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## A Critical Study on Missile and Missile Guidance

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**Abstract—** As a result of advancements in armament technology, traditional conceptions of battle are going through a profound transformation. The use of technology as a force multiplier is extremely prevalent in modern combat. In the modern battlefield, autonomous weapons are absolutely necessary. In this day and age, the presence of missiles is almost always indicative of a country's level of military power. The employment of guided weapons is an unavoidable need in the arsenals of modern militaries. The study will primarily concentrate on several types of weapons, ranging in range from extremely short to medium, long, and automated. This study analyses a wide variety of missiles and classifies them according to the criteria that distinguish them, including the type of missile, its target, its range, how it is launched, and whether or not it has an autopilot guiding system (APG).

**Keywords-** Missiles, warheads, Classifications, Guidance systems

### Introduction

In the modern world, the defense or attack system of any country is strengthened by its autonomous and modern inventory of weapons. Most of the missions involve automatic and précised weapons which becomes the strength of any army. Missiles play an important role in contemporary warfare where it can eliminate enemy's object or place remotely [1-4]. The unguided missile generally known as rocket is the unmanned vehicle which contains explosive, aimed manually and hit towards the target with assumption that it will hit the target. The fired rocket/unguided missile does not have any mean to change its path by itself, so it lacks the accuracy. However unguided missiles are cheap. In 1792 Seringapatam war, Tippu sultan and its army while fighting with British colonial army used and fired thousands of rockets resulting in winning of troops [2]. The rockets also known as

mysorean rockets were attached with steel spears or with bamboo and powered with gun powder propellant compacted in cast iron chamber with nozzle and igniters With the idea of remotely guiding and airplane bomb towards a target in World War 1, originated the concept of missile guidance [4]. So the guided missile is unmanned space travelling vehicle which contains explosives warhead and can control its path towards the target with some controlling algorithms and elements [1]. They are more accurate for the target which changes their position. Torpedoes are different then missiles as in definition of missiles these are space travelling vehicles however torpedoes may be guided vehicles but they travel in water instead of air/space [5,6]. The first guided missile was developed by NAZI Germany during World War 2. To keep the missile flying along a pre hosen path a mechanical auto pilot radio-controlled system was used. V2 (guided missile) is an example of World War 2, it was powered by liquid propellant rocket engine.



Fig. 1 Missiles may be classified on basis of their range, type, warhead, its launch mode, propulsion and guidance system.

## I. CLASSIFICATION OF MISSILE

The missiles may be classified on range, type, speed, warhead, launch mode and guidance.

### *Classification on Range*

On the basis of maximum range achieved by missiles, the missiles may be classified as

**Short Range Missiles** - The missiles which can travel less than 1000 kilometer are known as short range missiles [6].

**Medium Range Missiles**- The missiles which can travel between 1000 to 3000 Kilometers are known as medium range missiles

**Intermediate Range Ballistic Missiles**- The missiles with travelling distance between 3000 Km to 5500 Km are known as intermediate range ballistic missiles [5].

**Intercontinental Ballistic Missiles**- Missiles having maximum travel distance over 5500 Kilometers comes under this category [6].

### *Classification on basis of speed*

Missiles may be classified on basis of speed as subsonic, supersonic and hypersonic.

**Subsonic**- Missiles have speed less than speed of sound (343 m/s) are known as subsonic missiles [7].

**Supersonic**- Missiles which have speed greater than speed of sound is known as supersonic missiles [1].

**Hypersonic**- Missiles having speed more than five times the speed of sound are called as hypersonic missiles.

### *Classification on basis of types*

There are two types of missiles

**Cruise Missile**- An unmanned self-propelled guided vehicle which provides special payload on the target is known as cruise missiles. They use jet engine technology and travel within earth's atmosphere. They can be categorized as subsonic cruise missile, supersonic cruise missile and hypersonic cruise missile [1].

