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Advanced Navigation Control Systems

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***Abstract*— Compared to the other major modes of transportation aircraft is the fastest mode till now with few challenges. The major and important challenge is the safety of passengers. A small mistake regarding safety operations in aviation leads to demise of passengers and crew. In recent times and in history many flights had gone missing and highjacked. Even the information about some of the flights were unknown till now. We even had a history about the airlines that pay-off a huge indemnity for an air crash. Various navigation systems are present with the advanced navigation techniques from GPS to satellite navigation with many limitations. There are even many safety considerations and advanced techniques that are in effect for the safety of passengers but the plane crashes had not been nullified. There is a need to improve the safety procedures and navigation systems for the safety of flights. This paper presents the information about the safe navigation systems that enables the safe flight. These methods and techniques are suggested based on the research and analysis of various missing flights and flight crashes. Using these navigation systems, highjack, flight crashes, missing flights can be reduced to a great extent. By incorporating these methods and systems on board, flight will be safer.**

Keywords—Aviation; Analysis; Communication; Navigation system; On-board; Safety

I. INTRODUCTION

There are many flight accidents through ages due to the failure of navigation systems. In fact, as a count there were nearly 2,000 flights had been crashed killing nearly 30,000 people involving various jets and airplanes. After some plane crashes in ages, there were many modifications in the safety systems and made air travel safer. Some crashes made airplane navigation systems and structure more reliable, safer and brought out many safety regulations and advanced technologies.

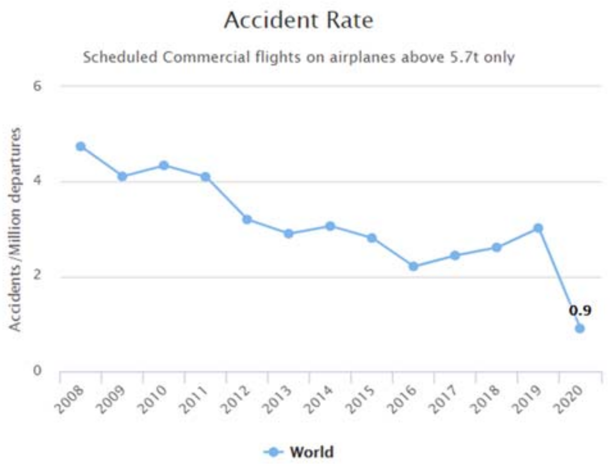

Fig 1. Flight Accidents per million Departures

Some of them are

In 1956 the clash of United Airlines Douglas DC-7 and Lockheed L-1049 had resulted in the death of 128 passengers the midair. This flight accident had resulted in the implementation of air traffic control system (ATC) between two airports and collision-avoidance systems. This crash had even resulted in the creation of Federal Aviation Agency (FAA) to monitor air safety in 1958.

In 1978, United Flight 173 crashed on the runway due to the failure of landing gear and shortage of fuel. Flight engineer had informed about the situation to the pilot but ended up with a crash due to the inability of the pilot decision skills. This had resulted in the advancement of cockpit training procedures.

Delta Flight 191, a Lockheed L-1011, approached for landing and resulted in the crash due to lighting on the airplane. This crash ended in on-board forward-searching radar wind-shear detectors that have become well-known system on airliners withinside the mid-1990s.

Likewise,

TABLE 1: Advanced navigation systems from air crash

Year	**Flight**	**Reason for crash**	**Advancement**
1983	Air Canada 797	Fire in passengers' cabin	Flame-resistant interior materials
1985	Delta Flight 191	microburst wind shear	on-board forward-looking radar wind-shear detectors
1989	United Airlines flight 232	Engine failure	Engine safety improvements
1988	Aloha Airlines Flight 243	corrosion and widespread fatigue damage	Retiring tin
1994	US Air Flight 427	Failure in the movement of rudder	Rudder Rx
1996	ValuJet Flight 592	fire	Making smoke detectors and automatic fire extinguishers mandatory.
2009	Air France 447	Reason not found (mystery)	Manual training to fix over-dependence on automation
2014	Malaysia Airlines 370	Reason not found (mystery)	Suggested methods
2018	Lion Air 610 and Ethiopian Airlines 302	Flight control problems	Suggested methods

II. Review Of Literature

Vlada Sokolovic et.al This paper suggested the usage of magnetometer and accelerometers for gyroscopes drift estimation. Developed a specific method of gyroscope drift compensation by PI controller. Error compensation in the navigation system by using adaptive control signals and analysis of the results for the proposed solutions had been analyzed.

