TARGET SIMULATOR FOR GUN FIRE CONTROL SYSTEM

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Target Simulator for Gun Fire Control System

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Certificate

This is to certify that the work in the thesis entitled *Target Simulator for Gun Fire Control System* by *Alok Kumar* is a record of an original research work carried out with my supervision and guidance in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering. Neither this thesis nor any part of it has been submitted for any degree or academic award elsewhere.

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I would conclude with my deepest gratitude to my parents and all my loved ones. My full dedication to the work would have not been possible without their blessings and moral support.

Alok Kumar

Authors Declaration

I hereby declare that all the work contained in this report is my own work unless otherwise acknowledged. Also, all of my work has not been previously submitted for any academic degree. All sources of quoted information have been acknowledged by means of appropriate references.

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Abstract

The objective of our project work is to develop a Target Simulator for Radar application which takes initial position of pseudo targets and returns computed values of future position and shown in PPI.

Gun fire control system is a system which has quick reaction, multisensory, Multiweapon defence system and ranges from short/medium/long systems against Air surface or shore targets. It comprises many functional subsystem, tracker weapon controller etc. In normal scenario the GFCS works like initially the RADAR will give the target co-ordinates. The GFCS in turn gives command to gun for tracking the target. The gun gives the tell back about the position of its own self. The GFCS checks the values of target given out by the against the co-ordinate values gives out by the gun.

In our project by using single computer opening two terminals in one terminal running client side program and in other terminal running simulator program for connection between them we are using Ethernet communication using sockets. The Target Simulator will be running on server side. The client side will be GUI using VS on windows platform. Initial position of pseudo targets will be given to simulator and returns the computed values of future position and the movement of pseudo targets will be shown on PPI (Plan Position Indicator) by converting values to pixels using Bitmap.

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Chapter 1

Introduction

1.1 OVERVIEW

Fire control is the technique of delivering effective fire on a selected target. It includes the material, personnel, methods, communications and organization necessary to harass, damage, or destroy the enemy.

The fundamental problem of gun fire control is to direct the gun in such a way that the projectile will hit the designated target. If the targets is stationary and close enough, the problem is not difficult. Complications are introduced by increasing the range, by shooting from a moving platform such as a ship, by shooting at moving targets, and by shooting many guns at the same target with centralized control.

1.2 AIM OF THE PROJECT

The Aim of our project work is to develop a Target Simulator for Radar application which takes initial position of targets and returns computed values of future position and shown in PPI.

1.3 PROBLEM STATEMENT

Two types of problems may occur:

- The first problem which may arise with GFCS using Radar is if the Radar is not available, the gun system cannot be made to look at the Target object.

- The second problem is if the target object is not present, using Radar we cannot make the gun to look at the desired position.

1.4 WORKFLOW

In our project by using single computer opening two terminals in one terminal running client side program and in other terminal running simulator program for connection between them we are using Ethernet communication using sockets. The Target simulator will be running on server side. The client side will be the GUI implemented using VS in windows platform. Initial position of pseudo targets will be given to simulator through GUI and these values will be taken by the simulator and returns the computed values of future position of the targets and the movement of targets will be shown on PPI (Plan position indicator) by converting values to pixels using Bitmap.

Chapter 2

LITERATURE SURVEY

A detection system, a computing system, and communications links were the elements of a fire control system. For the detection system we use a radar set. The radar uses the transmission and reception of electromagnetic radio frequency energy to provide us with information as to the target's precise location with respect to our own ship at any given time.This information is automatically transmitted to the computer in the form of target ranges and bearings. The computer automatically compares the range and bearing information with elapsed time and continuously generates target course and speed.The computer also accepts course and speed information automatically from own ship's gyro and pitometer log, certain inputs (such as initial velocity), air density, wind speed and direction, level and cross level signal information from the ship's stable elements, and parallax corrections, in some cases Corio 1 is effect, and other inputs which have a lesser bearing on the problem. In addition, it automatically compensates for super elevation.

Our survey showed us problem which may arise with GFCS using a Radar is if the Radar is not available, the gun system cannot be made to look at the Target object and the second problem is if the target object is not present, using Radar we cannot make the gun to look at the desired position.

