JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Gyroscopic Sensor-Based Helipad Stabilization System

Mr. K. Rushendra Babu
Assistant Professor, *Dept. of ECE*
Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru
AP–521356, India
rushendrababu.k@gmail.com

Bonthu Sai Snehith
Dept. of ECE
Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru
AP–521356, India
saisnehithbonthu@gmail.com

Bethu Yoga Lakshmi Nithya
Dept. of ECE
Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru
AP–521356, India
nithya57544@gmail.com

Amboji pravallika
Dept. of ECE
Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru
AP–521356, India
pravallikaamboju@gmail.com

Chebrolu Loka Sravani
Dept. of ECE
Seshadri Rao Gudlavalleru Engineering College, Gudlavalleru
AP–521356, India
sravanichebrolu@gmail.com

***Abstract*—Our pioneering work focused on the development of a gyroscope sensor-based helipad stabilization system specifically designed for ship carriers, especially in harsh weather conditions such as strong winds and high waves. Conventional helipads on ships at sea are often weatherproof, compromising the safety of the crew and the integrity of the aircraft. Our solution includes the integration of the MPU-6050 3-axis gyroscope sensor placed on the helipad to actively track ship movements in real time. This information is processed quickly, allowing the system to respond to changes and provide a stable landing point for the helicopter. Unlike traditional methods, our responses are dynamic and adaptable to the unpredictable nature of the marine environment. The system uses Arduino UNO for control and data processing. Our gyroscope sensor-based helipad stabilization system features dynamic sensor integration, robust construction to withstand harsh sea conditions, and emergency response mechanisms. We propose the creation of a helipad stabilization system based on gyroscopic sensors that prioritizes the safety of the helicopter and passengers. The system can be adapted to different ship types, providing versatility and potential for a variety of applications in different areas of the sea.**

Keywords*— *MPU-6050 3-axis gyroscope sensor, ship carriers, safety of personnel and aircraft, helipad stabilization, dynamic sensor integration, Real- time Monitoring, harsh weather conditions, Efficiency, adaptable, Arduino UNO

I. Introduction

Our project focuses on the development of a gyro sensor-based helipad stabilization system specifically designed for maritime companies in harsh offshore environments with severe weather conditions such as strong winds and large waves. Traditional ship-based heliports often face limitations in ensuring safety and security, posing risks to personnel and aircraft. To solve these problems, our system incorporates advanced gyro sensors, specifically the MPU-6050 3-axis gyro sensor, to track the movement of the ship over time and provide feedback output at the helipad.

The main purpose of our system is to ensure continuous monitoring of the ship's movement and timely adjustment of the direction of the helipad. By integrating gyroscope sensors into the helipad model, we ensure that the system is fast and responsive to changes in the ship's position. This dynamic response mechanism ensures that the helipad remains stable and level, providing a safe landing platform for helicopters even in the roughest seas. However, unlike the static security system, the change and change of our body makes it more vulnerable to the expectations of the marine environment. This response is necessary to improve the safety and performance of the onboard high-performance helicopter, reduce risk and ensure operational efficiency. Central to the operation of our system is the use of the Arduino UNO microcontroller, which acts as a central control center for processing data and operations. Arduino UNO facilitates seamless communication between gyroscope sensors and control systems, allowing instant data analysis and precise adjustments to ensure helipad safety.

In addition to its real-time monitoring feature, our machine is designed with a robust structure that can withstand the harsh conditions of the sea. This performance ensures long-term reliability, providing a consistent and safe operating environment for helicopter operations. Our system also includes an emergency response system designed to respond to unforeseen emergencies that occur during helicopter operations. This additional security system increases the overall safety and security of onboard operations by ensuring the safety of the crew and passengers. Our proposed gyro sensor-based helipad stabilization system represents a significant advance in maritime safety technology, offering a versatile and adaptable solution for many ship types and marine uses. Based on the importance of safety and security, we have the ability to change the operation of coastal helicopters and open new possibilities for safe and profitable maritime transportation and reconnaissance operations.

II. TERATURE REVIEW

Helipad stabilization techniques traditionally used in maritime operations reveal various shortcomings when faced with the challenges posed by the harsh marine environment:

1) Limited Adaptability: Traditional helipad stabilization system is its lack of ability to adapt to the movements of ships at sea. These systems often rely on static assumptions and may not account for rapid changes in the ship's pitch, yaw and roll.

