Problem Statement on Missile Firing

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ABSTRACT

The control system increasing and is very crucial system in space science. Patriot weapon control computer performs crucial system functions for tracking and intercepting targets, as well as other control tasks. The performance of actuation system plays a decisive role in determining the performance of the flight control system for a highly maneuverable missile. In controlling of l the missile aerodynamics, control surfaces, sometimes called fins, are used. In missile guidance system, to reduce the interception distance, it is important to choose a suitable guidance law and navigation constant. Miss distance as low as 0.012m can be achieved with significantly lower control effort than required by ISM alone.

Keyword: - *Fire control system, patriots radar, artillery spotting, HACS, fins, Guidance system, Miss Distance.*

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1. INTRODUCTION

The Patriot is a surface-to-air defense missile system manufactured by Raytheon and used by the United States Army, originally designed to protect against Soviet cruise missiles and medium to high altitude aircraft. Rapid technical improvements in the late 19th century greatly increased the range at which gunfire was possible. Rifled guns of much larger size firing explosive shells of lighter relative weight (compared to all-metal balls) so greatly increased the range of the guns. A fire-control system is a number of components working together, usually a gun data computer, a director, and radar, which is designed to assist a weapon system in hitting its target. A radar can give the system the direction to and/or distance of the target. It performs the same task as a human gunner firing a weapon, It is found that among all directed from 1946 to 2007, potential challengers possessing ballistic missiles are significantly more likely to initiate international crises. But attempts to do so faster and more accurately. In fact, most engagements before 1800 were conducted at ranges of 20 to 50 yards (20 to 50 m). Between the American Civil War and 1905, numerous small improvements, such as telescopic sights and optical rangefinders, were made in fire control. Astronautics has developed the Modular Artillery Fire Control System (MAFCS) to provide a highly adaptive solution for any artillery platform: Self-Propelled guns, Towed Artillery Guns, mortars and Multi Launch Rocket System (MLRS). The MAFCS enables autonomous gun Navigation and Pointing and provides ballistic computation capabilities to enhance weapon operation. The system ability to perform rapid changes of position, as well as its high responsiveness, enables the crew to Shoot and Scoot and thus gains the force-multiplier advantage which is essential to the modern battlefield.

Fig -1: Long-range radar antenna

Notable working appeared not only in traditional centers of learning but also in-still remote areas. The system meets modern MAFCS requirements, consists of Commercial-Off-The-Shelf (COTS) components, is in full-scale production and has been extensively tested and used by several armies.

1.1 The MAFCS Elements:

- Vehicle Reference Unit (VRU), three-axis Monolithic Ring Laser Gyro (MRLG), (embedded GPS-optional)
- Commander's Control and Display Unit & Tactical Computer (CDU&TC)
- Gunner's Display Unit (GDU)
- Muzzle Velocity Radar (MVR)
- Vehicle Motion Sensor (VMS)

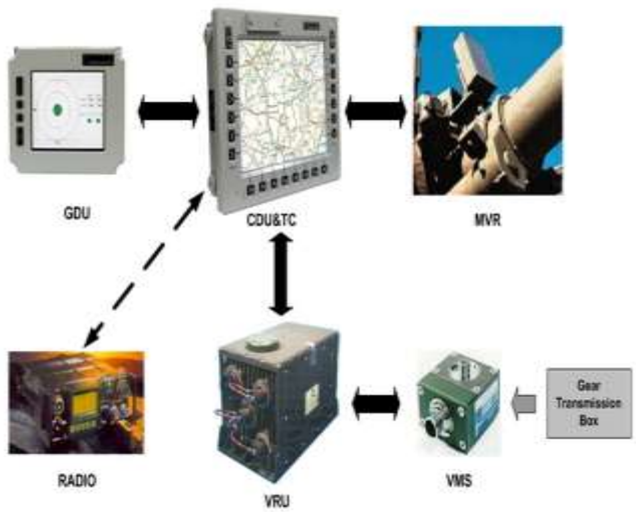

Fig -2: MAFCS Parts

1.1.1 Vehicle Reference Unit (VRU)

The VRU is a fully integrated inertial navigation unit with an optional GPS receiver which may either be embedded or external (PLGR). The VRU is installed on the elevating mass of the Gun and provides a continuous high precision output of position and attitude of the weapon. The VRU performs all navigation, attitude, pointing and north finding functions with heading accuracy to better than 1 mil RMS and attitude accuracy to better than 0.5 mil RMS.