To over come these problems, the proposed system can be used we make use of client and server for connection between them we are using Ethernet communication using Sockets, the Target Simulator will be running on server side. The client side will be the GUI using VS.Initial position of pseudo targets will be given to simulator and returns the computed values of future position and the movement of pseudo targets will be shown on PPI by converting values to pixels using Bitmap.

2.1 Existing Software Requirements

- Visual studio for developing the GUI
- C++ & C language as our programming language.
- We have used windows as our operating system platform since it supports socket programming.

2.2 Existing Hardware Requirements

- The hardware requirements are very conventional. The system works on the minimum requirements.
- Processor: Intel processor
- Hard Disk: 40 GB, 1 GB RAM and 256 MHz frequency.

Chapter 3

SOFTWARE REQUIREMENTS SPECIFICATIONS

3.1 Introduction

A software requirements specification (SRS) is a complete description of the behavior of the system to be developed. It includes a set of use cases that describe all of the interactions that the users will have with the software. Use cases are also known as functional requirements. In addition to use cases, the SRS also contains nonfunctional (or supplementary) requirements. Non-functional requirements are requirements which impose constraints on the design or implementation (such as performance engineering requirements, quality standards, or design constraints).

3.1.1 Purpose

The purpose of this document is to present a detailed description of the target simulator for GFCS. It will explain the purpose and features of the system, the interfaces of the system, what the system will do, the constraints under which it must operate and how the system will react to external stimuli.

3.1.2 Scope of Project

In our project the target simulator will take the previous co-ordinate values of the target from the radar, when radar goes down and it generates the co-ordinates values which will be the predicted position of the target and it will be displayed in PPI.

3.1.3 Definitions

Range: Range is the distance of the target.

Bearing: The angle where the target is moving.

Elevation: The height of the target where it is moving.

Course: The direction in which it the target is moving.

Speed: At what speed the target is moving.

PPI: Plan position indicator.

3.1.4 Feasibility Study

It is necessary to determine whether the proposed system is feasible or not. Every project is feasible if given unlimited resource and infinite time. Unfortunately the development of a computer-based system is more likely to be plagued by the scarcity of resources difficult deliver of data. It is both necessary and prudent to evaluate the feasibility of the project at the earliest time possible. Precious time and money can be saved and untold professional embarrassment can be averted if an ill-conceived system is recognized early in the definition phase. So detailed study is carried out to check the workability of the system.

Feasibility study is undertaken to evaluate its workability, impact on the organization, ability to meet user needs, and effective use of resources. The main objective of feasibility study is to test the technical, operational and economical feasibility of developing the system. Thus, during feasibility analysis for this project the following three primary areas of interest were considered. Technical Feasibility, Economical Feasibility, Operational Feasibility.

- The project contributes to the overall objectives mentioned earlier where it is used in military applications.

- The project is implemented by using current technologies.
- The system can be integrated on board naval ships.

3.1.5 Technical Feasibility

A study of resources availability may affect the availability to achieve and acceptable system. The technical feasibility is frequently the most difficult area to ensure at this stage. Because objective, functions and performance are somewhat hazy, anything seems possible if the right assumptions are made. It is essential that the process of analysis and definitions be conducted in parallel with an assessment of technical feasibility. Thus the project is considered technically feasible for development.

3.1.6 Economic Feasibility

A system that can be developed technically and that will be used, if installed must still be good investment for the organization. Economic feasibility deals with evaluation of development cost weighted against the ultimate income or benefit derived from the developed system. Financial benefits must equal or exceed the costs. The financial and economical questions raised during the preliminary investigation are for the purpose of estimating the following. The cost of hardware and software for the application being considered. The benefits in the form of reduced cost or fewer costly errors. The cost of conducting a full system investigation. Economical justification includes a board range of concerns that include cost benefit analysis. Cost benefit analysis delineates costs for project development and weights them against tangible benefits of a system.

3.1.7 Operational Feasibility

Proposed project are beneficial only if they can be turned into information system that will meet the organizational operating requirements. Operational feasibility is a consideration about the working of the system after installation in the company. Simply stated, this system of feasibility asks if the system will work when it is developed and installed. The following are the questions that help the operational feasibility at the project. Is there sufficient support for the project from management and users? Will it produce poor results in respect or area? Will the proposed system cause harm? Have the users been involved in planning and development of project? Will the accessibility of the information be lost?