2) Heavy Slow response time: The security system reacts slowly to changes in the fleet. Such delays can cause instability and increase the risk of crashes during takeoff and landing. The inability to react quickly to dynamic ship movements is a significant limitation often encountered in conventional systems.

3) Maintenance Challenges: Fixed systems always require regular maintenance and testing to ensure they are working properly. This maintenance can be difficult and time-consuming, especially in remote coastal areas or harsh environments.

4) Limited Security Features: Safety features are essential to ensure the safety of crew and passengers in the event of an emergency or unexpected incident.

5) Cost and complexity: Using traditional helipad stabilization methods would be expensive and complex. The cost and complexity of traditional systems can be prohibitive, especially for small ships or operators with limited resources.

III. PROPOSED SYSTEM

This paper introduces gyroscope sensor-based helipad stabilization system to solve the problems faced by traditional helipads on ships at sea, especially in cloudy weather, hurricane-like winds and large waves. The system includes an advanced MPU-6050 3-axis gyro sensor positioned on the helipad to quickly track the ship. Using the Arduino UNO microcontroller to store this information allows the system to quickly and accurately adjust the orientation of the helipad to provide a safe landing platform for the helicopter.

One of the fundamental characteristics of our body is motor coordination, which allows it to adapt to the unpredictable nature of the marine environment. Unlike traditional solutions based on static solutions, our system responds instantly to changes in the ship's position, maintaining stability and safety at all times.

It is equipped with an automatic stabilization system that will allow the helipad to accelerate in an emergency. These features increase the safety of helicopter operations on ship helipads, providing operators and crew with peace of mind. Additionally, the system is designed to adapt to different types of ships, making it suitable for a variety of maritime applications.

The hardware components used implementation of the Green Sward Cutter are listed in the table 1.

TABLE I. COMPONENTS AND THEIR SPECIFICATIONS USED IN THE STABILIZATION SYSTEM

S. No.	Components used	Specification	Count
1	Arduino UNO	Atmega328p controller	1
2	3-axis Gyro Sensor	MPU-6050	1
3	Servo Motor	Sg90	4
4	DC battery	12V	1
5	Voltage Regulator	IC 7805	1
6	Arduino IDE	Software tool with version 1.18.9	-

The hardware components used in implementation of this helipad stabilization system are described below.

A. Arduino UNO Module

Arduino UNO modules are frequently used as microcontroller boards and are known for their efficiency and ease of use in electronic projects. It is based on the ATmega328P microcontroller and has 14 input/output pins and 6 analog inputs, 6 of which can be used as PWM outputs. The operating voltage is 5V, the typical and preferred input voltage range is 7 to 12V, and the upper limit is 6 to 20V. Features include a power jack, 16 MHz ceramic resonator, reset button, ICSP header, and USB connector. The Arduino UNO module provides comprehensive instructions for both beginners and advanced users. Its features include 32 KB flash memory, 2 KB SRAM and 1 KB EEPROM, allowing it to perform many tasks. Whether used for prototyping, educational purposes, or building complex electronics, the Arduino Uno's size (68.6 mm x 53.4 mm) and light weight have contributed to its popularity among manufacturers.

Fig. 1. Arduino UNO Module

B. 3-Axis Gyro Sensor

Tri-axis gyro sensors are an important measurement tool that measures rotation in three vertical directions: pitch (X-axis), roll (Y-axis), and yaw (Z-axis). The sensor is important in many applications, from stabilizing drones and cameras to power-based controls on smartphones and game consoles. Its ability to make accurate and fast measurements makes it useful in navigation systems, robotics, and vehicle control. 3-axis gyroscope sensors have characteristics such as the measurement range of an axis (e.g., ±2000 degrees per second), sensitivity (e.g., 16,384 LSBs per degree per second), and noise rate (e.g., ±2000 degrees per second). . For example, the square root per second is 0.01 degrees per hertz).

These sensors typically communicate with a microcontroller or other device via an interface such as I2C or SPI, providing digital results for operation. They may also have a temperature sensor, self-monitoring and energy-saving mode. The sensor's compact size, low power consumption and microcontroller compatibility make it versatile and can be incorporated into a variety of electronic devices to improve their functionality and performance. Its high-precision and instantaneous information is very useful for many applications and increases efficiency and user experience.

