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FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

Project Report
Version 2

CENG 408
Innovative System Design and Development II

P2018-13
Human Interface Device: 3D Pointer

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Contents

Abstract

The human interaction with the computer created by Human Interface Device (HID): 3D Pointer has become more important with the increasing use of virtual reality. This technology is actively used in the fields of education, industry, military, health and entertainment and we aim to use it in our project. The aim of this study is to transfer the spatial data in real life to the computer in 3D and visualize it in various fields. As a result, this system should be able to calculate the data quickly and accurately in accordance with its purpose. Human Interface Device is a system that calculates the position data obtained with ultrasonic sensors using Arduino and visualizes them in 3D as a result of C#. The purpose of this project is to transfer the spatial data without using any receiver in general and to perform various studies on the transmitted data.

Key words: Arduino, C#, Trilateration, 3D Localization

Özet

Human Interface Device(HID): 3D Pointer sayesinde oluşturulan bilgisayar ile insan etkileşimi günümüzde sanal gerçekliğin kullanım alanının artması ile daha önemli bir hale gelmiştir. Bu teknoloji eğitim, endüstri, askeri, sağlık ve eğlence alanlarında aktif olarak kullanılmaktadır ve biz de projemizde kullanmayı hedefliyoruz. Bu çalışmanın amacı gerçek hayattaki konumsal verilerin 3 boyutlu olarak bilgisayara aktarılması ve görselleştirilerek bu verileri çeşitli alanlarda kullanabilmektir. Sonuç olarak bu sistem amacına uygun olarak, verileri hızlı ve doğru bir şekilde hesaplayabilmelidir. Human Interface Device, ultrasonik sensörler ile aldığı konum verilerini Arduino kullanarak hesaplayan ve bu hesaplamalar sonucunda C# üzerinden 3D olarak görselleştiren bir sistemdir. Bu projenin amacı genel olarak herhangi bir alıcı kullanmadan konumsal verinin aktarılması ve aktarılan veri üzerinden çeşitli çalışmalar yapabilmesidir.

Anahtar Kelimeler: Arduino, C#, Trilaterasyon, 3D Konumlandırma

1. Introduction

1.1 Problem and Solution Statement

The aim of this study is to transfer the spatial data in real life to the computer in 3D and visualize it in various fields. As a result, this system should be able to calculate the data quickly and accurately in accordance with its purpose. The necessary calculations are made by the ultrasonic sensors using the trilateration method. At the same time the results will be transferred to the computer as data and will be visualized on C#.

1.2 Motivation

Research on learning; it shows that most of the learning takes place through visual descriptions. The contributions of computers and digital technologies to visualization further increase the importance of visual elements in education. Ultrasonic sensors using sonar(Sound Navigation and Ranging) system to calculate the distance from the object against the input source. Human Interface Device(HID) is a 3D positioning application. Users can use the system easily because the system positions itself and outputs 3D output to the screen. All the user has to do is to place the object at any point within the system frame where the sensors are placed.

2. Literature Review

2.1 Introduction

A human interface device (HID) is a method by which a human interacts with an electronic information system either by inputting data or providing output. There are countless Human Interface Devices. All devices supplying an interface between the user and computers are considered HIDs. This tool has some purposes. These are being extensible and strong, being as compact as possible to device informations, allowing the software application to skip unknown data and supporting collections. Data from at least 3 devices must be detected to determine the position in 2 dimensions. At the same time, in order to be able to determine the position (latitude, longitude and altitude) of this object in 3 dimensions, these data should be calculated with a methodology. Trilateration technique should be used for this purpose.

2.2 What is the Human Interface Device: 3D pointer?

This study aims to determine the object in 3 dimensions by using ultra-sonic sensor and search for suitable sensors for the project. Nowadays, we aim to design a device that can keep up with human and device interaction.

2.2.1 Trilateration Methodology

In this Section, we describe the formula that we will use in the project. We decide the use trilateration formula. Formula has a simple algorithm and it needs at least 3 parameters to work. Algorithm use the distance between the point. In our case points are sensors. After the sensors are calculated from distances. We try to find direction using intersection between sensors.

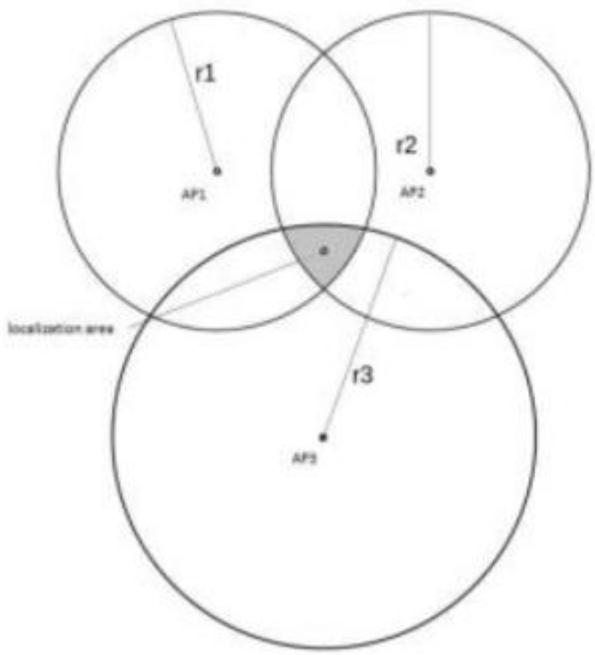
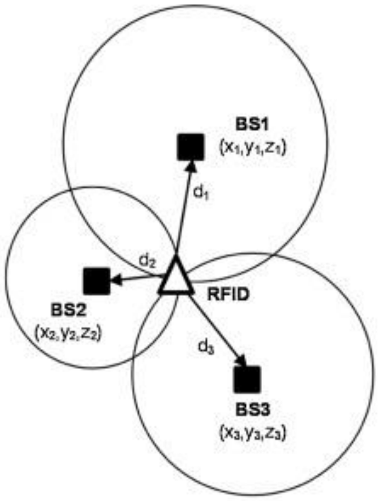