1.1.2 CDU&TC and GDU

The man-machine interface within the MAFCS is the Control Display Unit & Tactical Computer (CDU&TC). This unit is provided for use by the gun's Commander and a similar or smaller unit is provided to the gunner for aiming. The CDU&TC includes a powerful Pentium processor, which provides overall control, management and fire control computation. The CDU&TC includes a high brightness back light, color liquid crystal display and a number of software-driven programmable keys to provide a state-of-the-art flexible multi-function device. The display has a wide-angle active viewing area and provides high resolution combined with high brightness for sunlight readability. The CDU&TC has 20 sealed buttons mounted on the front bezel around the screen for menu-driven operation. The CDU&TC performs all system level management and processing tasks within the MAFCS. The various functions can be defined as Commander MMI, overall system mode control and management (VRU, Gunner Display, Radio, MVR and other optional units), graphic display generation and the on-board technical fire
Control and ballistic computation. Each of these functions is designed with software modularity to allow a flexible and customized approach by the Gun User. Per customer request, 2 and/or 3 Dimensional (2-D/3-D) map layers can be incorporated to improve navigation and control.

1.1.3 Muzzle Velocity Radar (MVR)

The MAFCS is designed so that to accept inputs from a MVR to allow real time monitoring of the effect of gun wear and, in a predictive manner, to improve the ballistic computation. The MVR processing unit and antenna are housed in a single module located externally at the front of the cradle. The MVR measurements are integrated within the ballistic missile computation process, via a predictive algorithm, to improve the first-round effectiveness of the weapon and thus avoid the need for traditional calibration rounds.

1.1.4 Vehicle Motion Sensor (VMS)

The VMS provides a continuous independent measurement of wheel or track speed to the VRU during vehicle/gun movement for optimal system performance. The VMS is mounted within the engine or gear transmission compartment. Electricity, airplanes, computers, and nuclear weapons have all been thought way at some point, but none of them appear today because of invention of powerful and efficient working of missiles. Only rockets stand with them because rockets are achieving success in every field without fail. In ancient time, the idea of blending natural ingredients into a substance that will burnt or explode when they are get ignited. After they, Gun powder replaced these which uses three ingredients charcoal, subpar, and potassium nitrate. But it works only when it is mixed in proper way. In order to decrease disadvantages of gun powder recipes developed. It is equal to black powder in operations. Due to some technical problems, I is replaced by black powder. One of the advantages of this is that it would burn steadily than previous innovations. Another excellent technique invented by Chinese was fireworks. It improved stability & reliability. Fireworks then are then as now, a wide range of explosive devices. Space-weapons can be categorized as opposed to bombs, torpedoes and rockets, missiles are both powered and guided. If unguided, it would be termed a rocket. A bomb is neither powered nor guided. A guided bomb is called a "smart" bomb. If powered and traveling underwater, it is termed a torpedo. Main difference between gun and rocket body is that a gun burns explosively, but a rocket burns steadily. The technical idea behind this is, in a gun the combustion gases push a projectile while in a rocket push the body itself.

Fig -3: Hypersonic BRAHMOS Vehicle

A missile is self-guided munition that travels through air to targets. Missiles can be classified by type, launch mode, range, propulsion, warhead and guidance systems. We can categorize missiles as cruise missile and ballistic missile. All these missiles used two types of motor, solid fuel booster, liquid fuel sustainer.

Commonly using parameters in a war are

Battlefield range (BRBM):less than 124 miles (200 kilometers)
Tactical (TAC): between 93 - 186 miles (150 - 300 km)
Short Range (SRBM): less than 621 miles (1,000 km)
Theatre (TBM): between 186 - 2,175 miles (300 - 3,500 km)
Medium Range (MRBM): between 621 - 2,175 miles (1,000 - 3,500 km)
Intermediate Range (IRBM) or Long Range (LRBM) : between 2,175 - 3,418 miles (3,500 - 5,500 km)
Intercontinental (ICBM): greater than 3,418 miles (5,500 km)

A cruise missile is unmanned self-propelled guided vehicle. They fly within the earth atmosphere and uses jet engine technology. Depending upon the speed cruise missiles are classified as: subsonic, supersonic and hypersonic sonic cruise missiles.

Fig -4: classification of Cruise Missile

Ballistic missile: a ballistic missile is that has a ballistic trajectory over most of its first path regardless of weather. It is not a weapon delivery vehicle. Ballistic missiles are categorized according with range, launch mode. It can load a huge payload. A ballistic missile travel along a suborbital trajectory.