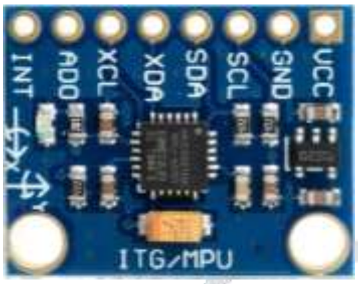

Fig. 2. 3-axis Gyro Sensor

C. Servo Motor

Measuring approximately 23 mm x 12.2 mm x 29 mm, the SG90 servo motor is a popular choice among hobbyists and professionals due to its compact size, lightweight design and affordable price. It operates at 4.8V to 6V, delivers power from 1.5 to 2.5 kg/cm and rotates in approximately 0.1 seconds per 60 degrees. It is controlled by PWM signal and provides approximately 180 degrees of rotation, making it suitable for many applications requiring precision and control. The plastic array and housing of the SG90 servo motor make it robust and reliable in many locations. It is compatible with most microcontrollers and control boards, simplifying project integration, and its wide availability makes it easy to choose for many. Whether used in robotics, remote-controlled vehicles or other automation projects, SG90 servo motors offer a versatile and reliable solution for motion control in confined spaces.

Fig. 3. Servo Motor

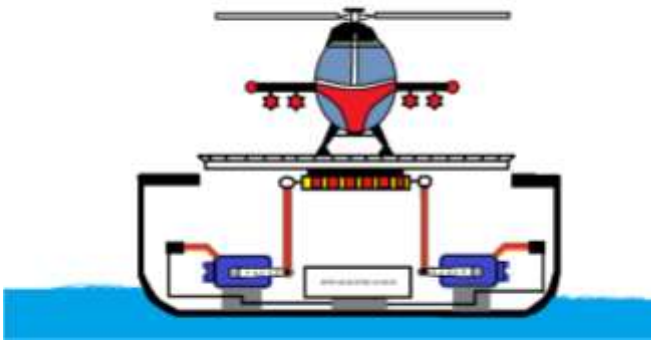

Fig. 4. Model design of the proposed system

The design describes the design of a three-axis gyroscope sensor-based helipad stabilization system designed for marine vessels. The system integrates advanced gyro sensors, servo motors and Arduino UNO microcontrollers to proactively monitor and stabilize the helipad in real time. The design visually shows the layout and connection of key components, showing how the system detects the movement of the ship and adjusts the orientation of the helipad to provide a stable platform for the operating helicopter. The model works as a map of the physical use of the body, guiding the placement and integration of products to achieve optimal performance and reliability.

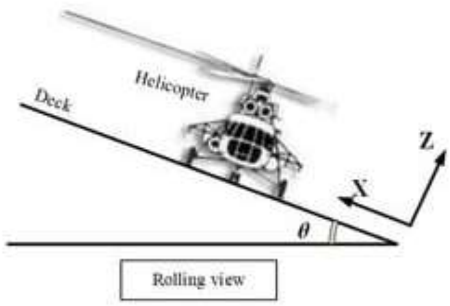

Fig.5. Rolling view

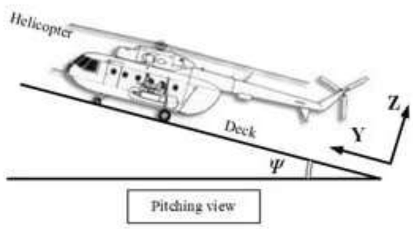

Fig. 6. Pitching view

In our project, we are utilizing the MPU-6050 3-axis gyro sensor, focusing on its X-axis for roll and Y-axis for pitch measurements, omitting the Z-axis for yaw. The MPU-6050 gyro sensor integrates a 3-axis MEMS (Microelectromechanical Systems) accelerometer and a 3-axis MEMS gyroscope on a single chip, providing accurate angular velocity data along these axes. By monitoring the X-axis for roll (sideways tilting) and the Y-axis for pitch (forward and backward tilting), we can precisely track the ship's orientation and motion. This data is crucial for stabilizing the helipad during challenging weather conditions on ship carriers. The MPU-6050's digital motion processing capabilities, including built-in 16-bit analog-to-digital converters and digital low-pass filters, enable us to obtain reliable sensor data for our stabilization system. By utilizing only the roll and pitch axes of the MPU-6050 gyro sensor, we can design a more efficient and targeted control algorithm for our Gyroscopic Sensor-Based Helipad Stabilization System. This approach enhances the system's effectiveness, ensuring safe and stable helicopter operations on ship carriers.