Issues that appear to be relatively minor in the beginning have always of growing into a major problems after implementation. Therefore all the operational aspects must be considered carefully. The most successful system projects are not necessary the biggest or most visible in a business but rather those that truly meet the user expectations. More projects fail because of inflated expectations than for any other resources.

3.2 Functional Requirements

Flexibility: The line edits provide certain default initial value. But the user is not given provision to enter values other than numbers. The system will support multiple targets at the same time, if the user feels it is necessary.

Default Values: The user should provide values wherever possible to reduce the entry.

Security: Only the authorized persons can access to the system.

Compatibility: The previous values which the user gives the input should be valid so that the system can predict the future position correctly.

Performance Requirements: One of the important requirements is that there is no need to wait after radar goes down the proposed system will automatically take the values and predict the future position of the target and gives to gun fire control system.

Acceptance Criteria: The requirements should be available for acceptance of this system continuously when the radar goes down.

3.3 Hardware and Software Requirements

Hard Disk: 40 GB

Processor: Intel processor

RAM: 1 GB

Operating system: windows/Linux

Front End: Visual Studio

Coding Language: C, C++

Chapter 4

SYSTEM ANALYSIS

4.1 Identification of the Needs

The first step in the system development life cycle (SDLC) is the identification of a need. The project request identifies the need and authorizes the initial investigation. Because there is likely to be a stream of such requests, standard procedures must be established to deal with them. The initial investigation is one way of handling the identification. The objective is to determine whether the request is valid and feasible or it is restricted, to improve by computerizing or build a new one. The outcome of the initial investigation is the presentation of results called project proposal.

A statement describing the significance of the problems or solutions is also given. Whether the project request has been triggered by a single event or recurring situation is mentioned.

Since an initial investigation will be considered to learn more about the problems or situation, the requester also provides the names of other people who can provide more information. After reading the project request and after carefully studying the existing system, we come to the conclusion that the problems or limitations mentioned were real and valid, and move towards the goal of achieving the solution with minimum possible constraints as well as the risk.

4.2 Preliminary Investigation

The most important step in system development life cycle is the preliminary investigation. The purpose of preliminary investigation is to evaluate project requests. It is not design study nor does it include the collection of details to describe the business system in all respect. Rather, it is the collecting of information that helps committee members to evaluate the merits of the project request.

During this phase, a problem with an existing information system or an opportunity to usefully develop a new system is develop a new system is developed, and a limited amount of initial investigation takes place to see whether a systems project is warranted.

Analysts working on preliminary investigation should accomplish the following objectives:

- Clarify and understand the project request.
- Determine the size of the project.
- Assess costs and benefits of alternative approaches.
- Determine the technical and operational feasibility of alternative approaches.
-
- Report the findings to the management, with recommendations outlining the acceptance or rejection of the proposal.

Chapter 5

SYSTEM DESIGN

5.1 Introduction to System Design

Systems design is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. One could see it as the application of systems theory to product development. There is some overlap with the disciplines of systems analysis, system architecture and systems engineering. If the broader topic of product development blends the perspective of marketing, design, and manufacturing into a single approach to product development, then design is the act of taking the marketing information and creating the design of the product to be manufactured. Systems design is therefore the process of defining and developing systems to satisfy specified requirements of the user.

5.1.1 Design Considerations

The purpose of the design is to plan the solution of a problem specified by the requirements document. This phase is the first step in moving from problem to the solution domain. In other words, starting with what is needed design takes us to work how to satisfy the needs. The design of the system is perhaps the most critical factor affecting the quality of the software and has a major impact on the later phases, particularly testing and maintenance. System design aims to identify the modules that should be in the system, the specifications of these modules and to interact with each other to produce the desired results. At the end of the system design all the major data structures, file formats, output formats as well as major modules in the system and their specifications are decided.

The primary objective of the design, of course, is to deliver the requirements as specified in the feasibility report. Practicality

1. Efficiency
2. Flexibility
3. Extensibility
4. Reliability
5. Maintainability
6. Portability

5.2 Introduction to Detailed Design

5.2.1 Project Front End

The front end behaves as client in our project, and we will give the inputs to the Target Simulator through one set of line Edits. After entering all the values like range, bearing, height, speed, course when the user clicks the start button the entered values goes to the Target Simulator through socket which has been created. The target simulator will behave as server and will be running in back-end. As we are also displaying output in the front-end itself we have used another set of line edits to display the predicted future co-ordinates values which is received from back-end through the socket. According to these values, the targets move in the PPI. The PPI is drawn using the paint event function and the target shown will get updated periodically. When there is ready read signal emitted it indicates that there are still pending datagram's and the program processes the received values and it updates the GUI until there are no datagram's.

