

## FLIGHT DYNAMICS AND CONTROL OF FLIGHT VEHICLES

# Analysis of Emergency Situations Arising from the Interaction of Air and Ground Vehicles

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Received April 12, 2021; revised June 14, 2021; accepted October 29, 2021

**Abstract**—The paper considers the problem of collisions between flight and ground vehicles at the airport. The statistics of such incidents at Russian and foreign airports is systematized. Collisions are classified according to the level of danger of their consequences.

**DOI:** 10.3103/S1068799821040280

**Keywords:** risk, factor, emergency, collision.

## INTRODUCTION

According to information of the Federal Air Transport Agency [1], since 2006 there is an increase in accidents with aircraft of general aviation.

General aviation is the civil aviation not used for commercial air transportation and aerial work [1].

In total, in the period 2006–2015, 169 aviation accidents occurred with general aviation aircraft, including 98 crashes, in which 192 people died (Fig. 1) [1].

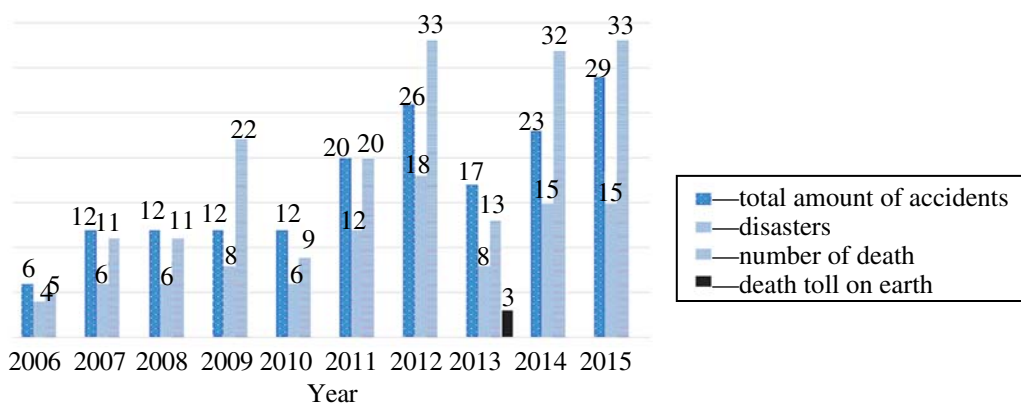


Fig. 1.

Causes of accidents with aircraft of general purpose aviation in 2006–2015 are systematized in Fig. 2 [1].

According to the data in Figs. 1 and 2, accidents involving air transport occur not only in the air, but also on the ground. Moreover, such events can often occur during the interaction of air vehicles (AV) and ground vehicles (GV) at the airport area [2–10].