Vsevolod Peysakhovich et.al The aviation domain can benefit from the growth and progress of eye-tracking technology to further reduce the rate of incidents. This paper provides four important steps for the mixing of eye-monitoring structures into cockpits. These steps were ordered in the order of their implementation, thus retracing the vector of the eye-tracking integration process into the cockpits. If this is used wisely, the eye-tracking technology can facilitate and boost up pilot training, facilitate the exploration of in-flight incidents and substantially decorate flight safety. This work can also be useful for other domains such as automobile, air traffic control and command and control centers.

Igor Schagaev et.al This paper suggests the set of parameters for the safety of passengers. These include monitoring of safety on extremely reliable and real time decision-making system. In critical conditions of flights this approach enables to accumulate experience and operates accordingly best ever known algorithms and hardware. Fault tolerant hardware of on-boards safety system has to have mean time to failure (MTTF) figures higher than airplane itself in the whole circle of application. Aircraft safety system for airplane are extraordinarily vital and critical, and as should be designed as an energetic proactive device, to manipulate protection in actual time of flight. To obtain this a completely dependable device of flight statistics collecting, recording and processing needs to be designed and developed. Real time flight statistics processing, and response in actual time of flight are truly crucial capabilities of this device.

Richard clewley et.al Pilots are not always able to recognize events and this often leads to undesirable pilot behavior. Using categorization theory, stable lexicon is established to understand how pilots recognize and respond to flight safety events. The idea of event prototypes and analyzed the cognitive benefits and costs of knowledge structures is extended. The framework also accounts for vital occasional variety, describing both the typical and familiar, and troubling divergence far from reference concepts.

III. Description Of Problem And Proposed Solution

Today, in this advance technology; there are several missing and crashes of the flights due to failure of some systems and highjacks. These failures result in loss of human lives. The major suspects are:

- ✓ Failure of navigation system
- ✓ Hijacking of flight path
- ✓ Malfunction of communication system

So, this paper proposes the theoretical solution methods that can be implemented in the aircrafts for reducing the suspected problems.

IV. Implementation Methods

The suggested implementation methods are

- ✓ Flight recorder
- ✓ Live portal down feed link from flight recorder (black box)
- ✓ Introduction Introducing standby navigation control system (SNCS)
- ✓ Satnav in aviation and flight control
- ✓ Introducing “counter autopilot control system for base approach guidance

4.1. FLIGHT RECORDER (BLACK BOX)

Flight recorder consists of cockpit voice recorder (CVR) and flight data recorder (FDR). It consists of Self-installed beacon system which will give location identification and pulse signals for 30 days, when the aircraft crashes. This pulse can be identified only when the depth is less than 13,123 feet. With the advancement in flight data recorder (FDR), the pulse rate is increased from 30 days to 60 days which will help for future search and rescue. When the recorder is immersed in water it transmits an acoustical sign on 37.5KHz that may be detected with a unique device. A self-propelling device is also inserted in the Blackbox which propels the Blackbox to a surface. As the beacon transmits the signals, it will be ease to find the Blackbox for the rescue team. Since this is in-built with aircraft empennage, it’s hard to find FDR without finding the aircraft.

4.2. EMERGENCY LIVE PORTAL LINK TO FLIGHT RECORDER

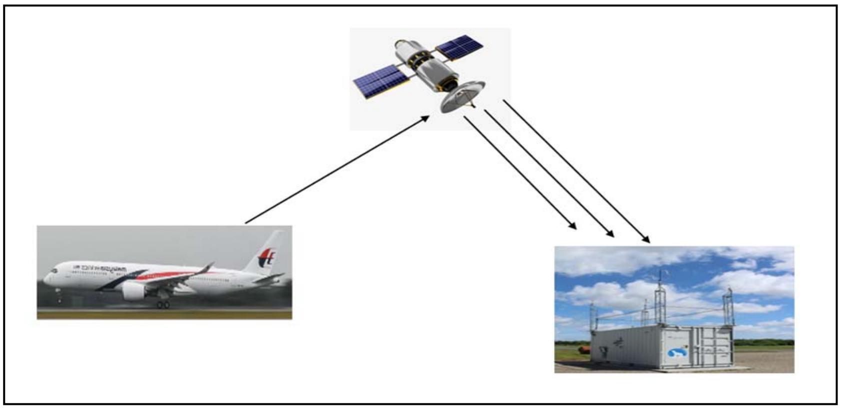

Fig 2. Emergency live portal link to flight recorder procedure

Emergency live portal is the direct contact of the airplane with the ground station in case of any emergency. It can be operated as required, based on the situation like when there is no contact or communication failure(emergency).

