



Iron Shield:

Real-Time Defence System

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SUBJECT : 24MAT112 & 24AIM113

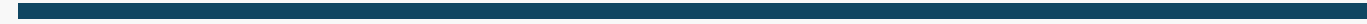




Introduction

The Iron Dome is an advanced missile defense system developed by Israel to intercept and destroy short-range rockets and artillery shells. Its operation involves a combination of trajectory prediction, and interceptor missile guidance, all of which rely heavily on mathematical principles.





Problem Statement

Design and implement a 2D simulation of a missile defense system, inspired by Israel's Iron Dome, enhanced with AI-driven decision-making.





LITERATURE REVIEW

TITLE	YEAR	KEY POINTS
Economics Drives Ray-Gun Resurgence	2023	This article discusses Israel's field-testing of an airborne antimissile laser called Iron Beam, a play on the name Iron Dome.
Top Tech Defence	2023	The article mentions that Israel opted to pursue laser weapons in part because its Iron Dome missiles cost so much more than the unguided, largely homemade rockets they defend against
Aerospace Defense Systems	2023	This workshop, organized Aerospace and Electronic Systems Society (AESS), discusses the world of air defense, including the Iron Dome system.



Methodology

Data :

- We have initialized the missiles coordinates and simulated it using the below mathematical equations.

Mathematical Modelling:

- Using kinematics equations and the distance formula, we will compute the missile's trajectory to determine the interception point where it can successfully block the target.

$$P_{\text{missile}}(t + dt) = P_{\text{missile}}(t) + V_{\text{missile}} \cdot dt$$

$P_{\text{missile}}(t)$ = missile position at time t

V_{missile} = velocity of the missile

dt = time step

Interceptor Guidance :

$$P_{\text{interceptor}}(t + dt) = P_{\text{interceptor}}(t) + V_{\text{missile}} \cdot dt \cdot u$$

$$D = P_{\text{missile}} - P_{\text{interceptor}}$$

$$u = \frac{D}{||D||}$$

D = difference in position between missile and interceptor

u = unit direction vector

$P_{\text{interceptor}}(t)$ = interceptor position at time t

$V_{\text{interceptor}}$ = interceptor speed



ARRAYS

- Arrays are non-primitive data structures that allow for fast access and manipulation of data, which is crucial for real-time or near-real-time simulations.
- In this simulations often involve numerous iterations and require efficient data handling, so an array is essential for our project.





Timeline



Jan3&4th Week

Information and proper guidelines are gathered and started working on codebase

2nd Review

Works on enhancing the code and also making the simulation realistic by involving environmental factors

1st Review

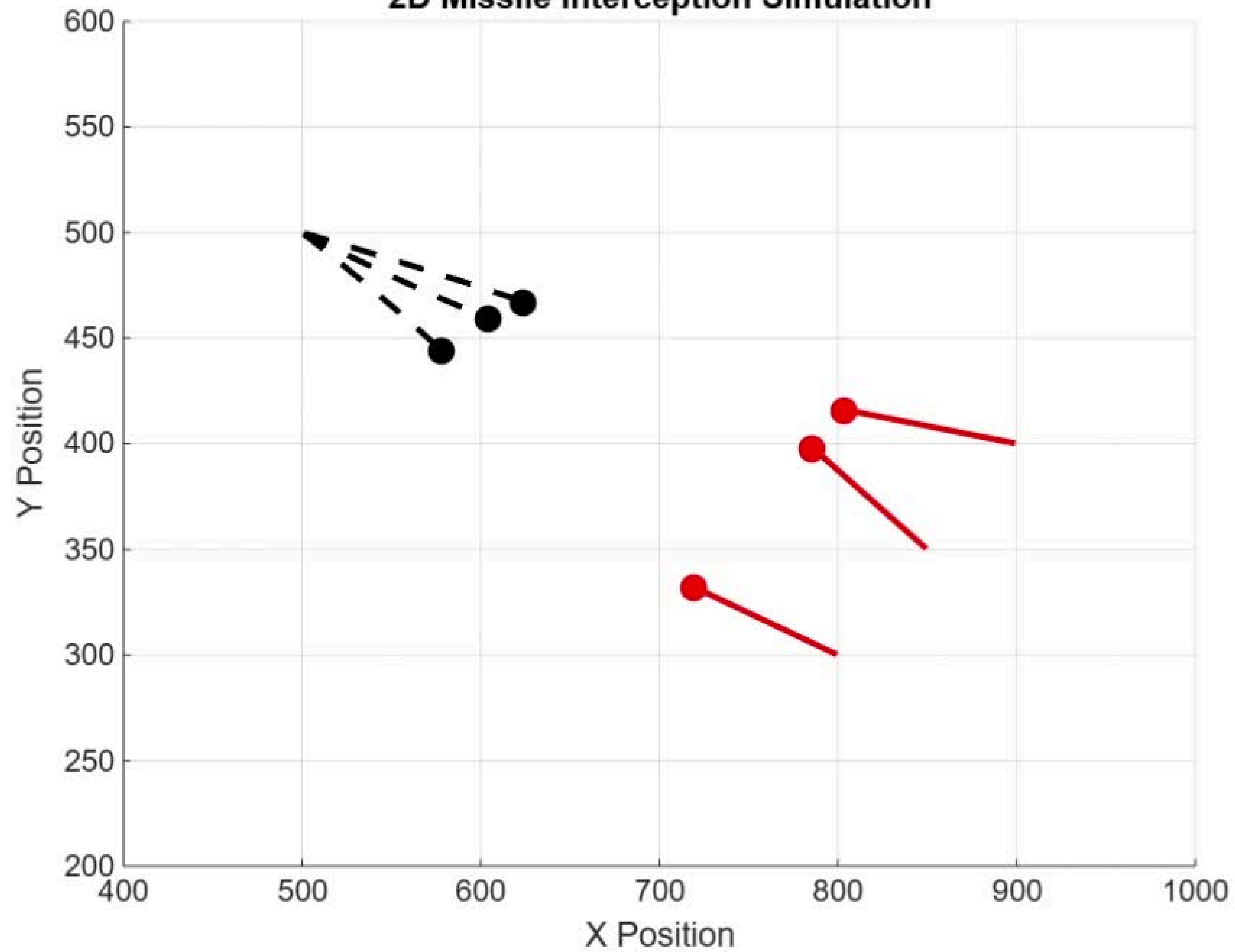
For this review, a rough visualization of the missile interception was shown generated by our code

Final Review

Works on the implementation of AI driven defense mechanism by introducing a ML model.



2D Missile Interception Simulation





Conclusion

This project demonstrates the application of mathematical modeling, including differential equations and distance formulas, to simulate and optimize the Iron Dome's interception mechanism. It highlights the critical role of mathematics in enhancing missile defense systems, providing a foundation for future improvements in accuracy and efficiency.



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Thank you

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