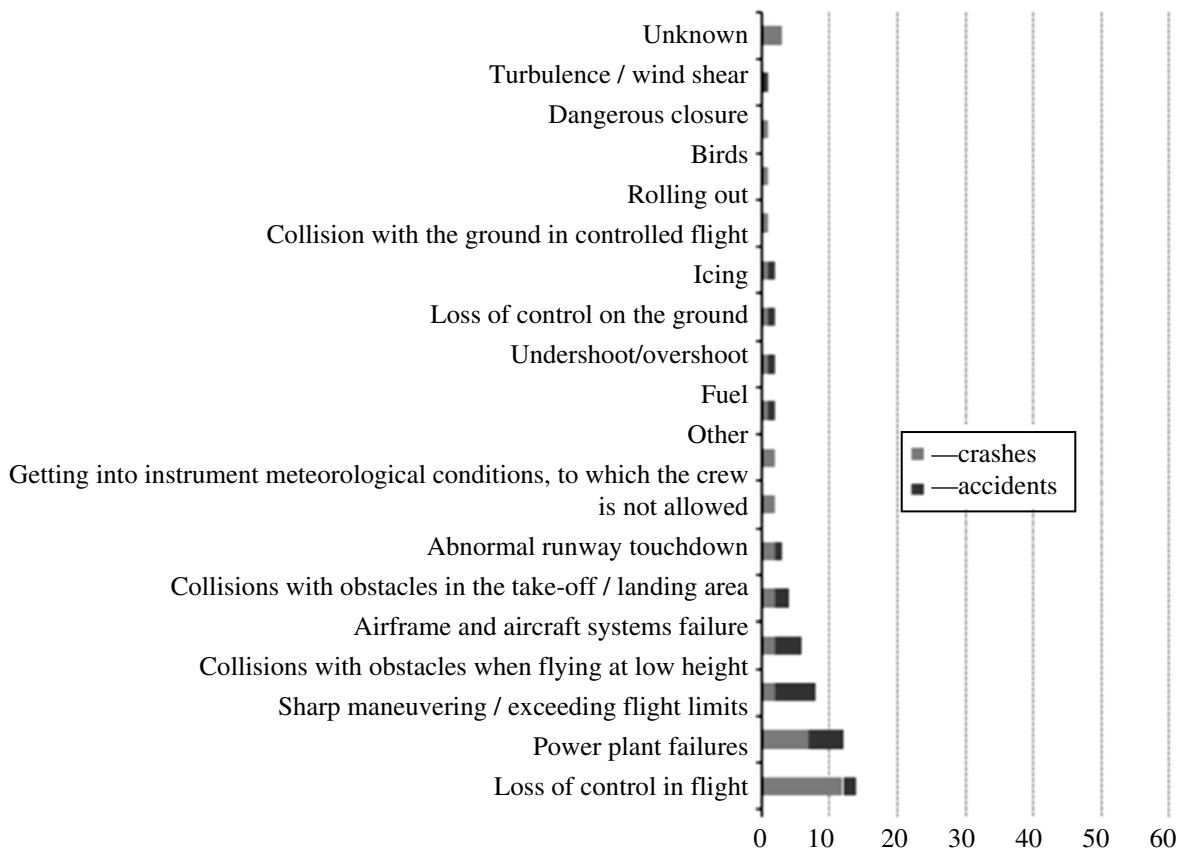


Fig. 2.

An example of such events is the collision of a ground vehicle (special vehicle—rotary snow blower SUPRA-5001) and an air vehicle (passenger plane—Falcon 50EX) on the runway of Vnukovo airport, which occurred on October 20, 2014.

The cause of the plane crash was the departure of a special vehicle to the runway in front of the aircraft taking off [11]. The scheme of the collision of the special vehicle and the passenger plane is shown in Fig. 3 [11]. Here: 1—the spot, where the airplane right main landing gear collided with the engine hood of the special purpose vehicle; 2—the spot, where the airplane right wing collided with the cab roof of the special purpose vehicle; 3—the spot, where the airplane right wing collided with the loading chute of the special purpose vehicle.

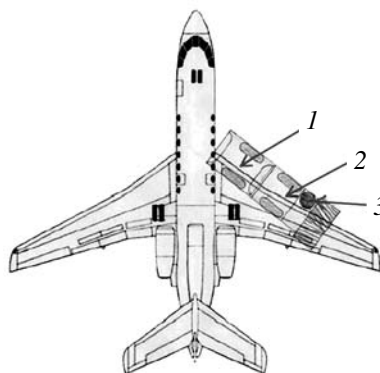


Fig. 3.

Data on emergency situations in the period 2010–2020 that occurred during the interaction of air and ground vehicles at the airports of the Russian Federation [12] are systematized in Table 1.