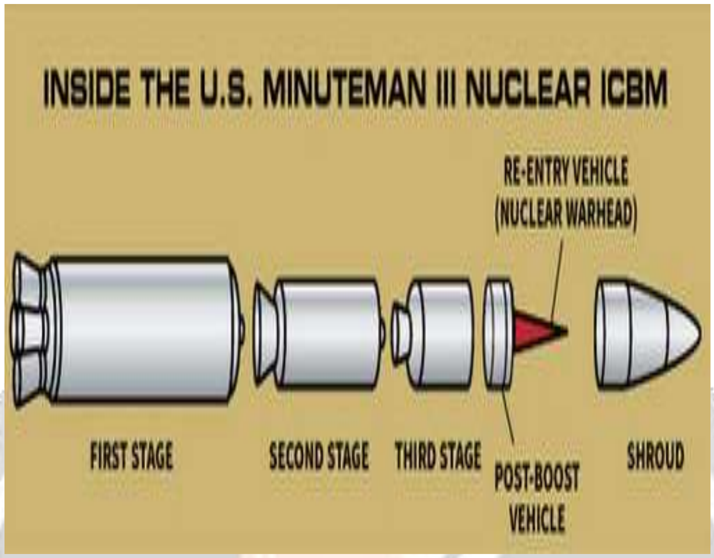

Fig -5: an intercontinental ballistic Missile

The remainder of this paper is organized into as follows:
Part 2 contains a review of related work. Part 3 explains problem statement, part 4 proposed solutions, part 4 about some methods, In part 5 , we give important calculations to decrease firing problem in missiles, In part 6, conclusion is given and in part 7 references are given which were used in preparing of this paper.

2. RELATED WORK

At first, the guns were aimed using the technique of artillery spotting. There were also procedural improvements, like the use of plotting boards to manually predict the position Then increasingly sophisticated mechanical calculators were employed for proper gun laying, typically with various spotters and distance measures being sent to a central plotting Around 1905, mechanical fire control aids began to Become available, but these devices took a number of years to become widely deployed. Lord Kelvin, widely regarded as Britain's leading scientist first proposed using an analogue computer to solve the equations to calculate the required trajectory and therefore the direction and elevation of the guns. Pollen aimed to produce a combined mechanical computer and automatic plot of ranges and rates for use in centralized fire control. To obtain accurate data of the target's position, Pollen developed a plotting unit (or plotter) to capture this data. The early versions of the High Angle Control System, or HACS were examples of a system that predicted based upon the assumption that target speed, direction, and altitude would remain constant during the prediction cycle. Typically, weapons fired over long ranges need environmental information, the more the wind, temperature, etc. Aircraft altitude performance had increased so much that guns had similar predictive problems, and were increasingly equipped with fire-control computers. The Kerrison Predictor is an example of a system that was built to solve laying in "real time", simply by pointing the director at the target and then aiming the gun at a pointer it directed. The radar-based M-9/SCR-584 Anti-Aircraft System was used to direct air defense artillery since 1943. The MIT Radiation Lab's SCR-584 was the first radar system with automatic following, Bell Laboratory's M-9 was an electronic analog fire-control computer that replaced complicated and difficult-to-manufacture mechanical computers (such as the Sperry M-7 or British Kerrison predictor). In combination, this system accomplished the astonishing feat of shooting down V-1 cruise missiles with less than 100 shells per plane (thousands were typical in earlier AA systems).

The system tracked and intercepted missiles in a number of stages:

1. The system was instructed to search for airborne objects with Scud missile characteristics on its radar.
2. A range gate, an electronic device in the radar, calculates an area in the air space for where the system should look next for the incoming missile. The missile is tracked by the system as it approaches.
3. The Patriot would launch one of its own missiles once the incoming missile was in range.
   Payload

