these errors.

TCP/IP Handshake Mechanism

TCP/IP has a built in 3-way handshaking mechanism that ensures that a message is transmitted.

Every segment is labeled with a sequence number. The sequence numbers allow us to detect dropped segments. Also, by using TCP, we can be acknowledged by a message after data is transmitted. On the other hand, if a segment is dropped or damaged, TCP verifies it via CRC (Cyclic redundancy check) on every segment that is sent or received. If segments do not match, CRC discards them.
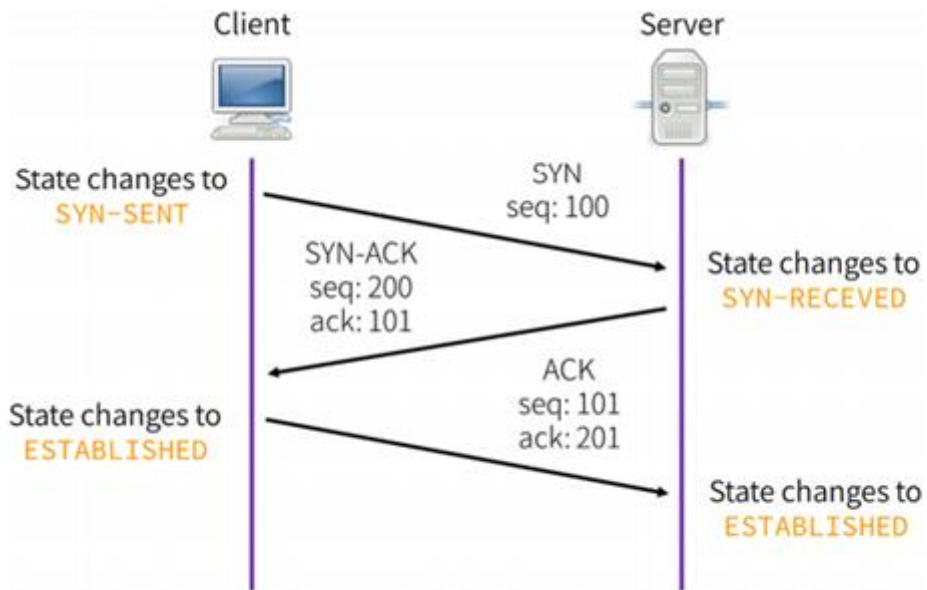
Figure 2: TCP three-way handshake diagram

As it can be seen from Figure 2, three-way TCP handshake mechanism works like this (Hsu et al.):

1. The client sends a SYN (synchronize) packet to the server, which has a random sequence number.

2. The server sends back a SYN-ACK packet, containing a random sequence number and an ACK number acknowledging the client's sequence number.

3. The client sends an ACK number to the server, acknowledging the server's sequence number.

4. The sequence numbers on both ends are synchronized. Both ends can now send and receive data independently.

Note that the ACK number that one side sends in Figure 2 is simply obtained by adding 1 to the sequence number of the other side. RST message is used to reset TCP. Another figure showing steps from initialization to the end of connection is Figure 3 below.

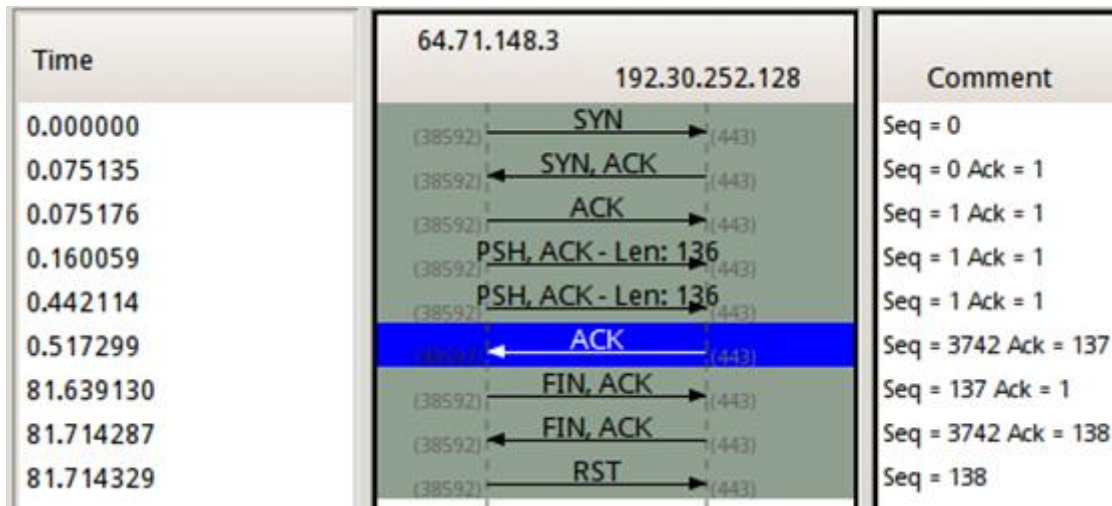| Time	64.71.148.3 ... 192.30.252.128	Comment
0.000000	(38592) ──── SYN ────► (443)	Seq = 0
0.075135	(38592) ◄── SYN, ACK ──── (443)	Seq = 0 Ack = 1
0.075176	(38592) ──── ACK ────► (443)	Seq = 1 Ack = 1
0.160059	(38592) PSH, ACK - Len: 136 (443)	Seq = 1 Ack = 1
0.442114	(38592) PSH, ACK - Len: 136 (443)	Seq = 1 Ack = 1
0.517299	(38592) ◄──── ACK ──── (443)	Seq = 3742 Ack = 137
81.639130	(38592) ──── FIN, ACK ──► (443)	Seq = 137 Ack = 1
81.714287	(38592) ◄── FIN, ACK ──── (443)	Seq = 3742 Ack = 138
81.714329	(38592) ──── RST ────► (443)	Seq = 138

Figure 3: Initialization, data transmission and end of connection steps of TCP/IP handshake mechanism

In this project each robot should have a socket that has a port in number 5000. All data send will be done through this socket, and each robot should listen always the port in the socket.