**Table 1**

Incident	Year, airport	Consequences
The refueling vehicle collided with the Airbus A321 passenger plane in a remote parking lot	2020, Sheremetevo airport (Moscow)	The plane and the refueller were damaged. Further operation of the GV and AV is possible after the repair work. There are no casualties. The airport operation was not disrupted
The tractor collided with the Airbus A320 passenger aircraft, which was preparing to take off	2019, Voronezh airport	The aircraft left engine was damaged. Further operation of the AV is possible after repair work. There are no casualties. The airport operation was partially disrupted (the departure of a number of flights was postponed for several hours)
The snow blower collided with the Falcon 50 EX passenger aircraft, which was in a takeoff run	2014, Vnukovo airport (Moscow)	Four people on board the aircraft were killed. The plane was completely destroyed. The airport operation was disrupted for several hours
The truck was carrying luggage and collided with the passenger Airbus A319 aircraft	2014, Magadan airport	The plane was damaged. Further operation of the AV is possible after the repair work. There are no casualties. The airport operation was partially disrupted (the departure of a number of flights was postponed for several hours)
The tractor collided with the Airbus A320 passenger aircraft, which was preparing to take off	2014, Domodedovo airport (Moscow)	The aircraft skin was damage. Further operation of the AV is possible after the repair work. There are no casualties. The airport operation was partially disrupted (the departure of a number of flights was postponed for several hours)
The loader while maneuvering collided with the Airbus A320 passenger airplane	2014, Kol'tsovo airport (Ekaterinburg)	The plane did not receive any visible damage and continued flying after inspection. There are no casualties. The operation of the airport was not disrupted
The airstairs truck collided with the Boeing 737-800 passenger aircraft while installing the airstairs	2013, Norilsk airport	The plane suffered damage to the window. Further operation of the air vehicle is possible after the repair work. There are no casualties. The airport operation was not disrupted
The passenger car collided with the Yak-42 passenger plane	2011, Pulkovo airport (St. Petersburg)	The aircraft skin was damage. Further operation of the AV is possible after the repair work. There are no casualties. The airport operation was not disrupted

Collisions between ground and air vehicles are not a problem of Russian airports only; this problem is also relevant for airports in other countries of the world. Data on some incidents of this kind are systematized in Table 2.

**Table 2**

Incidents	Year, airport	Consequences
The water transport vehicle collided with an Airbus A320neo passenger plane that was preparing to take off	2021, Gdansk airport (Poland)	The aircraft and the GV were damaged. Further operation of the AV and GV is possible after repair work. There were no casualties. The airport operation was partially disrupted (the departure of a number of flights was postponed for several hours)

**Table 2** (Contd.)

Incidents	Year, airport	Consequences
Airbus A320 aircraft collided with the airport company car when taxiing to the runway	2017, Alicante airport, (Spain)	The plane right engine was damaged. Further operation of the AV is possible after the repair work. The ground vehicle suffered a significant damage. There were no casualties. The airport operation was partially disrupted (the departure of a number of flights was postponed for several hours)
The airport service van collided with the Airbus A330 passenger plane on the runway during preparing to take off	2016, Hong Kong airport (China)	The aircraft left engine was damaged. Further operation of the AV is possible after the repair work. The GV was completely destroyed. The GV driver was injured. The airport operation was partially disrupted (the departure of a number of flights was postponed for several hours)
The aviation security vehicle collided with the Airbus A320 passenger plane on the runway, which was being serviced at that time	2015, King Abdulaziz International airport (Jeddah, Saudi Arabia)	The aircraft right engine was damaged. Further operation of the AV is possible after the repair work. The GV was completely destroyed. The GV driver was injured. The airport operation was partially disrupted (the departure of a number of flights was postponed for several hours)
The aircraft Boeing B737-300 during takeoff collided with the airport company car on the runway	2007, Henri Coanda airport (Bucharest, Romania)	The plane and the ground vehicle were completely destroyed. Several people were injured. The airport operation was disrupted within a few hours

Air and ground vehicle collisions can be categorized as follows. The first (highest) category is the category, which includes collisions that led to the death of people and the destruction of vehicles. The second category is the category, which includes collisions that resulted in damage to vehicles.

Considering the data given in Tables 1 and 2, we can conclude that from all the incidents described, a collision of the first category of danger took place at the Henri Coanda and Vnukovo airports, in all other cases, there were collisions of the second category.

## CONCLUSIONS

During the study, data were collected on more than fifty collisions of air and ground vehicles that occurred in the period 2000–2021 at airports of different countries of the world, which allows us to conclude that there is a systemic problem of accidents involving air and ground vehicles at airports as well as the need to develop new science-based solutions aimed at ensuring traffic safety at the airport.

The development of an integrated technical computer vision system based on artificial intelligence and the Internet of machines (IoT) [13–15] that implements the function of monitoring blind spots and informing the aircraft pilot and GV operator about the start of movement of nearby vehicles and movement parameters (speed, distance, etc.), can be an option for solving the problem of collisions between AV and GV.

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