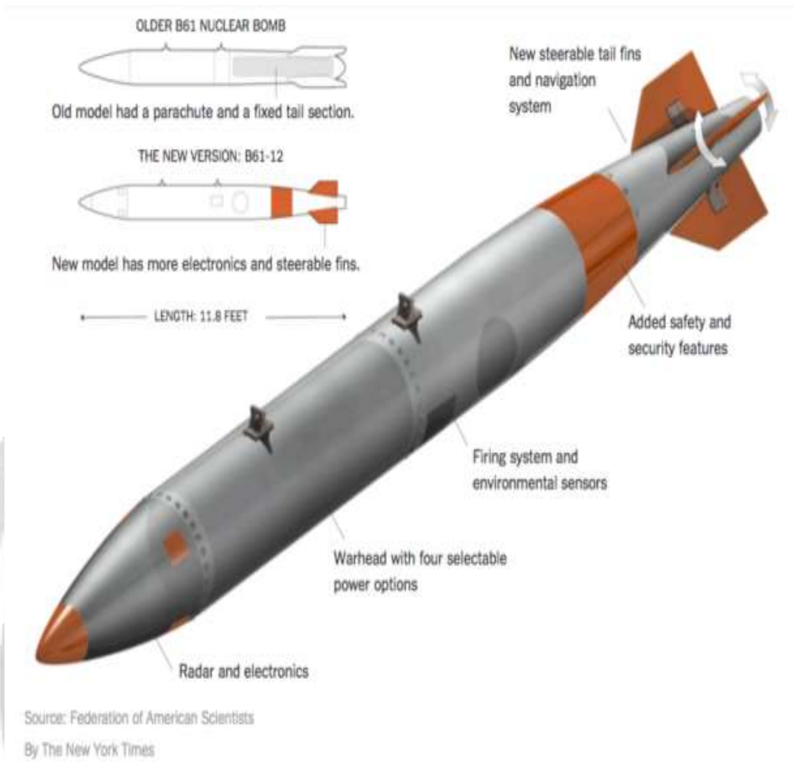

Fig -6: a missile structure

Modern fire-control computers, like all high-performance computers, are digital. The LABS system was originally designed to facilitate a tactic called toss bombing, to allow the aircraft to remain out of range of a weapon's blast radius. The principle of calculating the release point, however, was eventually integrated into the fire control computers of later bombers and strike aircraft, allowing level, dive and toss bombing. In addition, as the fire control computer became integrated with ordnance systems, the computer can take the flight characteristics of the weapon to be launched into account. The added performance allows basically any input to be added, from air density and wind, to wear on the barrels and distortion due to heating. These sorts of effects are noticeable for any sort of gun, and fire-control computers have started appearing on smaller and smaller platforms. Tanks were one early use that automated gun laying using a laser rangefinder and a barrel-distortion meter. Fire control computers are not just useful for large cannons. They can be used to aim machine guns, small cannons, guided missiles, rifles, grenades, rockets any kind of weapon Fire-control computers have gone through all the stages of technology that computers have, with some designs based upon analogue technology and later vacuum tubes which were later replaced with transistors. Fire-control systems are often interfaced with sensors (such as sonar, radar, infra-red search and track, laser range-finders, anemometers, wind vanes, thermometers, etc.) in order to cut down or eliminate the amount of information that must be manually entered in order to calculate an effective solution.Often, satellites or balloons are used to gather this information. Once the firing solution is calculated, many modern fire-control systems are also able to aim and fire the Weapon. Once again, this is in the interest of speed and accuracy, and in the case of a vehicle like an aircraft or tank, in order to allow the pilot/gunner/etc. In most aircraft the aiming cue takes the form of a "pipper" which is projected on the heads-up display (HUD). The pipper shows the pilot where the target must be relative to the aircraft in order to hit it. Once the pilot maneuvers the aircraft so that the target and pipper are superimposed, he or she fires the weapon, or on some aircraft the weapon will fire automatically at this point, in order to overcome the delay of the pilot. In the case of a missile launch, the fire-control computer may give the pilot feedback about whether the target is in range of the missile and how likely the missile is to hit if launched at any particular moment.

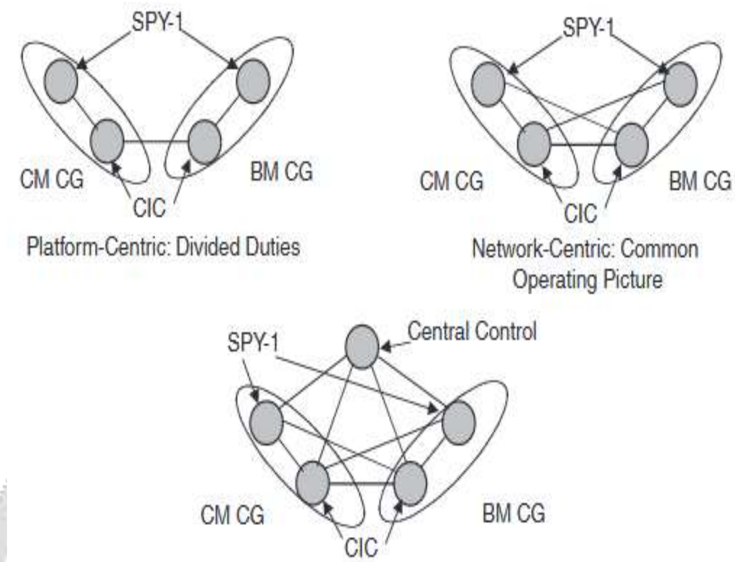

Fig -7: Network-Centric co-operative engagement

3. PROBLEM STATEMENT

The cause of the missile system failing to defend against the incoming Scud was traced back to a bug in Patriots radar and tracking software. Problems for failing missile firing are due to software problems, and technical problems.