Figure 1: Method Representation

Figure 1 is sample image about what we are do. The main principle is that first sensors calculate the distance between the # object and itself. But we have no direction. Then second sensor to do same thing. Then intersection area gives information about the direction. Then second sensor to do same thing. In this way, we can decrease the intersection area for ultimate results. As the number of sensors increases, we can determine a more exact location.



$$d1 = c\Delta t_{12} = \sqrt{(x_1 - x)^2 + (y_1 - y)^2 + (z_1 - z)^2}$$
$$d2 = c\Delta t_{23} = \sqrt{(x_2 - x)^2 + (y_2 - y)^2 + (z_2 - z)^2}$$
$$d3 = c\Delta t_{31} = \sqrt{(x_3 - x)^2 + (y_3 - y)^2 + (z_3 - z)^2}$$

Figure 2: Trilateration Formula

Figure 2 shows the mathematical representation of trilateration formula.

2.2.2 Sensors

Firstly, we chose to use the HR-SC04 sensor for project. There are two main reasons. First reason is price of sensors. We want to increase the project’s cost. Second reason is simple to use sensor.

Figure 3: HC-SR04 Ultrasonic Sensor

In the Figure-3, HC-SR04 sensor is a sample to use but as a result of our research we realized view angle is too low than we expect. View angle is about 15 degree that’s means we should use approximately 10-12 sensors. If the number of sensors we use increases, it is difficult to synchronizing them and we are looking for wider angle sensors. Then we found JSN-SR04T

2.0 sensor. It has a 75 degree view angle. It is similar to the car distance sensors. Figure-4 is a sample image for JSN—SR04T 2.0.

Figure 4: JSN-SR04T Ultrasonic Sensor

2.3 Main Findings

Positioning can be made more precise by using the hybrid ie with other sensors and positioning systems. The best way to do this is to use radio waves at these distances and use the WI-FI positioning system. Triangulation and Trilateration are the mathematical functions behind this. Depending on the sensitivity of the transmitter and receiver, the position can be determined with precision at the centimeter level. This requires a good image processing software. The different sensors take the image from different emergencies, the software matches moving objects with patterns and determines the position with centimeter accuracy by calculating over grids on the previously known area.

2.4 Conclusion

As a conclusion, positioning techniques were first initiated for military studies but with the advancement of technology, nowadays, many areas are used for many purposes. Nowadays, it has become used in scientific and technical studies. The constantly evolving technology can help us to use these techniques in many areas. In the classification of sound waves, sound signals in the range of 20Khz-1Ghz are defined as ultrasonic sound. Our sensor and a lot of ultrasonic sensors produce ultrasonic sound at 40Khz frequency. What is important here is the frequency that determines the height of the sound. The higher the volume, the higher the frequency. Ultrasonic audio signals cannot detect the human ear. This is because all of the sensors are sending ultrasonic audio signals to obtain a certain distance information. We don't know the angle, but we know the distance. Therefore, this distance creates an equal circle in each direction. So we know how far away the sensor is from the center signal that hits the object surface, but we can be anywhere on that ring. In this case, the trilateration method and solution will reach the result.

3. Software Requirements Specification

3.1. Introduction

3.1.1 Purpose

This document describes the 3D Human Interface Device (HID). HID finds the 3D position on the computer by using the trilateration methodology used in GPS using Arduino.

3.1.2 Scope of Project

Nowadays, with the advancement of technology, positioning techniques are used for many fields and many purposes. Today, it is used in scientific and technical studies. Continuously developing technology helps us to use these techniques in many areas. In the classification of sound waves, sound signals in the range of 20KHz-1 GHz are defined as ultrasonic sound. Our ultrasonic sensors produce ultrasonic sound at 40Khz frequency. It will be analyzed using the trilateration method by measuring how far away it is from the center by using signals that multiply the object surface without having the angle and distance information.

3.1.3 Glossary

Term	Definition
Trilateration	Process of determining absolute or relative locations of points by measurement of distances, using the geometry of circles, spheres or triangles.
Ultrasonic Sensor	Instrument that measures the distance to an object using ultrasonic sound waves.
Arduino	Open-source electronics platform based on easy-to-use hardware and software.

Term	Definition
Microcontroller	Control device which incorporates a microprocessor.
User	Person who can use the system.