To cross check whether the generated future co-ordinates are correct, we can place the mouse pointer over the moving target which shows the target current co-ordinate value and we can compare this value with the generated value. This is implemented using the mouse tracking function. When the user clicks stop button the target simulator stops generating the future co-ordinates and the GUI updating also stops.

5.2.2 Project Back End

The back-end is the Target Simulator which acts like server to front-end GUI part. First it receives the initial values from the GUI through the socket and using these values further it generates the future co-ordinates values.

The target simulator initializes a posix timer and creates a thread then it binds to the socket port and receives the values from front-end. Next, using the received values it generates the future co-ordinates values.

Next, the generated values must be sent to the front-end for displaying so again using socket we transfer values from front-end to back-end. The target simulator continuously goes on generating the values until it receives the command to stop. The back-end is implemented using the C++-programming.

Chapter 6

IMPLEMENTATION

6.1 Implementation Details

The implementation phase of any project development is the most important phase as it yields the final solution, which solves the problem at hand. The implementation phase involves the actual materialization of the ideas, which are expressed in the analysis document and developed in a suitable programming language in order to achieve the necessary final product. Often the product is ruined due to incorrect programming language chosen for implementation or unsuitable method of programming. It is better for the coding phase to be directly linked to the design phase in the sense if the design is in terms of object oriented terms then implementation should be preferably carried out in a object oriented way. The factors concerning the programming language and platform chosen are described in the next couple of sections.

The implementation stage in a system project in its own right. It involves

- Careful planning
- Investigation of the current system and the constraints on implementation.
- Training of staff in the newly developed system.

Implementation of any software is always preceded by important decisions regarding selection of platform, the language used, etc. these decisions are often influenced by several factors such as real environment in which the system works, the speed that is required, the security concerns, and other implementation specific details. There are three major implementation decisions that have been made before the implementation of this project. They are as follows:

- Selection of the platform (Operating System).
- Selection of the programming language for development of the application.

6.2 Top-Down Approach

A top-down approach starts by identifying the major components of the system, decomposing then into their lower-level components and iterating until the desired level of detail is achieved. Top-down methods result in a form of stepwise refinement. Starting from an abstract design, in each step it is refined to more concrete level, until a level is reached where no more refinement is needed and the design can be implemented directly. The top-down approach has been promulgated and had has been found to be extremely useful for design. A top-down approach is suitable only if the specifications of the system are clearly and the system development is from scratch.

6.3 Bottom-Up Approach

A bottom-approach starts with the lowest-level component of the hierarchy and proceeds through progressively higher levels to the top-level component. A bottom-up design approach starts with the most basic or primitive components and proceeds to higher-level components that use these lower-level components. Bottom-up methods work with layers of abstraction. Starting from the very bottom, operations that provide a layer of abstraction are implemented. The operations of this layer are then used to implement more powerful operations and a still higher layer of abstraction, until the stage is reached where the operations supported by the layer are those desired by the system. If an iterative enhancement type of process is being followed, in later iterations, the bottom-up approach could be more suitable.

6.4 Validation Checks

Software Testing is one aspect of a broader job that is often referred to as verification & validation (V &V). Verification refers to the set of activities to ensure that software correctly implements a specific function. Validation refers to different set of activities to ensure software, that has been built, is traceable to customer requirements.

The definition of V&V encompasses many activities that relating to software Quality Assurance (SQA). Verification & Validation encompasses a wide array of SQA activities that include formal technical reviews, quality and configuration audits, performance, monitoring, simulation, feasibility study, qualification testing & installing testing. In the proposed system, the validation is checked for a given input values in the knowledge base, each field is checked for all types of syntactical & semantic errors.

The proposed system consist of several validation checks. They are:

- Input validation: Input validations are done to check the integrity of data. To perform input validations, expect the numerical values other inputs are not allowed.

- Code checking: Here every unit of code is checked to see whether to see whether the code is performing its task to the conditions specified.