IV. RESULTS

The results of proposed gyro sensor based helipad stabilization system are as shown in below figures.

Fig. 7. Helipad Stabilization System

The system essentially uses an Arduino UNO microcontroller to time the movement of the ship. The MPU-6050 gyro sensor and servo motor are used to adjust the orientation of the helipad. It also includes a breadboard and connecting cables for safe integration to ensure that even in a competitive maritime environment the electrical equipment guarantees continuous operation, providing reliability to all products, improving the safety and efficiency of the ship's operation as a helicopter and demonstrating the ability to stabilize the helipad in adverse conditions.

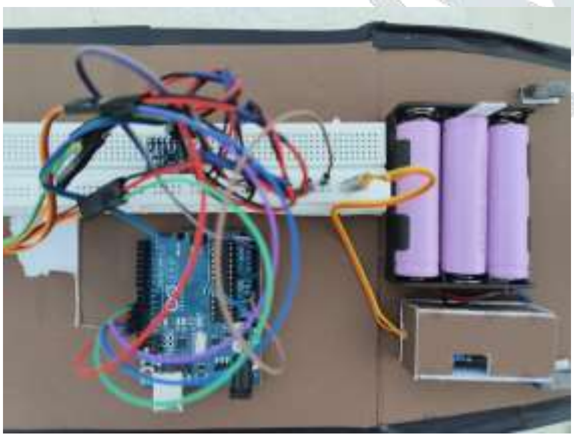

Fig. 8. Breadboard Connections

V. FUTURE SCOPE

The safety and efficiency of using helicopters on ships in coastal operations is essential. Our gyro sensor-based helipad stabilization system represents a significant advance in overcoming these challenges, but the potential for further development and expansion is enormous. Looking ahead, one of the most important areas of future development is the integration of technology to improve resources. By combining higher resolution gyroscopes and accelerometers, we can improve the body's ability to detect and respond to ship motion more accurately and precisely. This not only improves the overall performance of the system, but also increases its reliability in the competitive offshore environment.

Additionally, the integration of machine learning algorithms has an exciting opportunity to improve the performance of the system. Machine learning can improve the system's ability to predict and respond to ship movements in real time by enabling the system to learn from historical data and adjust its strategies accordingly. This ability to adapt will make the body more efficient and effective, especially in a dynamic and unpredictable environment.

The future of our project includes researching wireless communications that will assist in remote monitoring and control systems. By integrating wireless communications, employees can monitor physical activity and make adjustments as needed without physically accessing the system. This not only increases the usability of the system, but also makes the system easy and flexible in various operating scenarios.

Another path for future development is to integrate autonomous navigation capabilities into the system. We can increase its safety and efficiency by ensuring that the system can adjust the direction of the helipad according to the ship's departure time and the environment. This will lead to more coordinated and efficient operation of helicopters on ships, especially in difficult weather conditions or during critical operations.

Also research on the use of advanced management strategies such as strategic management models can improve performance and organizational performance. Using predictive modeling technology, the system can predict the future movement of the ship and attempt to adjust the orientation of the helipad to ensure stability. This sustainable approach can increase operational efficiency, especially in a dynamic and rapidly changing environment.

VI. CONCLUSION

In conclusion, our gyroscope-based helipad stabilization system represents a significant advance in improving the safety and efficiency of helicopter operations on cargo ships. The system is capable of monitoring and stabilizing the helipad in real time based on data on the ship's movements, especially in difficult weather conditions. But there is a lot of room for improvement and further development. An important area of future development is the integration of advanced technology to increase accuracy and performance. Higher resolution gyroscopes and accelerometers improve the body's ability to detect and respond to motion more accurately, improving overall performance and reliability. Additionally, the integration of machine learning algorithms allows the system to adjust and optimize its strategy based on real-time data, further increasing its benefits.

In addition, research into the integration of wireless communications can realize remote monitoring and physical control, improve usability and be easily replaced. This will allow operators to manage the system remotely from shore or other locations, increasing efficiency and flexibility. Additionally, the system can benefit from integrated navigation capabilities that allow the helipad to adjust its orientation based on the environment and activity study. These improvements can increase the safety, reliability and efficiency of maritime helicopter operations.

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