3.1.4 Overview of the Document

In this documentation, we mentioned and explained why we need ultrasonic sensors and trilateration method. We pointed out what is the problem and what are the solutions for this problem. The requirement part of this documentation provides what are the functions of our system and shows use cases of each function which will be in web interface.

3.2 Requirements Specification

3.2.1 Required Technologies

3.2.1.1 Trilateration Methodology

Trilateration is a process that's used to determine absolute or relative locations of a point by the measurement of distances.

3.2.1.2 Sensors

Ultrasonic sensors measure distances that we require to determine the locations of a point by using ultrasonic waves. The sensors determines the distance to the target by measuring the time between the emission and reception.

3.2.1.3 Arduino

Arduino is an open-source stage utilized for building hardware ventures. Arduino comprises of both a physical programmable circuit board (frequently alluded to as a microcontroller) and a piece programming, or IDE that runs on your PC, used to compose and transfer PC code to the physical board.

3.2.2 Nonfunctional Requirements

3.2.2.1 Performance

Performance is the most important aspect of the project. The response to the minimal movements of the object must be as quick as possible with a high accuracy.

3.2.2.2 Accuracy

Another important aspect for this project. The measurement must be very accurate to give a proper response.

3.2.3 Functional Requirements

3.2.3.1 User Use Case

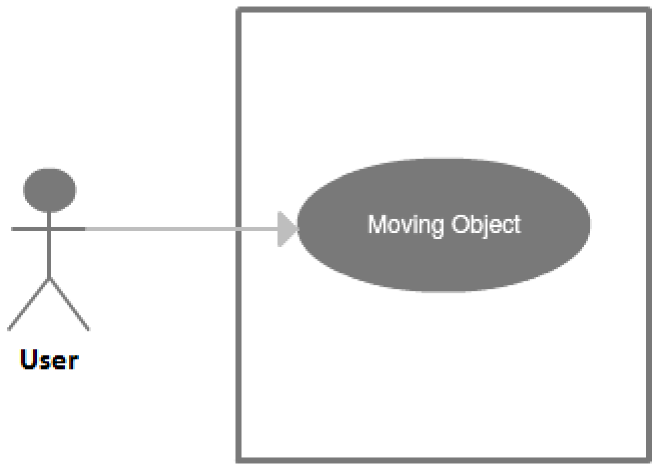


Figure 5: User Use Case

Brief Description:

As shown in Figure 5, there are only one user. The user can create an object position by moving the object at hand.

3.2.3.2 Technician or Developer Use Case

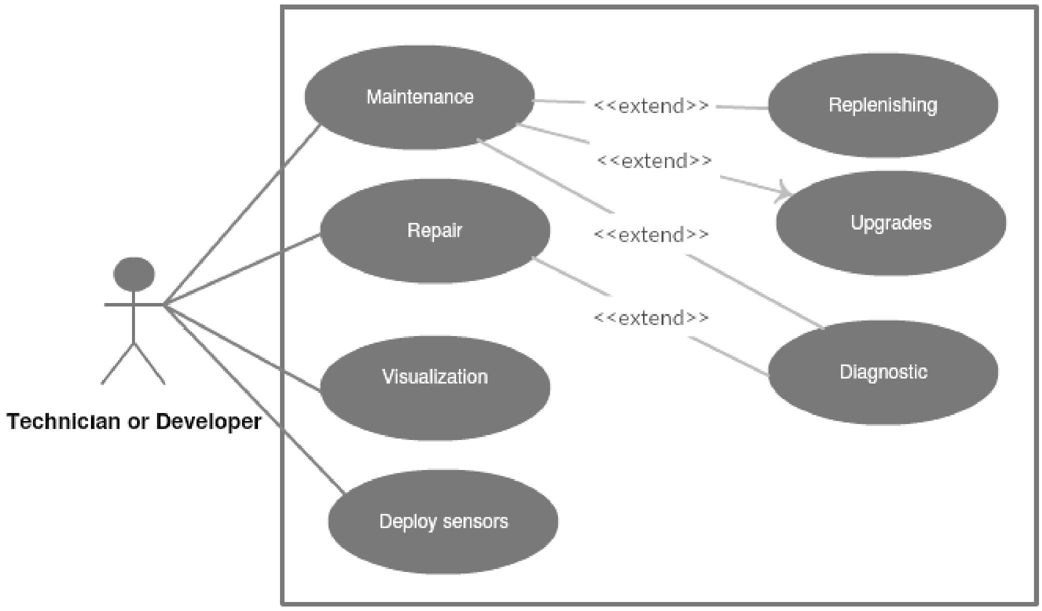


Figure 6: Technician or Developer Use Case

Brief Description:

As shown in Figure 6, there are 4 functions that can be usable only by developer or technician. Developer or technician can deploy sensors, visualize of received data, maintenance and repair system.

