

Active Sensor Working System on Anti-Aircraft Flying Missiles

Resi Elvita Sari*¹, Citra Melamedika¹, Tri Hartati¹, Choirunnisa Iljannah¹

¹Physics Education, Faculty of Teacher Training and Education, Universitas Riau

*Corresponding author's email:

resi.elvita1153@student.unri.ac.id

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ABSTRACT

Along with the development of the times, the rapid development of technology, especially in the field of national defense and security, where a country designs advanced weapon technology, namely missiles (guided missiles). These weapons are usually owned by developed countries which are useful as a defense tool so that there is no attack on the country. The weapon technology used utilizes the active sensor working system and also other important components on the missile. The development of these weapons has given rise to several types of guided missiles based on their range such as tactical, medium-range, long-range and ballistic missiles. The use of important components in missiles such as missiles that are useful in carrying warheads, control systems that can control missiles while flying in the air, navigation systems in which there are GPS, inertial techniques, and positioning techniques, fuel and propulsion systems that provide thrust and thermal shields as heat shields when crossing the atmosphere and flying in the air so as to produce missiles that can reach target points accurately and effectively which is good. In addition, the existence of fighter aircraft owned by a country as a supporting weapon in defense and utilization in the development of guided missile components creates anti-aircraft missiles that have rocket-based boosters that are useful for shortening the time to reach the target.

Keywords: *Aircraft, Active Sensor Working System, Missile*

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1 Introduction

With the development of the times, technology is also developing rapidly. This makes human life activities easier, such as the field of technology, which has always experienced rapid advances in the field of aviation. Now, we can feel the advancement of aviation technology.

The invention of airplanes has a significant historical impact, one of which is in the context of its use for peaceful or military purposes. In the short time after its discovery, the aircraft had reduced distances between regions and even opened up the possibility of space flight. More than that, the aircraft that carried humans became the beginning of space exploration. At the national level, security and defense are important factors in demonstrating the strength of a country. Fighter aircraft are an example of how a country shows its capabilities and qualities, especially in the era of modern technology like today (Harpini et al., 2017).

With the advancement of the times, the demand for sensors in the industry has grown significantly, sensors and transducers are a vital part of the automatic regulation system.

The national air defense system (sishanudnas) is a structure that is arranged within the framework of national security defense, involving all elements of air defense capabilities to integrate and continuously face all forms of air threats. In carrying out air defense operations, the sishanudnas adopts the layout of the main tools of the weapon system (alutsista) which includes air defense areas, terminals, and points, this approach allows for the effective and efficient implementation of air defense to protect vital opiates.

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One of the important elements in the *sisshanudnas* is ground-based and air-to-air missiles, both medium-range and short-range, which play a key role in air defense operations. Medium-range surface-to-air missiles are used for terminal air defense, while short-range surface-to-air missiles are used for point air defense, therefore, the existence of surface-to-air missiles is very important to stabilize the deployment pattern of defense equipment that is being applied (Priyono et al., 2011).

2 Research Methodology

This study adopts a qualitative methodological approach. Data and information were obtained through a literature review process from various current and relevant sources, which were then presented in this study in a narrative manner. The researcher used a literature analysis method using the word "Aircraft, Active sensors, Missiles". Literature studies involve reviewing previous research journals, which are then evaluated. Findings and analyses were obtained through the collection of information from various references, including reviews of relevant journals (Putri et al., 2022).

Bernoulli's Law has various applications in life, one of which is on airplanes. As with Bernoulli's law, where the flow velocity is highest, the pressure is the lowest. Resulting in less air pressure on the wing than under the wing. This difference in pressure will result in an upward thrust on the aircraft. The formula for the upward thrust force on an airplane is:

$$F_2 - F_1 = \frac{1}{2} \rho (v_1^2 - v_2^2) \cdot A$$

Information:

ρ	= air density kg/m^3
v_1	= airspeed at the top of the aircraft m/s
v_2	= airspeed at the bottom of the aircraft m/s
$F_2 - F_1$	= Aircraft lift (N)
P_1	= air pressure at the top of the wing (Pa)
P_2	= air pressure at the bottom of the wing (Pa)
A	= total cross-sectional area of the wing (m^2)

So, in order for an aircraft to fly upwards, the upward thrust must be greater than the mass of the aircraft $F_1 - F_2 > mg$ (Rahma et al., 2024).