The Information Containing Message

Each group should be assigned a static IP address in order for their robots to communicate with other robots. The IP numbers will be 192.168.1.ID   where 'ID' is each groups ID number. ID number is given by sorting groups in alphabetical order and adding that order number 1. For example if a group is at 4th place when the groups are ordered alphabetically, their ID is 4+1=5, and their IP address is: 192.168.1.5 . Each of the groups and their respective IP addresses and IDs are shown in Table 1.

Table 1: Group names and their IDs and static IP addresses

Group Name	ID	Static IP Address
ACME Inc.	2	192.168.1.2
Atlanta	3	192.168.1.3
Autonomous Technology	4	192.168.1.4
Blitz	5	192.168.1.5
Doston Bynamics	6	192.168.1.6
Duayenler	7	192.168.1.7
Epiphany	8	192.168.1.8
Esinti	9	192.168.1.9
Jacobian Art Project	10	192.168.1.10
Mind Wizards	11	192.168.1.11
Morpheus	12	192.168.1.12
Orbis Robotics	13	192.168.1.13
Puzzles	14	192.168.1.14
RESTIN	15	192.168.1.15
Robotz with Attitude	16	192.168.1.16
Sesca Dynamics	17	192.168.1.17
SolidVisio Softcorp	18	192.168.1.18
Startech	19	192.168.1.19
Vector Robotics	20	192.168.1.20

It is decided that the robot sending the first message will be the one that catches the other robot. That is, the robot that is 5 cm behind the other robot will send the first message. The message consists of 4 characters, all of which are numbers, first two numbers determine the ID number of the sender while the last two numbers determine the message of the sender.

When the first robot catches the other firstly it sends the message "ID00", where ID is the ID number of the group that owns the robot. After receiving this message the robot at the front (who has been caught) acknowledges this by sending the message "ID01". After receiving this acknowledgement signal the robot at the back sends the message "ID10", which means "stop". After sending this message the robot behind immediately stops and the robot at the front immediately stops after it received "ID10" message. If the robot at the front doesn't acknowledge the fact that the robot behind it catches it, it has to send "ID11". There are 4 different colored LEDs which are red, green, blue and yellow as given table 2. The time of LED lighting will be 3 s for red, green, and yellow LEDs. It will be at least 10 s for the blue LED.

Summary of the contains of the messages are shown in Table 2.

Table 2: Content of the message and meanings with associated LED lights

First two characters	Last two characters	Respective LED light	Meaning
ID of the sender	00	Red	The sender has caught the other robot
ID of the sender	01	Green	The sender acknowledges that it has been caught
ID of the sender	10	Blue	The sender signals to stop
ID of the sender	11	Yellow	The sender does not acknowledge that it has been caught

2. Racetrack Properties

Racetrack material is XPS foam board with 2 cm height. A craft which has Color Yeşil/UCA-113 code is glued to the top of the foam board. The path consists of four symmetrical parts. Its edges is perpendicular to the ground.

3. Vehicle Properties

There are two plates at both the front and back sides of the robot to prevent sensor interference. Both plates are perpendicular to the ground. The front plate is lifted 9 cm from the ground and back plate is lifted 3 cm from the ground. Both plates has the dimensions of 10cm wideness x 6cm height. The plates will be made by 3D printer and a minimum of 2 mm thickness is required. The plate also has to be the color of red. The project owners are not allowed to mount any sensor or any kind of material on the surface of the plates.

Representatives:

Teams	Representatives	Signature
1. BLITZ	İsmail ATASEVEN	
2. MindWizards	Mert KOÇ	
3. SESCA Dynamics	Murat Sezgin Baloğlu	
4. DUAYENLER	Sarper SERTEL	
5. Orbis Robotics	Oğulcan Emre ÖRSEL	
6. Autonomous Technology	M. Furkan Coşkun	
7. RESTIN	İsmail Taylan Yeşilyurt	
8. Puzzles	Onur YENER	
9. DostON Bynamics	Samet Yıldırım	
10. Robotz With Attitude	Barkın Tuncer	
11. EPIPHANY	İclal Satıcı	
12. ACME Inc.	Yusuf ARSLAN	

13. Morpheus   Fatih YILDIRIM

14.StarTech   Sadık Akyar

15. Atlanta   Salih Aksoy

16. Vector Robotics   Zülfü Serhat Kük

17. Jacobian Art Project   İ. Orçun Çetintaş

18. SolidVisio Softcrop   Tamer AKTEKİN

19. ESİNTİ   Alper Bilgiç

Standard Committee Coordinators:
1. Arzu Koç
2. Murat Eyüboğlu