**Ballistic Missile**- A missile which has ballistic trajectory over most of its flight path are known as ballistic missile. These types of missiles contain huge payload [2].

### *Classification on basis of launch*

On the basis of launch the missiles may be categorized as Surface to Surface, Surface to Air, Air to Air, Air to Surface, Sea to Surface and Surface to Sea. Figure 3 shows categorization of missile on basis of launch.

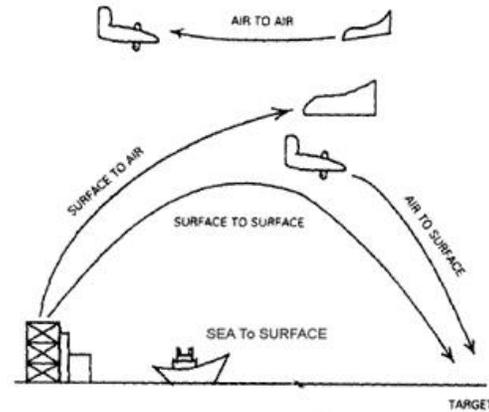


Fig. 2 Missile trajectory path

**Surface to Surface**- In surface-to-surface missiles, the guided projectile is launched from fixed ground station towards the target which is on ground.

**Surface to Air**- In these types of missiles, the missile is launched from the stationary station from ground and target is in space or air. These missiles are also known as anti-aircraft or anti-missile [1,2].

**Air to Air**- These missiles are launched in air (by aircraft) towards the target in air.

**Air to Surface**- The guided projectile is launched in air (by aircraft) towards a target which is on ground.

**Surface to Sea**- The missile launched from the stationary station on ground towards the target which is in sea is called surface to sea.

**Sea to Surface**. Missile launched by any object in sea (Ship) towards the target which is on ground are called sea to surface missiles.

### *Classification on basis of Warhead*

On the basis of warhead, the missiles may be categorized as conventional warhead and strategic warhead.

**Conventional Warhead**- The missiles which contains high energy explosives mostly chemical explosives are known as conventional warhead missiles

**Strategic Warhead**- In these types of missiles, instead of high explosive materials, radioactive materials are filled in warhead. When triggered radio activity can wipe out even cities.

### *Classification on the basis of guidance system*

The missiles may be classified depending upon the type of guidance method used as wire guided, command guided, terrain comparison guided, terrestrial guided, inertial guided, LASER guided and GPS guided missiles.

Wire Guided Missiles- The signals for command are passed along wires dispensed from missile after the launch of missile shown in figure 4. As the missile flies, the thin wires are reeled behind it. This type of guidance system is mostly used in anti-tank missiles. These have semi-automatic command and are line of sight guidance [7].



Fig. 3 Ground to air Trajectory

Command Guided Missiles- The Command guided missiles are tracked from the station and further commands are transmitted from station to missile via radio, laser impulses, radar and optical fibers [4].

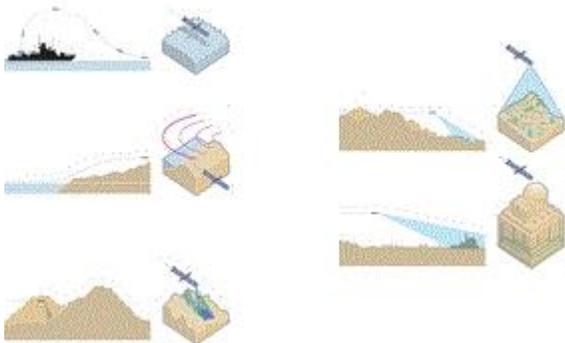


Fig. 4 Terrain Mapping model view

Terrain Comparison Guided Missile- This type of guidance method uses terrain comparison, the sensitive altimeters measure the profile of ground and checks the results against prestored information data. Figure 5 shows the guidance using terrain comparison, the missile is fired and missile seeks the terrain information compares with the target data and after finding suitable target guidance method directs missiles towards it.

