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Ai-Based Multi-Interceptor Missile Neutralization System

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***Abstract*—This research presents an advanced AI-driven multi-interceptor defense framework designed to neutralize high-speed aerial threats. The system integrates 3D trajectory modeling, predictive artificial intelligence, and sequential interception strategies. Unlike traditional single-interceptor systems, this model uses coordinated dual-interceptor engagement to improve interception probability and efficiency.**

***Index Terms*—AI Defense, Missile Interception, 3D Simulation, Multi-Interceptor System, Predictive Targeting**

I. INTRODUCTION

Modern missile systems exhibit high velocity, adaptive trajectories, and evasive maneuvers. Conventional defense systems rely on direct interception, which has limitations in accuracy and reliability. This paper proposes a novel approach based on:

- AI-based prediction
- Multi-interceptor coordination
- Sequential disruption and neutralization

II. MATHEMATICAL MODELING

2.1 Missile Motion Equation

The missile trajectory in 3D space is defined as:

$r_m(t) = r_0 + v_m * t$

Where:

- $r_m(t)$ = missile position vector
- r_0 = initial position
- v_m = velocity vector

2.2 Interceptor Motion

$r_i(t) = r_{i0} + v_i * t$

Where:

- $r_i(t)$ = interceptor position
- v_i = interceptor velocity

2.3 Lead Pursuit Equation

Target prediction:

$r_{target} = r_m + v_m * (\|r_m - r_i\| / v_i)$

2.4 Interception Condition

$\|r_m - r_i\| < d_{threshold}$

III. AI PREDICTION MODEL

Machine learning is used to predict future missile trajectory.

Model:

Linear Regression:

$x(t) = at + b$

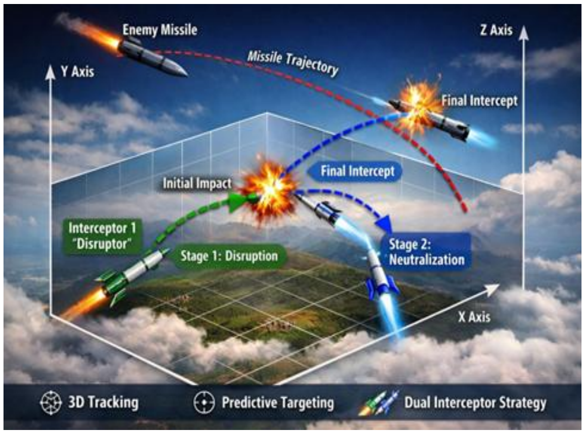
Where:

- a = velocity estimate
- b = initial position

IV. SYSTEM ARCHITECTURE

1. Detection Layer (Infrared + Radar)
2. AI Processing Unit
3. Decision Engine
4. Multi-Interceptor Deployment

V. SEQUENTIAL INTERCEPTION STRATEGY



Stage 1: Disruptor

- Alters missile trajectory

Stage 2: Neutralizer

- Final destruction

VI. SIMULATION CODE (3D)

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits. mplot3d import Axes3D

missile_pos = np.array([0.0, 500.0, 300.0])
missile_vel = np.array([450.0, -120.0, 80.0])

int1_pos = np.array([200.0, 0.0, 0.0])
int2_pos = np.array([0.0, 0.0, 0.0])

int1_speed = 550.0
int2_speed = 600.0
dt = 0.05

traj_m, traj_i1, traj_i2 = [], [], []
def unit(v):
return v / np.linalg.norm(v)

for t in np.arange(0, 6, dt):
missile_pos += missile_vel * dt
traj_m.append(missile_pos.copy())

dist1 = np.linalg.norm(missile_pos - int1_pos)
target1 = missile_pos + missile_vel * (dist1 / int1_speed)
int1_pos += unit(target1 - int1_pos) * int1_speed * dt
traj_i1.append(int1_pos.copy())
dist2 = np.linalg.norm(missile_pos - int2_pos)
target2 = missile_pos + missile_vel * (dist2 / int2_speed)
int2_pos += unit(target2 - int2_pos) * int2_speed * dt
traj_i2.append(int2_pos.copy())

if np.linalg.norm(missile_pos - int2_pos) < 10:
break
traj_m = np.array(traj_m)
traj_i1 = np.array(traj_i1)
traj_i2 = np.array(traj_i2)

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')

ax.plot(traj_m[:,0], traj_m[:,1], traj_m[:,2], 'r--')
ax.plot(traj_i1[:,0], traj_i1[:,1], traj_i1[:,2], 'g')
ax.plot(traj_i2[:,0], traj_i2[:,1], traj_i2[:,2], 'b')

plt.show()
```

VII. RESULTS

- Improved interception probability
- Reduced reaction time
- Effective multi-stage engagement

VIII. INNOVATION

- AI-driven prediction
- Dual interceptor model
- 3D spatial tracking

IX. CONCLUSION

This research demonstrates a scalable and intelligent missile defense framework. The integration of AI with physics-based modeling enhances system efficiency and reliability.

X. FUTURE SCOPE

- Deep learning integration
- Swarm drone interception
- Real-time battlefield deployment

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