3.2.3.3 : Sensor and Microcontroller Use Case

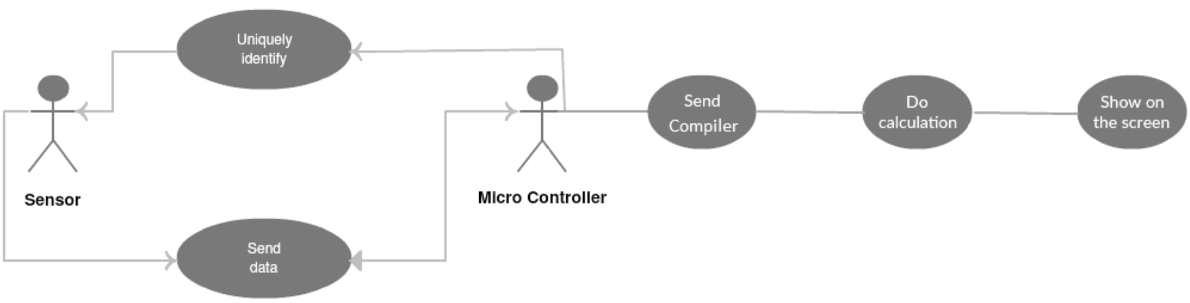


Figure 7: Sensor and Microcontroller Use Case

Brief Description:

As shown in Figure 7, there are 2 functions that can be usable only by sensor and 5 functions that can be usable only by microcontroller.

4. Software Design Description

4.1. Overview

This document contains the software design descriptions for Human Interface Device using 3D pointer project. This document provides the details of how the HID software should be built. The details are represented by using graphical notations such as viewpoints, use case models, sequence diagrams, class diagrams, object behavior models and other supporting design information.

4.1.1. Scope

Our project HID is an 3D positioning project. HID is a system built on determining the locations of objects. System provides users to determine the location of the object to a specific location. There are many projects using positioning, especially gps systems, techniques that are used in many fields, but our project provides a data by analyzing the positions by means of the trilateration method.

It’s an 3D positioning application which means that users need some sensors for this purpose. Users can easily use the system because the system positions itself and gives a 3D output to the screen. All the user has to do is to place the object in his or her hand at any point within the system frame where the sensors are located.

4.1.2. Purpose

This document aims to describe and visualize the design and architecture of HID by using different viewpoints and describe the software system which is structured to meet the needs specified in SRS document. This document will be the primary reference for the implementation phase. Topics covered include the following:

- Class hierarchies and interactions
- Data flow and design
- Design constraints and restrictions
- Design Concerns
- Design Elements
- Example Languages

In short, this document is meant to equip the reader with a solid understanding of the inner workings of Human Interface Device system.

4.1.3. Intended Audience

The Software Description document is intended for:

- Developers: by using the SDD, developers can easily understand the software and it helps developers to improve the current project features or add new features to existing system.
- Testers: by using the SDD, testers can find some bugs for their testing strategy. Instead of searching whole software program, testers can examine SDD.
- Users: by using the SDD, users can easily understand how to use the software.

In this project our users can be anyone who uses HID application.

4.2. Definition

Term	Definition
User	Person who can use the system.
Microcontroller	Control device which incorporates a microprocessor.

Term	Definition
Technician	Person employed to look after technical equipment or do practical work.
GPS	Global Positioning System
UML Diagram	Unified Modeling Language (UML) is a standardized general- purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created, by the Object Management Group. UML 2.2 has 14 types of diagrams divided into two categories. Seven diagram types represent structural information, and the other seven represent general types of behavior, including four that represent different aspects of interactions.
Software Requirements Specification (SRS)	A complete description of the behavior of a system to be developed and may include a set of use cases that describe interactions the users will have with the software.
SDD	Software Design Description which is the complete description of the design of system.

In this section, conceptual model for the SDD will be presented. This conceptual model mainly explains the context in which SDD is prepared.

4.3 Software Design In Context

In HID project, imperative approach will be used as a design method. Hence, it will be easier to implement the project and add possible future features. Method will help modularity, security and adaptability of the software. With imperative programming paradigm provides us:

- Bugs-Free Code.
- Efficient Parallel Programming.
- Better Performance.
- Better Encaspulation.
- Increase Reusability.
- Better Modularity.
- Easy Lazy Evaluation.

4.3.1. Software Design Descriptions Within The Life Cycle

4.3.1.1. Incfluences On SDD Preparation

The key software life cycle product that drives this software design is the SRS we have prepared. All the details and requirements are taken from there in order to prepare this document.

4.3.1.2. Influences On Software Life Cycle Products

This SDD influences the content of SRS of this project. It also has influences on the whole implementation phase of wHere application. More than that, the test documentation and test plans of the system are also influenced by the SDD. In addition, the contents of SDD is taken into consideration by the developers in order to develop test cases and test procedures.

4.3.1.3. Design Verification And Design Role In Validation

Test cases will be prepared after document phase. Verification of the software will be tested with these test cases and all parts will be evaluated. Success of the software system will be determined with test cases. After the results, validation of the software will be checked if requirements of the system are fulfilled or not.

4.4. Design Description Information Content

4.4.1. Introduction

Software Design Description of the HID gives information about how HID will be designed and implemented. SDD identification, design viewers, design elements, design rationale, design languages are topics which will be described.

4.4.2. SDD Indentification

This document is a first version of System Design Description for this project. Draw.io is used for drawing diagrams. Organization of the project team and date of the report are given in cover page of SDD. In the first section an overview of SDD is given. Scope of the SDD report refers to the section 1.1, Purpose of the SDD report refers to section 1.2 and Intended Audience of this document refers to section 1.3. For design conceptual model for software design descriptions refer to the section 3. Lastly, for the design viewpoints including context, composition, logical, information, patterns use, interface, interaction, state dynamics and resource viewpoints refer to the section 5.