4. METHODS

1. In order to cut down or eliminate the amount of information that must be manually entered to calculate an effective solution. Once the firing solution is calculated, many modern fire-control systems are also able to aim and fire the weapon(s)
2. The bug occurs in the calculation of the next location of the incoming target by the range gate. The prediction is calculated based on the target velocity and the time of the last radar detection.
3. Velocity is stored as a whole number and a decimal, and time is a continuous integer or whole number (i.e. the longer the system has been running, the larger the value) measured in tenths of a second.
4. The algorithm used to predict the next air space to scan by the radar requires that both velocity and time be expressed as real numbers. However, the Patriot computer only has 24 bit fixed-point registers. Because time was measured as the number of tenth-seconds, the value 1/10, which has a non-terminating binary expansion, was chopped at 24 bits after the radix point. The error in precision grows as the time value increases, and the inaccuracy resulting from this is directly proportional to the target velocity.

The “shooting” policy affects the degree to which the weapon inventory on board the cruisers is depleted. In this work, we postulate three policies: shoot only, shoot-look-shoot, and shoot-look-salvo 2. We explain each of these next, but reserve explanation of their implications on success to later.

4.1 Shoot Only

This is the simplest policy. As threat missiles present themselves, one or both of the ships launch a counter missile. In case of a miss, the target missile is considered a leaker. No further attempt is made to engage it with counter missiles.

4.2 Shoot-Look-Shoot

In this case, one or both of the cruisers will fire against a target missile. Next, the radar tracking the missile will determine if the engagement was a success. If not, a second shot will be fired. If the second shot misses, the target missile is again considered a leaker and no further attempt is made to en- gage it with counter missiles.

4.3 Shoot-Look-Salvo 2

This last case begins as in shoot-look-shoot, but instead of firing just one counter missile after a miss, two are salvoed. If the salvo misses, the target missile is again considered a leaker and no further attempt is made to engage it with counter missiles. Because there may be insufficient time to fire the "post look" shots in the shoot-look-shoot and shoot-look-salvo 2 modes, we may also explore intermediate cases.

5. CALCULATIONS

If we let τ1 be the mean time to prepare a launcher,
τ2 the mean time required to launch the intercept, and
τ 3 the mean time to fly out to the target, then the total mean service rate for each cruiser is:

$$\mu = \frac{1}{\tau_1 + \tau_2 + \tau_3}.$$

Service is complete when the incoming attack missile and the de-fending missile "meet."

5.1 Survivability

The survivability of the defending Aegis cruisers depends on their ability to engage incoming cruise missiles, their firing rate, and the ability of the terminal defenses (CIWS) to destroy terminal leakers. The firing rate can be thought of as the "service rate." When the arrival rate exceeds the service rate, then the system becomes "saturated." Whether because of intercept failure or saturation, cruise missiles not destroyed become "leakers." In both cases, the leakers join a second queue to be serviced by the CIWS. The implications of this are discussed below.

5.2 Terminal Defense queue

The number of leakers in a period depends on the shooting policy, the engagement procedures (one or two ships firing independently), and the degree of network-centricity. The proportion of terminal leakers allocated to each of the Aegis cruisers. By "damage" to the cruiser, we mean that its ability to engage attacking missiles is impaired by the fraction and by "disable," we mean that its ability to engage cruise missiles has been lost. When the accumulated damage exceeds pa, we assume the ship can no longer engage attacking missiles. The expected fraction of damage caused by the NL attacking missiles follows a binomial distribution.

6. CONCLUSION

Exact aim on target using modern controlling technology. The bugs occur in in the missile software can rectified efficiently. In this, we have linked the effectiveness of the two Aegis cruisers in defending against both the cruise missile and ballistic missile threat to alternative command and control processes and to alternative operational networks. To do this, it was first necessary to establish adequate measures of effectiveness and performance. Next, we developed mathematical models of collaboration and network complexity to assess the performance of the alternative command and control procedures. Finally, these models were used in an allocation decision process that directly influenced the survivability of the cruisers and the infrastructure targets they were defending.

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