A Review of Collision Avoidance System in Commercial Aircrafts

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Abstract— Airplanes are one of the quickest, safest, and essential mode of transport. The broad spectrum of uses for airplanes includes recreation, transportation of goods and people, military, and research. Aircrafts have many systems implemented which ensures safety of aircraft, to avoid midair collisions amongst each other. One of such popular system is known as Traffic Collision avoidance system (TCAS). Despite such systems collisions are recorded on ground which causes damage to wingtips of the plane. These leads to develop a system for avoiding ground collisions which is known as Ground Collision Avoidance system (GCAS). The system includes installation of sensor at right feasible location in Airplane model and designing routing to integrate it with existing system of the airplane. Designing and Development of this system would bring a huge impact in aviation industry by reducing number of collisions during taxiing.

Index Terms- TCAS, taxiing, Wiring Harness, Sensors

I. INTRODUCTION

Airplanes are one of the quickest, safest, and essential modes of transport. The broad spectrum of uses for airplanes includes recreation, transportation of goods and people, military, and research. Aircrafts have many systems implemented which ensures safety of aircraft, to avoid midair collisions amongst each other. One of such popular systems is known as Traffic Collision avoidance system (TCAS).

The aim of the project is to develop a system for avoiding ground collisions which is known as Ground Collision Avoidance system (GCAS). The system includes installation of sensors at the right feasible location in the Airplane model and designing routing to integrate it with the existing system of the airplane. Performing analysis of the bracket which is used to hold the sensor and performing simulation of working of sensor.

II. EXISTING SYSTEM

TCAS stands for Traffic Collision Avoidance System, also sometimes referred to as Airborne Collision Avoidance System (ACAS). TCAS works on Secondary surveillance Radar (SSR). SSR is a crucial system that works together with ground-based radars and transponders on airplanes to give TCAS the information it needs. Ground radars send out radio waves that bounce off airplanes equipped with SSR transponders. These transponders then respond with a coded message containing the aircraft's identification, altitude, and sometimes even speed. By receiving and interpreting this data from nearby aircraft, TCAS can build a real-time picture of the surrounding airspace and identify potential collision threats. SSR provides the essential information it needs to function and keep pilots informed of potential dangers.

Despite the TCAS like system, many incidents are reported of ground aircraft collisions during taxiing against another aircraft, stairs, Cargo handling, Buses, Maintenance, and repair equipment. Some of the recent Aircraft collisions are:

1. Air India and Indigo: This incident was reported on 27th March 2024 where the wings of both planes crashed against each other while taxiing which caused huge damage to wingtips of both the planes.
2. A330-200(Air France) and A330-300(Delta Airlines): On 31 October 2018, the planes collided against each other while preparing to take off, which resulted in damage to the APU system which caused a huge loss and planes were immediately sent to the inspection bay.
3. A321, Daegu South Korea, 2006: On 21 February 2006, an Airbus A321-200 being operated by China Eastern failed to follow the marked taxiway centreline when taxiing for departure in normal

daylight visibility and a wing tip impacted an adjacent building causing minor damage building and aircraft.

These incidents were reported due to lacking of system in aircraft which avoids ground collisions as the TCAS system gets deactivated as soon as the airplane's landing gear hits the ground. This rises an opportunity for to design and develop a system which avoids such incidents which can be named as Ground Collision Avoidance system (GCAS).

III. LITRATURE REVIEW

To Support the evidence of above-mentioned problem the topics considered for Literature survey were TCAS, Electrical Routings and harness, Designing of brackets, Types of sensors, Sensors in automotive vehicles. The summary of the reference papers referred are mentioned below.