4.4.3. Design Stakeholders And Their Concerns

In HID, design stakeholders are the developer team of HID and their advisors. Our design stakeholders are the people who know and understand software development and our stakeholders are the part of the development. Our stakeholders' concerns are listed below:

- The implementation should be safe, secure, maintainability and open to future changes.
- The codes for system operation shall be easy to read and use.
- The desired results should be obtained from the developed system.
- System usage should be simple and efficient.
- New features should be applicable and developable into HID, so software must be proper for it.

4.4.4 Design Views

Representing the diagrams of view, UML is used. Design views of this SDD are design rational, contextual, composition, interface, logical and interaction views. These design views are governed by design viewpoints that are explained in section 5.

4.4.5. Design Elements

The main design elements are entities, attributes and some other member associated with communication and relations between modules and user of our project. These main design elements are defined inside the related viewpoints in detail in section 5.

4.4.5.1. I/O Handling Component

Users make their connections all of components of wHere through I/O handling component.

4.4.5.2. Programming Language

Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler. The application will be implemented in C/C++ and it will use Ardunio.

4.4.5.3. Design Constraints

- Software must be implemented imperative and it must be reusable.
- System must be formed of accessible and they should be implemented separate and understandable.
- Application codes are developed in arduino.
- Method should help modularity, security and adaptability of the software.

4.4.6. Design Overlays

In HID, simplicity, maintainability and intelligibility are main factors to determine design choices. Considering new features which are probably added the software in the future, wHere is designed with this vision. Therefore developers of HID document all development process and we put their comments into their code, so a person who do not have any idea about HID can understand the system and they can add new features or modify old features easily in the future.

4.4.7. Design Languages

In this project, Unified Modeling Language (UML) is selected as a part of design viewpoint and it will be used for clarifying design viewpoints.

5. Design Viewpoints

5.1 Introduction

In this part, the viewpoints of the HID is explained in detail. During this section, diagrams will be used to increase understandability. This section will explain main design viewpoints in detail.

5.2 Work Plan

	Start Week	Sep 24, 2018

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Starting Date	24 Sep	1 Oct	8 Oct	15 Oct	22 Oct	29 Oct	5 Nov	12 Nov	19 Nov	26 Nov	3 Dec	10 Dec	17 Dec	24 Dec	31 Dec
Finishing Date	30 Sep	7 Oct	14 Oct	21 Oct	28 Oct	4 Nov	11 Nov	18 Nov	25 Nov	2 Dec	9 Dec	16 Dec	23 Dec	30 Dec	6 Jan
Project Proposal Form	GB														
Project Selection Form		MGK	MGK												
GitHub Repository			TEAM												
Project Work Plan				AK											
Literature Review		TEAM	TEAM	TEAM	TEAM										
Software Requirement Specification							AK	AK	AK						
Website								MGK	MGK	MGK					
Software Design Documentation										AK	AK	AK			
Project Report											GB	GB	GB	GB	
Meeting & Tracking Form	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM	TEAM
Preparing Presentation														GB	GB

Figure 8: Gantt Chart

Figure 8 shows the work plan. Tasks to be performed are divided into weeks. Each stage has completed the tasks of team members as well as individually.