Chapter 7

TESTING

7.1 UNIT TESTING

Unit testing focuses verification effort on the smallest unit of software design of the module. This is also known as Module testing. Since the proposed project has two modules, the testing is done individually. Using the design description as a guide, important controls paths are tested to uncover errors within the boundary of the module. This testing was carried out during the programming stage itself. In this testing step, each module provided the results as expected.

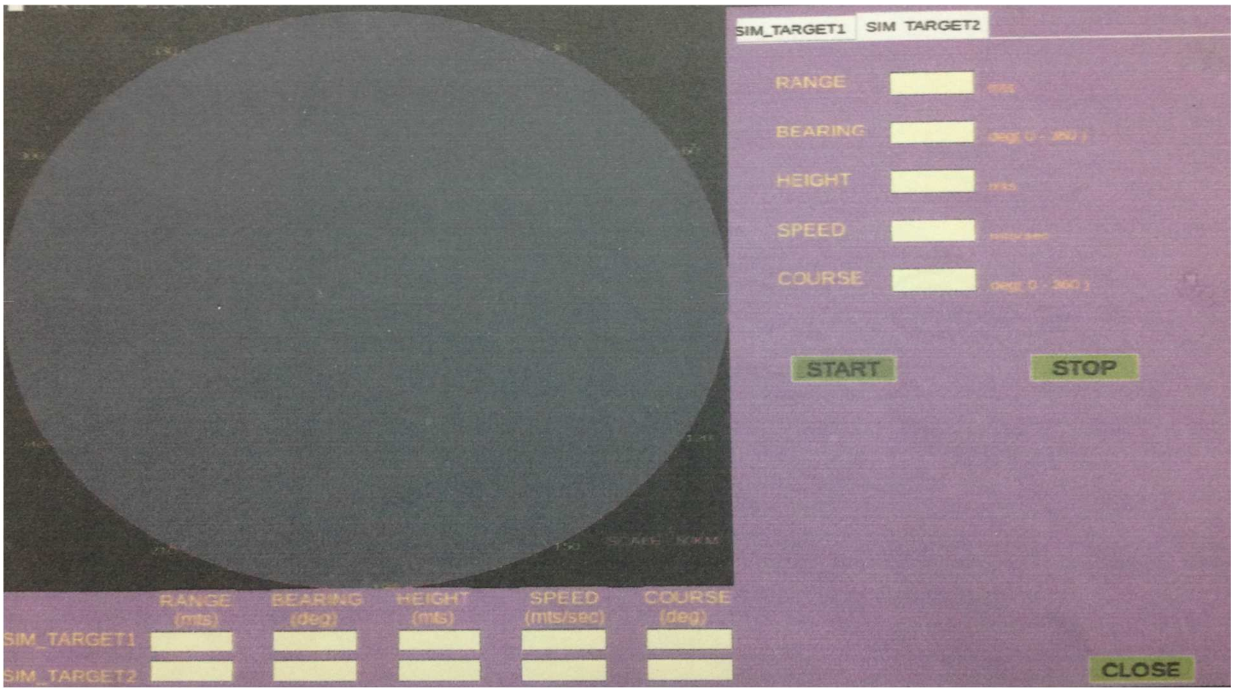
7.2 VALIDATION TESTING

Validation test can be defined in many ways, but a simple definition is that Validation succeeds when the software functions in a manner that can be reasonably expected by the user. After validation test has been conducted one of the two possible conditions exists.

1. The function or performance characteristics confirm to specification and are accepted.
2. A deviation from specification is uncovered and a deficiency list is created Deviation or an error discovered at this step in this project is corrected prior to completion of this project with help of user by negotiating to establish a method for resolving deficiencies. Thus, the proposed system under consideration has been tested for validity and found to be working satisfactorily.