Terrestrial Guided Missile- In this type of guidance, the system continuously measures star angles and then it compares the angles with pre-programmed angles expected on missile's intended trajectory. The missile flight path is controlled by reference to strength of earth's magnetic or gravitational field.

Inertial Guidance- this type of guidance is mostly used in cruise type surface to surface missiles. The missile has three accelerometers stabilized by gyros which measures acceleration along 3 perpendicular axes which are integrated twice. The first integration gives velocity and other gives position. Figure 6 shows inertial guidance method.

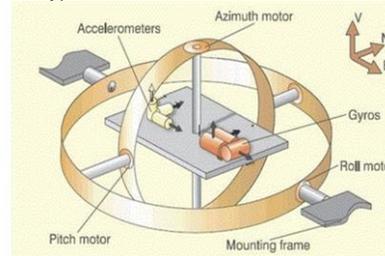


Fig. 5 Gimbal working mechanism

Laser guided Missiles- In this missile the beam is of LASER that is transmitted towards target. The beam hits target and get scattered and laser detector detects the laser scattering. The detector provides direction to the missile guidance system [5].

GPS Guided Missile- In this type of missile guidance system, the GPS signal is sent to guide the missile to reach particular longitude and latitude. Figure shows GPS missile guidance

## II. FUNDAMENTALS OF GUIDANCE SYSTEMS

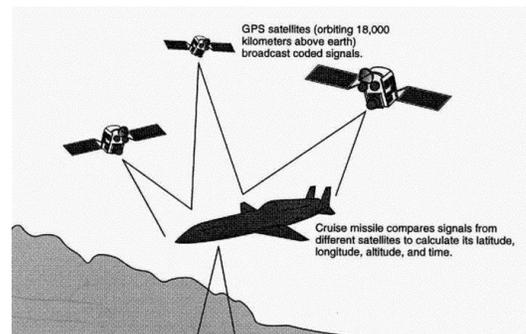


Fig. 6 Guidance through satellites for a missile

Guided missile is the term used for missile post World War- II era. This was because the weapons were replaced by the technology of guided missile. Due to the advancement in the technology of guided missile the accuracy in the weapons used in the military was increased significantly, though along with it the threat complexity was also increased. The applications of missile technology includes Guided Projectiles, Air to Air and Surface to Air Guided Missiles, Surface to Surface Aerodynamic Guided Missiles etc.

### Purpose and Function

The system of missile guidance contains two types of control systems. One is the attitude control system and the other one is the flight path control system. The function of the attitude control system is that it maintains the missile in its desired attitude as the missile is controlled in its roll, pitch and yaw on the ordered flight path. Its main function is to operate as an auto pilot so that there is deflection from the ordered flight path of the missile. The determination of the flight path is the main function of the flight path control system. This is necessary for the interception of target and also for the order generation to the attitude control system for the maintenance of the path. The behavior of the vehicle while travelling from A to B should be proper in addition to maintaining the path of the particular vehicle. This includes the main concept of "Guidance and control". A missile which is following its way or path to target should follow its full path properly. If the missile becomes unstable dynamically in its half way then it will not be able to complete its full distance to the target. For the vehicle or missile to work properly, it must be pilot and follow the control signals properly so that it does not fail in its structure aerodynamically and complete its flight to the target. The principle of feedback is very important during the guidance and control system operation. The corrective adjustments are made with the help of control units when there is presence of guidance error. The stabilization of pitch, roll and jaw is also done by control units by adjusting the control surfaces. The corrections in the guidance and stabilization are combined and they act as an error signal given to the control system.

### III. CONCLUSION

In the modern era, the need for a country is best defense system for any terrorist or other attack. This

can be accomplished via modern and automatic weapons. The missiles are very important part of warfare inventory. The missiles should carry the payload to the target instead to other objects or location. In this paper, we discussed about missiles, its origin and evaluation and different classification of missiles. In the study various guidance methods are being discussed in the paper which has an impact on accuracy of the missile.

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