5.3 Activity Diagram

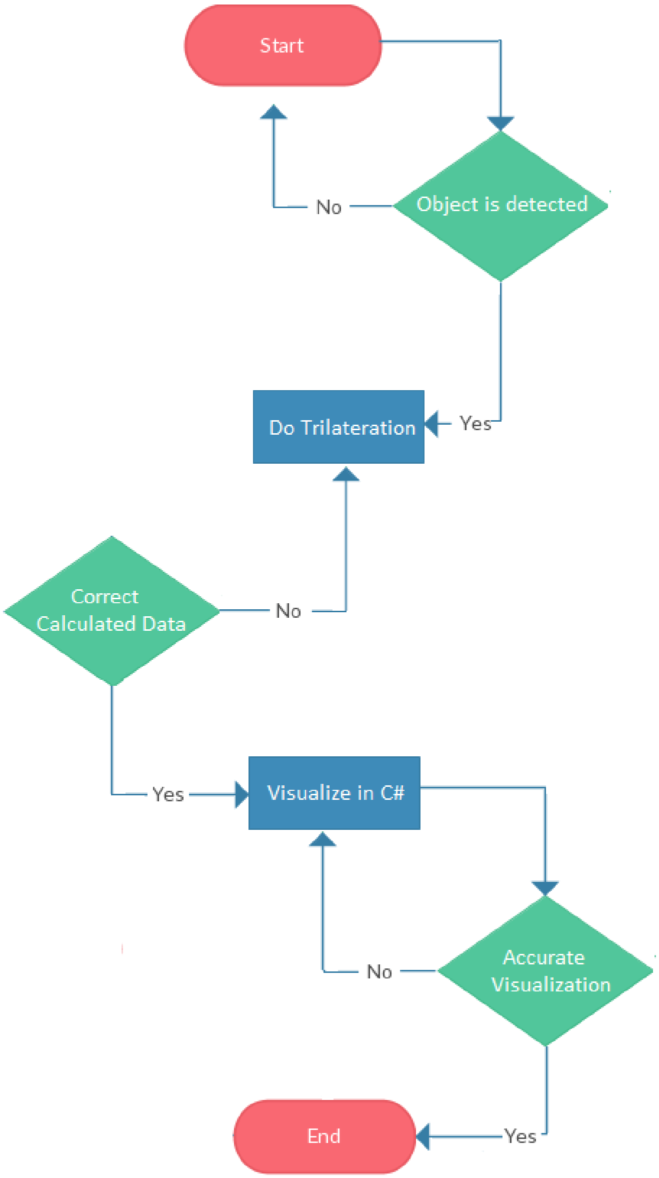


Figure 9: Flow Chart

5.4 Context Viewpoint

5.4.1. Design Concerns

There are one main service category concerning to our system which is User. Users are people who will use the system. They are going to interact with different clients of the final product.

5.4.2. Design Elements

Design entities: Design entities are user and actions of the application. Below diagram, use-case diagram with all functions can be seen.

5.4.2.1 Moving Object

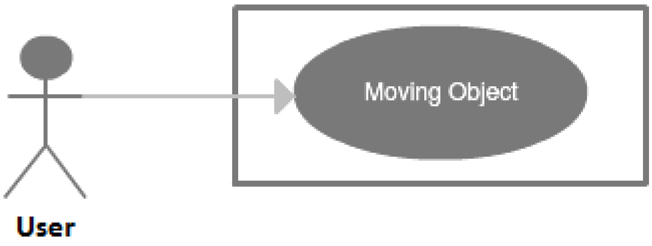


Figure 10: Moving Object Use Case Diagram

Term	**Definition**
Use Case Number	1
Use Case	Moving Object
Summary	User can create an object position by moving the object at hand.
Actor	User
Trigger	Object
Primary Scenario	The user should receive an object of her/his choice and have that object at any point in the area of the system.
Exceptional Scenario	* No object found. * 2. Object size insufficient.
Pre-Condition	The user must recognize the system and learn to use it.

Term	Definition
Post-Condition	User will use the system and he/she can see output.
Assumptions	System installation and connections must be completed.

5.4.2.2. Maintanence

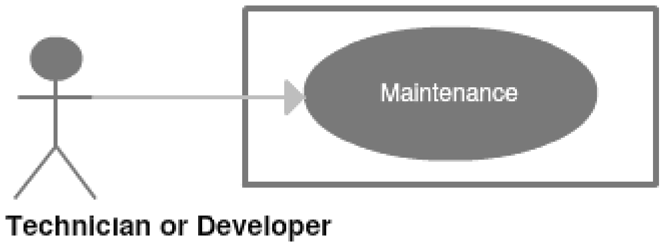


Figure 11: Maintanence Use Case Diagram

Term	Definition
Use Case Number	2
Use Case	Maintanence
Summary	If there is a problem, the system is repaired.
Actor	Technician/Developer
Trigger	HID Device
Primary Scenario	Developer or technician, by examining and controlling device and system, on the system can perform replenishing, uprageds or diagnostic operations.

Term	Definition
Exceptional Scenario	*No fault found. *There is no development available.
Pre-Condition	Technician or developer, identify problems or decide what needs to be improved.
Post-Condition	The problems should be resolved and the system should be running smoothly.
Assumptions	Solutions must eliminate all problems.

5.4.2.3. Repair

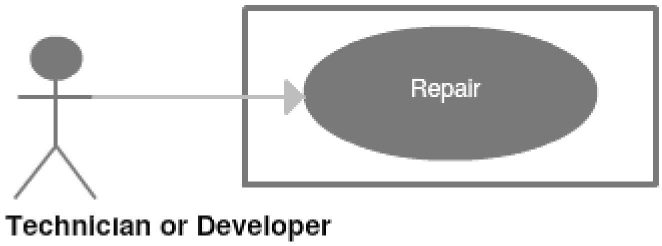


Figure 12: Repair Use Case Diagram

Term	Definition
Use Case Number	3
Use Case	Repair
Summary	Correction of system problems.
Actor	Technician/Developer

Term	Definition
Trigger	HID Device
Primary Scenario	If there is a systematic problem, the technician will repair it.
Exceptional Scenario	*No fault found.
Pre-Condition	The technician or developer identifies and examines system problems.
Post-Condition	System problems are solved and run smoothly.
Assumptions	Solutions must eliminate all problems.

5.4.2.4 Visualization

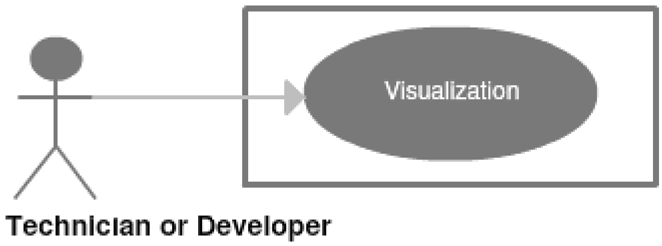


Figure 13: Repair Use Case Diagram

Term	Definition
Use Case Number	4
Use Case	Visualization
Summary	The system data is processed to give an output.

