UDC 629.7.07

N.A.Salo (Flight academy of the National Aviation University, Ukraine)
A.V. Zemlyanskiy (Flight academy of the National Aviation University,Ukraine)

Runway incursion warning system model for ATC tower simulator

The area of responsibility of ATC at the aerodrome is usually the maneuvering zone. The maintenance at the apron is usually done by the apron activity service. While the creation of a separate apron activity service body is the norm in some countries, the task of organizing such service befalls to ATC in others.

The responsibility for the operations at the aerodrome can be divided into 5 groups, each of which has different functions: aerodrome management, organizing apron activity, ATC, pilots and drivers of vehicles.

The personnel controlling and using the ground movement control system equipment bears a certain responsibility for its proper functioning; although operators may not bear responsibility for automated functions, the input data for which they do not possess.

The main responsibility for the tactical operation of the ground movement control system will be put on the air traffic controller within the system, which will include the following:

1.Control, provided by the system;

2.Routing, established by the competent authority in charge;

3.Detection of a conflict situation by the system and/or air traffic controller;

4.Resolving the conflict situation, including collaboration between the system, the air traffic controller, the pilot or driver of a vehicle.

ATC bodies control the movement of aircrafts and vehicles in the maneuvering zone, giving the priority to aircrafts.

In doing so the ATC bodies must use standard phraseology, procedures and language while maintaining radiotelephone communications. While in conditions of limited visibility, when the responsibility of preventing collisions on the ground overwhelms the capabilities of the ATC body, the air traffic controllers can reduce the number of aircraft and/or vehicle movements in the maneuvering zone.

In order for the ATC body to be able to carry out the aforementioned duties, the ground movement control system must be designed in such a way, so it at least provides help with preventing:

a)Runway and taxiway incursion by aircrafts and vehicles no matter the visibility conditions;

b) Collisions between:

1.Aircrafts in the maneuvering zone no matter the visibility conditions;

2.Aircrafts and vehicles in the maneuvering zone no matter the visibility conditions;

3.Aircrafts in the maneuvering zone and obstacles in it no matter the visibility conditions;

4.Vehicles in the maneuvering zone no matter the visibility conditions;

5.Vehicles in the maneuvering zone and obstacles in it no matter the visibility conditions.

Thus we can divide the task of the ground movement control into two subtasks, which require the creation of algorithms for their simulation:

- Runway incursion;
- Loss of minimum horizontal separation between aircrafts moving on the ground.

The runway incursion scenario is developed with the aim of determining the time needed by the monitoring system to give a warning about a potential incursion and preventing the aircraft from doing so (figure 1). The provided geometrical composition is relevant to airports, in which the runway holding point is located 75 meters from the runway centerline. Based on this scenario and the analysis of the sensitivity to change of precision, it was determined that a distance of 20 meters will provide enough time (with a certain tolerance) to detect an incursion and stop the aircraft before it reaches the runway. This conclusion is made while taking into consideration that the pilot is directly receiving the information about the conflict situation.

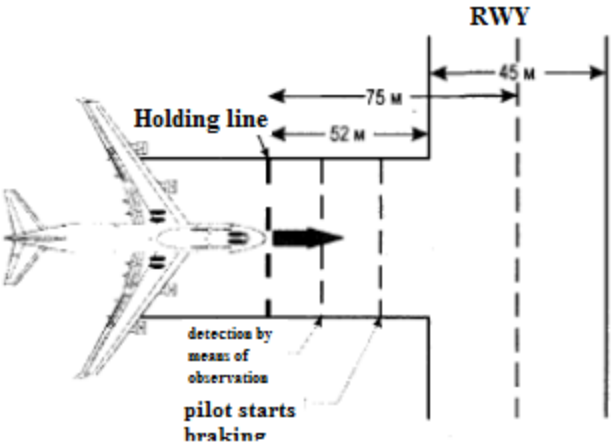

Fig. 1 Runway incursion warning

In the case when an air traffic controller must be warned about this and then he must give an instruction to the pilot, no matter the precision, all of this leads to an excessive delay and, as a result, the inability to prevent the runway incursion. Although in general the monitoring precision, corresponding to the distance of less than 20 meters, can substantially improve the system characteristics and provide more time to take the necessary measures to prevent the conflict situation.

Proceeding from the runway incursion warning algorithm we suggest using the following model for automated detection, and, if necessary, recording of such a violation. Four zones are built near the runway holding point, entering which could be considered as stages of incursion development (figure 2).

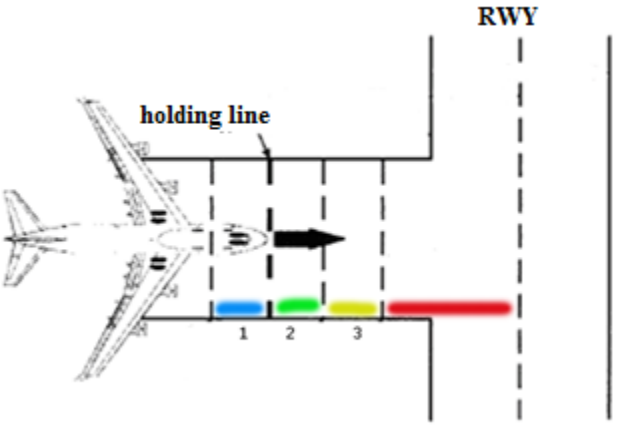

Fig. 2 Runway incursion warning

Let's look at these stages in detail:

1. The aircraft reaches the holding point. Along the movement direction of the aircraft we build a sector to determine the aircraft reaching the holding point. As soon as the aircraft enters this sector a report about reaching the holding point is simulated from the fight crew.
2. The aircraft is beginning to line up. This sector corresponds to a miniscule advance of the aircraft from the holding point to the runway. Such an advance can be seen as the beginning of a runway incursion, as well as the beginning of the lining up and/or commencing take off. In accordance with the classification of severity of consequences, an unauthorized entry to this zone is class C (incident, characterized by availability of sufficient time and/or sufficient distance, in order to avoid collision).
3. The aircraft continues moving to line up. This sector corresponds to such aircraft position, in which it can create an obstacle for a different aircraft, which is on the runway. In accordance with the classification of severity of consequences, an unauthorized entry to this zone is class B (incident, in which the separating distance is decreasing and a high probability of collision exists, as a result of which time sensitive correctional actions/maneuvers can be necessary).
4. The aircraft lines up on the runway. The aircraft enters the sector corresponding to the runway. In the case when this happens with ATC clearance, it means that the aircraft lined up on the runway and is ready for further taxiing or to commence take off. Unauthorized entry of this sector is class A (a serious incident, in which a collision almost took place). The development of this stage can be a go-around procedure for a landing aircraft, canceling take off or, as an extreme result – collision of aircrafts on the runway.