3 Results and Discussion

An airplane is a type of aircraft that has fixed wings and an engine to move itself. The aircraft has a greater weight than air, and is capable of flying autonomously. Although the term "aircraft" or "aircraft" is often used in general terms to refer to aerial vehicles, in aviation, the term "aircraft" refers more specifically to aircraft with fixed wings and engines, although the term "aircraft" includes both aircraft and helicopters (Saroinsong et al., 2018).

Missiles are generally long cylindrical with a pointed tip, the pointed end serves to reduce air resistance, while the circular cross-sectional shape provides optimal strength, this is because the pressure load circular shape becomes evenly distributed so that it produces optimal strength. A missile is a weapon that is launched towards a target point through the flight stage. In general, to obtain a short time to reach the target point, anti-aircraft missiles have rocket-based thrusters. Broadly speaking, the device has its own propellant material and also aims to cause destruction and damage at a specified target point. Guided missiles are created with the aim of air-to-air, surface-to-air, or surface-to-surface. Inside the missile there is a warhead, control system, propulsion system, and surface control (Agustian et al., 2021) The propulsion system is an important part of a missile because it has the function of providing enough thrust to bring the missile to the target point (Nurahman et al., 2023). Missiles use various propulsion systems such as rockets, ramjets, scramjets, turbojets, and turbofans (Agustian, E.S. et al., 2021).

Missiles have a wide range, high target accuracy, and are not easily shifted by the enemy, making many countries worried and trying to develop weapons to repel air attacks, especially missiles. Many countries are developing their missile capabilities to destroy enemies. The first is the missile from Russia, with the most advanced air defense system in the world, has the S-400 missile which is currently the most advanced weapon. Russia began developing the S-400 air-to-air defense system program in the 1980s, and experienced some delays, with the system being put into service by Russia's armed forces in 2007. This missile is considered the most advanced in its class. Its extraordinary capabilities have caused concern in many countries about Russia's advances in weaponry. The S-400 missile is capable of detecting opponents up to 600 km, and its missiles are capable of intercepting targets at a distance of 400 km. The S-400 can also simultaneously target up to 300 targets. In addition, the S-400 is the only missile in the world that is able to hit targets beyond the horizon and is well protected from electronic warfare, the S-400 is considered quite competitive and desired by various defense forces (Ngabekti., 2017).

Generally, the type of missile can be classified based on its range. There are several types of missiles, namely:

- a. Tactical missiles: These missiles tend to have a range that usually tends to be short, which is as small as 300 km. These missiles are usually used to attack targets close to the vicinity of military territory as well as to destroy special and small targets.
- b. Medium-range missile: Has a range ranging from 1,000 to 5,500 km. These missiles are used to attack target points that are farther away, such as military facilities in neighboring areas or outside the sending country's territory.
- c. Long-range missile: Has a range of more than 5,500 km. This missile is used when attacking target points that are located at a long distance, such as other countries or countries that are targets around the world.
- d. Ballistic missiles: These missiles can be classified based on their range, but they can also be grouped based on the type of movement. The ballistic missile launches upwards using a rocket and after that slides down at high speed to the targeted target point (Nurahman et al., 2023).

One of the components that supports the missile working system is sensors. Sensors are components used in detecting changes in a physical quantity such as pressure, force, electrical signals, light, movement, humidity, temperature, speed, and other natural phenomena. Then there is a change, the detected input will be changed to an output that can be understood by everyone, either through the sensor device itself or transmitted electronically through the network to be displayed or processed into useful information for the user. Sensors in general are included in the input transducer category because they are able to turn physical energy such as light, pressure, motion, temperature, and other physical energy into electrical signals or resistance, which can be converted back into voltage or electrical signals (Wicaksono, F.M., 2019).