Term	**Definition**
Actor	Technician/Developer
Trigger	HID Device
Primary Scenario	An object to run the system, giving an output to the screen.
Exceptional Scenario	*Output did not display.
Pre-Condition	The system must be run using an object.
Post-Condition	The output should appear on the screen.
Assumptions	Output is displayed on the screen as fluent.

5.4.2.5 Deploying Sensor

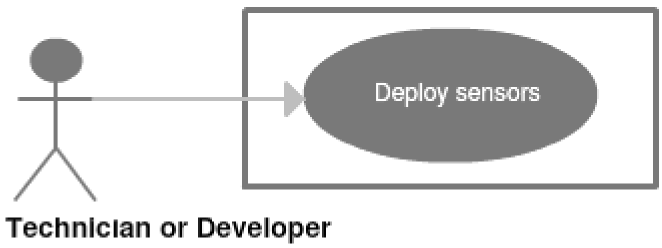


Figure 14: Deploying Sensor Use Case Diagram

Term	**Definition**
Use Case Number	5
Use Case	Deploying Sensor

Term	Definition
Summary	Locating sensors in a location where the system will run smoothly.
Actor	Technician/Developer
Trigger	HID Device
Primary Scenario	Developer or technician, by examining and controlling device and system, on the system can perform replenishing, uprageds or diagnostic operations.
Exceptional Scenario	*Sensor failure. *Misplace.
Pre-Condition	Technician must have sufficient knowledge about working principles of systems and sensors.
Post-Condition	System should be running smoothly.
Assumptions	Correct positioning of the sensors and smooth operation of the system.

6. Test Plan

6.1 Introduction

6.1.1 Version Control

Version No	Description of Changes	Date
1.0	First Version	April 22, 2019
2.0	Second Version	May 17, 2019

6.1.2 Overview
System features, the use case of Human Interface Device (HID): 3D Pointer is planned to be tested. Requirements and functions had been determined in SRS and SDD documents before.

6.1.3 Scope
This document includes new to all the functions of a specific product, its existing interfaces, integration of all functions.

6.1.4 Terminology

Acronym	Definition
UI	User Interface
GUI	Graphical User Interface
GF	General Features

6.2 Features to be Tested
This section lists and gives a brief description of all the major features to be tested. Human Interface Device: 3D Pointer has three main part: Pre-Production Mode, Production Mode and Post Production mode. In this section Graphical User Interface of Human Interface Device features will be discussed for testing.

6.2.1 GUI (Graphical User Interface)
Graphical user interface contains port name combo box and connection button. There are three main part of user interface: There are text fields, data fields, combo box, button and tables according to features of pages. Users who want to use the system must first start the system. The menu is very simple. There is a port selection and connect button. The user must establish the connection by selecting the port he / she wants to use. When the Connect Button is clicked, the system is activated directly.

6.2.2 GF (General Features)
In this field, user-independent systematic data is required for proper operation of the system.

6.3 Item Pass/Fail Criteria
Describe the general rule to use to decide when a test case passes and when it fails.

6.3.1 Exit Criteria

Describe under what conditions the testing of the product is considered successful. Some examples are:

- 100% of the test cases are executed
- 95% of the test cases passed
- All High and Medium Priority test cases passed

6.4 References

[1] CankayaUniversity, "CankayaUniversity/ceng-407-408-project-megareji," GitHub. [Online]. Available: https://github.com/CankayaUniversity/ceng-407-408-Human-Interface-Device-3D-pointer/wiki/Software-Requirement-Specification-(SRS). [Accessed: 23-Oct-2018].

[2] CankayaUniversity, "CankayaUniversity/ceng-407-408-Human-Interface-Device-3D-pointer" GitHub. [Online]. Available: https://github.com/CankayaUniversity/ceng-407-408-Human-Interface-Device-3D-pointer/wiki/Software-Design-Document-(SDD). [Accessed: 23-Oct-2018].

6.5 Test Design Specifications

6.5.1 GUI (Graphical User Interface)

6.5.1.1 Subfeatures to be tested

6.5.1.1.1 Port Name Combo Box (GUI.PN.CB)

Users need to select the correct port from the drop down list in order to run the system and start viewing.

6.5.1.1.2 Connection Button (GUI.CONN.BTN)

Once the matching port is found, the connection between the sensors and the system is established by clicking the connect button.

6.5.1.2 Test Cases

Here list all the related test cases for this feature

TC ID	Requirements	Priority	Scenario Description
	Give corresponding requirement no	*High or Medium or Low*	*A brief description*
GUI.PN.CB	5.1.1.1	H	Select the correct port from the drop down list.
GUI.CONN.BTN	5.1.1.2	L	Click connect button and run.

6.5.2 General Features

6.5.2.1 Subfeatures to be tested

6.5.2.1.1 Operation of Ultrasonic Sensors (GF.OP.US)

By operating the system, each of the ultrasonic sensors must operate and give accurate measurement results.

6.5.2.1.2 Movement Speed (GF.MOV.SP)

The sensors must be fast enough to measure the motion smoothly.

6.5.2.1.3 Sensor Stabilization (GF.SS)

Each sensor must able to provide a fixed position for a clear view.

6.5.2.1.4 Connection Compatibility (GF.CC)

Each sensor must be in harmony with each other. The result is accurate as a result of the simultaneous operation of all three sensors.