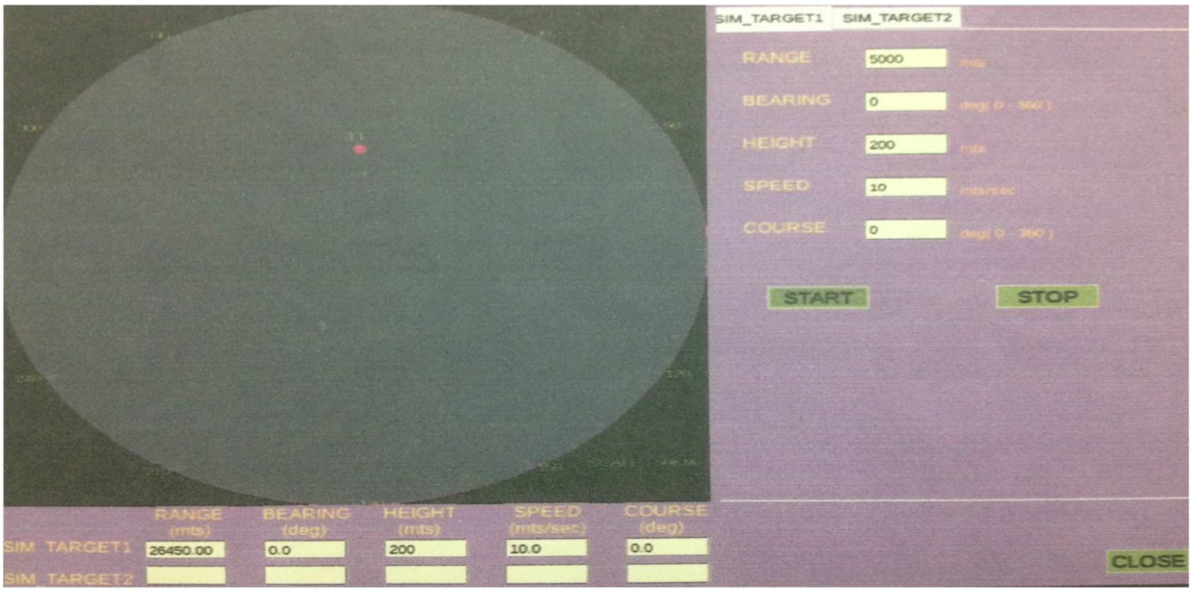
Chapter 8

RESULTS and ANALYSIS



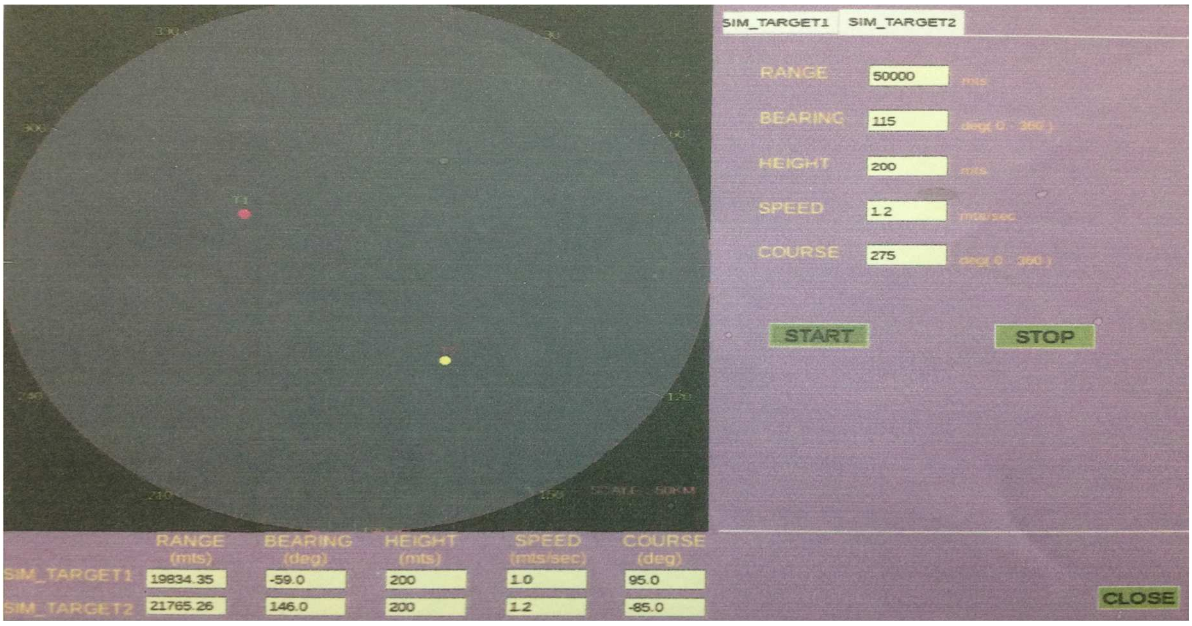
Screen shot 8.1: GUI of Target simulator for Gun Fire Control System

GUI can take two targets co-ordinates values which is feeded by the user, after giving the present values and if the user presses the start button, the socket will be created and these values will be given to target simulator running in the back end and which will calculate the future values and these values will be sent to GUI. If the user presses the stop button, the target simulator will be stopped and if close button presses GUI will be closed.