The below discussion encompasses on the Traffic Alert and Collision Avoidance System (TCAS), crucial for averting mid-air collisions.[1] TCAS development was very crucial in the field of aviation as it details the technical intricacies and operational procedures for pilots, emphasizing its reliance on secondary surveillance radar (SSR) transponders. It also helps in enhancements of safety in Aviation industry.[2] TCAS is also solution designed for low-altitude flights, proposing modifications and new algorithms tailored to address the challenges of flying at lower altitudes.[3] TCAS also evaluates operational performance within the U.S. National Airspace, likely including comprehensive assessments of its effectiveness in real-world scenarios, such as alerts, pilot responses, and collision avoidance outcomes, offering insights into its reliability and efficiency in preventing mid-air collisions in the U.S. airspace.

It is also important to highlight on the topic related to electrical wiring of the paper which is necessary to understand the existing wiring system to understand how to develop a new system to avoid ground collisions.

There is a well-known methodology aimed at automating the three-dimensional routing of aircraft electrical wiring interconnection systems (EWIS). It outlines a systematic approach to optimize wiring paths within aircraft structures, leveraging advanced algorithms and computational techniques. By automating this traditionally manual task, the methodology promises to enhance efficiency, reduce errors, and potentially decrease manufacturing costs in the aerospace industry. It provides technical insights into the methodology's implementation and its potential benefits for aircraft manufacturers and operators, marking a significant advancement in the optimization of aircraft EWIS routing processes.[4]

The overview of the topic is to focus on innovative approaches to aircraft system installation and integration during the conceptual design phase. [5] explores novel bracket design concepts aimed at enhancing overall aircraft performance by streamlining the installation process of aircraft systems. It emphasizes aspects such as material selection, structural integrity, and weight optimization. By introducing innovative bracket designs which contributes to ongoing efforts in aircraft engineering to develop more efficient and reliable installation solutions, potentially leading to advancements in aerospace manufacturing and maintenance practices. [6] This topic also centers on the application of parametric 3D modelling techniques to facilitate the integration of aircraft systems during conceptual design. This approach utilizes advanced software tools to create dynamic parametric models capable of adjusting to changes in system configurations and design requirements. By employing parametric modelling, it would be easy to streamline the integration process, optimize system layouts, and enhance overall design efficiency. This represents significant contributions that can be in the field of aircraft design, which offers innovative solutions to improve installation processes and system integration in aircraft design.

A decision support methodology is supposed to be designed to prevent dynamic conflicts on taxiways and runways. It likely utilizes real-time data analysis to identify potential conflicts between aircraft movements and offers proactive solutions. By integrating advanced algorithms, the methodology aims to enhance airport safety and efficiency during taxiing and runway operations.[7]

It is necessary to assesses runway accident hazards in the various countries aviation sector. It likely will support aviation industry investigate various factors contributing to runway accidents, such as runway conditions, air traffic control procedures, and pilot training. The study may offer recommendations to mitigate these hazards and improve runway safety within the aviation sector, potentially contributing to enhanced aviation safety standards and practices.[8]

Exploring the safety systems already implemented in Autonomous vehicles which introduces advanced collision avoidance systems tailored for different vehicles. [9] This would add an idea to present an automated anti-collision system designed for automobiles, likely employing advanced sensors and algorithms to detect potential collision risks and trigger preventative actions such as automatic braking or steering adjustments. It emphasizes the system's potential benefits for improving road safety. [10] It is also necessary to learn about a LIDAR obstacle warning and avoidance system customized for unmanned aircraft. This system likely utilizes LIDAR technology to detect obstacles in the flight path of unmanned aircraft, employing advanced algorithms to analyze data and trigger avoidance maneuvers for safe flight operations. [11] This also explores the application of LiDAR sensors in autonomous vehicles, focusing on how LiDAR technology enables environmental perception, obstacle detection, and navigation in self-driving cars. It offers insights into the technical aspects and integration of LiDAR with other sensor technologies in autonomous vehicle systems.

CONCLUSION

The comprehensive review underscores the importance of interdisciplinary research and technological innovation in advancing safety and efficiency across the aviation and automotive sectors. This literature survey provides valuable insights across aviation and automotive fields, crucial for developing a ground collision avoidance system aimed at minimizing accidents during taxiing.

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