6.5.2.2 Test Cases

Here list all the related test cases for this feature

TC ID	Requirements	Priority	Scenario Description
GF.OP.US	5.2.1.1	H	Ultrasonic sensors must operate and give accurate measurement results.
GF.MOV.SP	5.2.1.2	M	The sensors must be fast enough to measure the motion smoothly.
GF.SS	5.2.1.3	M	Each sensor provide a fixed position.
GF.CC	5.2.1.4	M	Each sensor must be in harmony with each other.

6.6 Detailed Test Cases

6.6.1 GUI.PN.CB

TC_ID	GUI.PN.CB
Purpose	Select the correct port from the drop down list.
Requirements	5.1.1.1
Priority	High
Estimated Time Needed	10 Seconds

Dependency	Run the program.
Setup	An admin user should be created.
Procedure	[A01] Run the main program.
	[A02] Click on combo box.
	[A03] Select port.
	[V01] Port name to be used appears.
Cleanup	Exit

6.6.2 GUI.CONN.BTN

TC_ID	GUI.CONN.BTN
Purpose	Click connect button and run.
Requirements	5.1.1.2
Priority	Low
Estimated Time Needed	10 Seconds
Dependency	Run the program.
Setup	An admin user should be created.
Procedure	[A01] Run the main program.
	[A02] Click on combo box.
	[A03] Select required port.
	[A04] Click on the “Connect” button.
	[V01] The necessary connection is provided and the 3D view is reflected on the screen.
Cleanup	Exit

6.6.3 GF.OP.US

TC_ID	GF.OP.US
Purpose	Ultrasonic sensors must operate and give accurate measurement results.
Requirements	5.2.1.1
Priority	High.
Estimated Time Needed	5 Minutes
Dependency	Run the program and connect.
Setup	An admin user should be created.
Procedure	[A01] Run the program on Arduino.
	[A02] Move the object.
	[A03] Check for accuracy for location.
	[V01] Positioning data is displayed correctly.
Cleanup	Exit

6.6.4 GF.MOV.SP

TC_ID	GF.MOV.SP
Purpose	The sensors must be fast enough to measure the motion smoothly.
Requirements	5.2.1.2
Priority	Medium.
Estimated Time Needed	5 Minutes
Dependency	Run the program and connect.
Setup	An admin user should be created.
Procedure	[A01] Run the program on Arduino.
	[A02] Move the object at various speeds.
	[A03] Check for accuracy for speeds.
	[V01] The object movement is displayed properly when the speed increases.
Cleanup	Exit

6.6.5 GF.SS

TC_ID	GF.SS
Purpose	Each sensor provide a fixed position.
Requirements	5.2.1.3
Priority	Medium.
Estimated Time Needed	5 Minutes
Dependency	Run the program and connect.
Setup	An admin user should be created.
Procedure	[A01] Run the main program.
	[A02] Control the transferred data.
	[V01] 3D view of object in which position appears fixes that position.
	-
Cleanup	Exit

6.6.6 GF.CC

TC_ID	GF.CC
Purpose	Each sensor must be in harmony with each other.
Requirements	5.2.1.4
Priority	Medium.
Estimated Time Needed	5 Minutes
Dependency	Add User test cases should pass
Setup	An admin user should be created.
Procedure	[A01] Run the program on Arduino.
	[A02] Control the transferred data.
	[A03] Enter the valid password for this user
	[V01] All three sensors operate at the same time and send accurate location information.
Cleanup	Exit

7.Conclusion

This document includes wide information about our project that titled as “Human Interface Device: 3D Pointer”. In this project, we have aimed to teach positioning techniques. In the project, we thought it was convenient to use ultrasonic sound sensors to calculate the location.

We have selected JSN-SR04T, one of the ultrasonic sensor models, for our project. Our aim is to have a wider angle than some other cheaper sensors. 3 sensors will be sufficient to receive data from each 3 coordinates. Sensors are positioned in this way.

To develop project, first of all, we have made a lot of research about ultrasonic sensors, its usage area and similar projects. We have analyzed the similar projects, and tried to understand what features have made them effective. We have gained a lot of information about sensors and how to develop a project that includes ultrasonic sensors. After research part, we have received requirements from a representative of General Staff. Upon these requirements, a SRS document is prepared SDD document. During this period, we have developed a basic prototype of the project.

Trilateration Methodology is the most suitable algorithm for calculating the intersection of positioning from different dimensions. In simple terms, trilateration is a mathematical technique in which a point in space is calculated using the distances from such a point. Trilateration is a sophisticated version of triangulation, though it does not use the measurement of angles in its calculations. Upon these requirements, a SRS document is prepared. After requirements are specified, design of the developing product are prepared and this design is explained in a SDD document.

As a result of our research, it is our goal to create a system that aims to inform about positioning techniques and working principles but is not more complex, smaller and portable and at the same time inexpensive.

This system will be developed in the future and will be able to make positioning measurements in large areas. Precise and most sensitive measurements can be achieved using different sensors and can be used even better in different work areas.

Acknowlegement

We are grateful for guidance we have received from Instructor Dr. Faris Serdar TAŞEL. The help we received from them was a great asset to improve this project and ourselves.

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