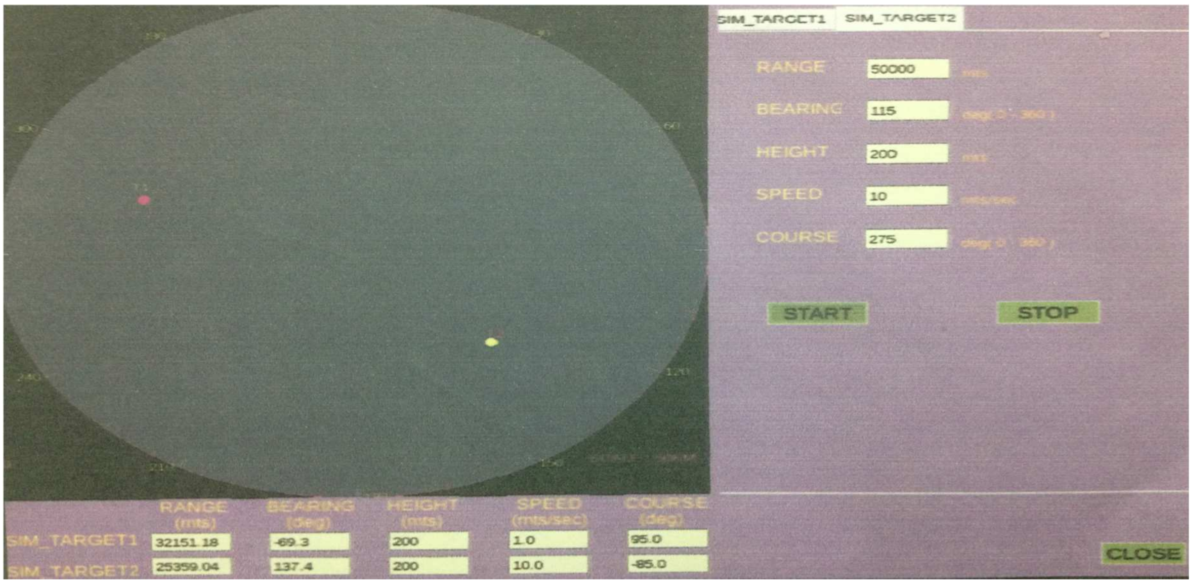


Screen shot 8.2: Target well within the range.

In this screen shot it is shown that the target is well within the range, where the target is moving towards 0 degree with a speed of 10 mts/sec2



Screen shot 8.3: Initial position of two targets moving horizontally.



Screen shot 8.4: Future position of the target's moving horizontally.

Chapter 9

CONCLUSION AND FUTURE WORKS

9.1 Conclusion

The system provides flexibility for incorporating new features which may be necessary in future the system has been tested and implemented finally we have concluded that system has capacity to do what it was expected to do. The project has given us a through insight of practical implication of the theoretical knowledge. Finally, we have concluded that system has capacity to do what it was expected to do. This project is complete, Interactive, User friendly, Flexible.

9.2 Future Works

- In this project we have showed with two targets it can be increased with multiple targets.
- We can also implement the turn rate option where we can calculate super elevation.
- The gun mount can be controlled by the proposed system.
- GUI can be improved for 3-D representation.

Bibliography

[1] Multicast sockets – practical series for programmers by David Makofske.

[2] NAVAL ORDANANCE AND GUNNERY VOLUME 2, FIRE CONTROL SYSTEM, Chapter 26.

[3] R. Hood, GMM 3 and 2 Chapters hitting a moving target. O'Reilly Media, Inc.

[4] BEL Ltd. [Online]. Available: http://www.bel-india.co.in/

[5] O.B. Akan and I.F. Akyildiz. Event-to-sink reliable transport in wireless sensor networks. *Networking, IEEE/ACM Transactions on*, 13(5):1003–1016, Oct 2005.

[6] Xiaojiang Du and Fengjing Lin. Secure cell relay routing protocol for sensor networks. In *Performance, Computing, and Communications Conference, 2005. IPCCC 2005.*