Sensors are a very important component in the anti-aircraft missile work system. Sensors have the ability to detect events in physics or chemistry and convert them into electrical signals, be it in the form of current or voltage (Kamelia et al., 2017) Sensors used in guided missiles can usually be grouped into two categories, namely passive sensors and active sensors.

The type of active sensor is a sensor that requires an external power source in order to operate. The physical properties of active sensors vary in the same direction as the external effects they provide. This type of active sensor sends energy pulses and detects changes in the return signal. Most active sensors operate on the microwave portion of the electromagnetic spectrum, which makes them able to penetrate the atmosphere in most conditions. The type of active sensor can also be called an automatic generator sensor (Eko Susetyo Yulianto et al., 2023).

Meanwhile, the passive type of sensor is a sensor that can produce an output signal without the need for an external electricity supply (Widharma, I.G.S., 2020).

Sensors are a vital part of a missile, the performance of sensors to collect information regarding object detection is essential in electronics and instrumentation technology.

The types of sensors used in anti-aircraft missiles include:

- a. Infrared sensors, also known as phototransistors, function to detect voltage changes by using infrared signals. As we know, this sensor consists of two main components, namely a transmitter to transmit an infrared signal and a receiver to receive the signal (Bahtiar et al., 2019) Infrared is a sensor that is very suitable for measuring distances by using signals reflected from the transmitter to estimate distances (Yunardi., 2017).
- b. There is also a radar that functions to detect and track threats inside the missile. Resolution is one of the key parameters in choosing radar for missile defense. Radar resolution refers to the ability of radar to distinguish between adjacent or separated objects with a very small distance. To detect and track targets such as Multiple Independently targetable Re-entry Vehicle (MIRV).

Good resolution capabilities allow the radar to distinguish between adjacent targets with a high degree of accuracy, allowing missile defense systems to identify and target each warhead individually. This is important to optimize the effectiveness of missile defense systems in the face of complex threats such as MIRVs. In addition, the high resolution of the radar also helps in reducing the possibility of false attacks or electronic jamming aimed at deceiving the missile defense system (Fontana, S., et al., 2022).

Missiles on sensors are divided into two, namely passive radar and active radar. Passive radar is an electronic device that is in charge of receiving electromagnetic waves from the surrounding environment to detect the presence of a target without transmitting electromagnetic waves itself. In its operation, passive radar uses electromagnetic wave signals emitted by the target and is captured using a receiver separate from the transmitter (Anova et al., 2019). Meanwhile, active radar is a radar that uses RF waves emitted towards the target and then captures the reflection of the waves to determine the position and distance of the target to the radar. Compared to passive radar, which only receives waves emitted by other sources, active radar requires the generation of its own waves. Because of this, active radars tend to be more complex and expensive to manufacture (Ramdani et al., 2021).

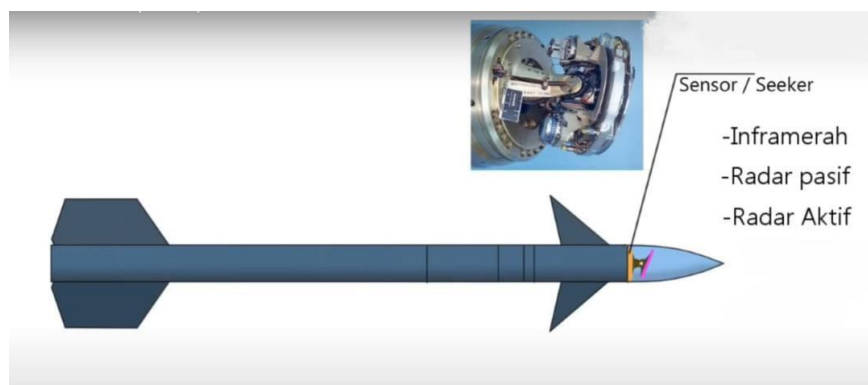


Figure 1 Types of Sensors on Missiles

In addition, there are also several components that determine the success and effectiveness of the weapon system. Some of the important components in a missile include:

- a. Missile/Rocket: It is the main part of the missile, useful in carrying the warhead and generating thrust to carry the missile to the target point.
- b. Control System: It is a system used to control the movement of missiles during launch so that they can direct the missile right to the target. Usually this system has sensors to find out the location of the missile, a system on the computer in processing data, and an error system in changing the direction of the missile launch.
- c. Navigation System: Able to provide information related to the location and direction of the missile while in the air. These parts of the system are GPS, inertial techniques, and other positioning techniques.

- d. Communication System: Useful in providing information between air and ground missiles, aircraft or submarines carrying missiles.
- e. Fuel and Propulsion System: This is an important part of the missile because it is useful in providing sufficient thrust when bringing the missile to the target.
- f. Thermal Shield: This part is useful as a shield for missiles by the heat caused by the discharge in the air and when crossing the atmosphere.

The components as a whole are assembled with great care and precision in order to ensure that the missile hits the target with the right accuracy and effectiveness (Nurahman, A., et al., 2023).

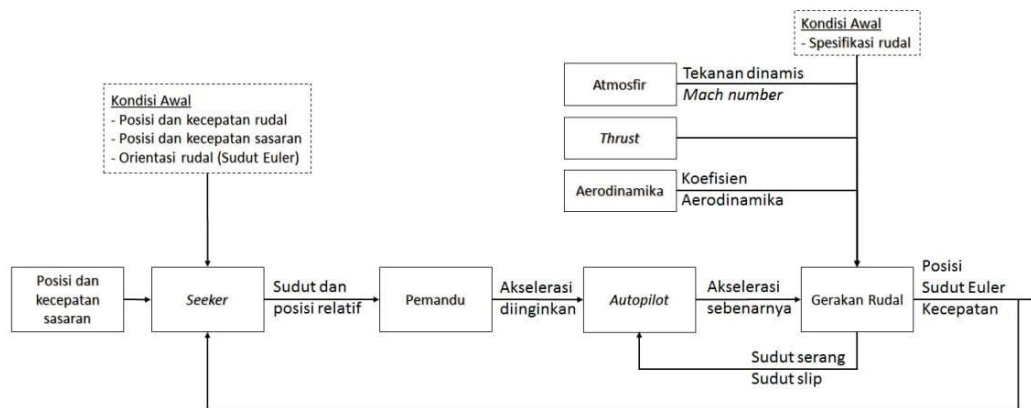


Figure 2. Flow Diagram of the Working Mechanism of the Missile

In its development, there is radar technology (radio detection and promoganda) which is usually used in detecting aircraft that may cross the territorial boundaries of a country. However, along with the advancement of radar technology, the effectiveness of radar when conducting security surveillance in the airspace area of a country is broken by the power of stealth aircraft technology (Stealth Fighter). Stealth aircraft is the result of technological developments in the field of military weapons, currently the ability of stealth aircraft itself is not limited to its ability to deceive radar (Hutabarat, J. P., 2016). With this technology, it has further triggered arms competition between developed countries, especially the United States, Russia, France, the United Kingdom, and China, where these developed countries compete in obtaining a level of technological superiority (Nugroho, L., 2008).

4 Conclusion

Guided missiles or commonly referred to as missiles are tools used by a country for the defense and security of a country. Anti-aircraft missiles have rocket-based boosters that are useful for shortening the time to reach the target point. The weapon technology has a high level of accuracy in hitting targets and a wide range so that it triggers competition between countries in developing the technology in the development of the sophistication level of this weapon technology, several types of guided missiles are obtained that are classified based on their mileage in reaching the target.

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