4.2.1 *Advantages and functions of emergency live portal*

- ✓ Can be used before the aircraft gets into the crash, so that we can prevent the failure or major damages.
- ✓ Cannot be interrupted on flight (maintenance or any other activities can be performed only when aircraft on – ground).
- ✓ Accessing to this panel may be prohibited by third line security systems.
- ✓ Since the maintenance panel are placed under the belly or empennage section of the aircraft, no human interruption can be performed during flight is impossible. So, this becomes the most secured flight recorder.
- ✓ Listening to the cockpit interactions is possible during hijack.

4.3. STANDBY NAVIGATION CONTROL SYSTEM

Because of navigation failure the pilots cannot understand the basic guidance of the flight. These sncs can help as the secondary navigation for providing the co – ordinates for the nearby airports.

Fig 3. Standby navigation control system

It acts as a secondary auto pilot system with pre-defined co – ordinates fed into navigation computers. The coordinates of nearby airports or runways can be registered automatically through this device. Standby navigation control system is engaged through the satellite support or by flight crew also.

4.4. SATNAV

Satnav is used when there is a communication failure (no response) from the ground station. Standby navigation control system is the base for satnav system, where further landing sequence can be initiated. When there is no response from flight crew, someone should engage the landing sequence, which is highly impossible. By operating the satnav, we can change the course of the flight with the help of standby navigation control system (by pre-defining different co-ordinates for landing) and landing can be done by CAT III -C landing. CAT III-C landing can be performed by the satellite navigation(satnav) without the help of pilots or crew members.

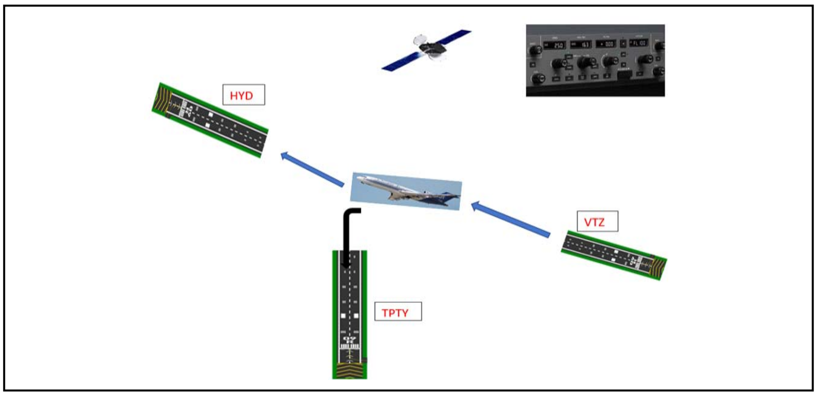

Fig 4. Implementation of SATNAV

4.5. COUNTER AUTOPILOT

An autopilot is a flight control system that enables a pilot to fly an airplane without continuous hand. It allows the pilot to focus on higher –order tasks navigation, communication with air traffic control. Moreover, any human interference can engage this autopilot by knowing the co – ordinates required for flying. It can also be done by flight crew or hijackers.

When the Standby navigation control system or satnav is engaged any human can able to disengage this system, in order to avoid this counter auto pilot should be introduced. Since this gets into third line protection device, the aircraft may be secured without difficulty despite the fact that there's a hijacker on board. No external interference is appreciated on this system. At that time the ground can take the controls of the flight when the pilots are not able to take over the flight. The counter autopilot can be engaged by the ground station through satellite and it can't be disengaged except the person who is operating from the ground. Once the counter autopilot is engaged the cockpit door will be locked (for the safety of pax) at the time of hijack.

Since it is digitalized, it is easy to change and control the aircraft from the ground and heading direction of the flight. It can perform CAT IIIC landing automatically with the command system from the ground control unit.

4.6. Over All Advantages

- ✓ As aviation looks for safety of passengers, these systems can provide them a secured flight with zero worries.
- ✓ Hijack, misguidance and lack of response from flight can be reduced to a greater extent and the risk of flight can be minimized.
- ✓ Investigation can be speedy in case when the aircraft is overlooked or long past invisible. We can able to listen to the conversation happens inside the flight deck which can further provide more clarity.
- ✓ Landing sequence can be initiated without any human interference.
- ✓ Safe landing is possible as the rate of 97%.

4.7. Disadvantages

- ✓ These methods are cost effective.
- ✓ Modifications need to done on aircrafts which is upcoming and also already in the field.

- ✓ All the airports must be capable of performing cat iii c landing.
- ✓ First stage of maintenance cost is expensive.
- ✓ Usually, satellite systems are involved which are high end projects.
- ✓ Basic training program should be provided for every airline company and to the pilots.

V. CONCLUSION

This paper presents the information of 5 safety navigation techniques. If these safety navigation techniques are implemented the flight accident mysteries will be resolved easily and provides the safe flight to the passengers. These techniques will even navigate the flight in case of any invisible flights or highjacks.

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