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Automated aircraft parking system

The proposed aircraft parking system, which is not currently used in practice, is based on the use of a device equipped with line sensors. This device will automate the docking process, thereby increasing its reliability and facilitate the work of the crew members.

The pilot of a civil aircraft (AC), especially a large one, cannot deliver the aircraft to the parking place by himself. Although the pilot has a large view from his cockpit, he cannot accurately steer the aircraft. Now parking the liner without assistance is not only not possible, but also strictly prohibited.

Currently, several systems of automatic visual positioning of aircraft are widely used in aviation (Stand guidance system), also called aircraft docking systems. They are devices that automatically provide information to the aircraft crew about its exact position when entering an airport parking lot.

A distinction is made between a visual docking guidance system (VDGS) and a visual docking guidance system (A-VDGS) [1].

Visual Docking Guidance Systems are classified into:

– Azimuth Guidance for Nose-In Stand (AGNIS), which is one of the most used tracking systems, consisting of two lines of colored lights installed side by side - while on centerline the pilot sees two green lights, and when moving from it, one of the lights will appear red to him;

– Parallax Aircraft Parking Aid (PAPA) is combined with the AGNIS system and informs the crew about the moment of stopping. The device contains no moving parts or electronics; it consists of a large gray box missing one or more edges with a large rectangular cutout in the front. To the observer, due to the phenomenon of parallax, it seems that a white pointer or reflective tube moves inside the box towards the rear as the viewing angle changes, although in fact it is fixed. Near the cutout there are special marks to determine the aircraft stopping point.

– Traffic light system with green and red signals, installed next to the AGNIS lights. The signals are usually round and installed vertically to avoid confusion with identical colored AGNIS square lights.

– Mirror. In combination with AGNIS, one or two mirrors are installed in the stands for extremely small aircraft, which allows the crew to see the ground markers relative to the aircraft nose strut in order to reach the stopping zone. Typically, two mirrors are used, mounted at different angles to accommodate different aircraft heights.

A-VDGS are subdivided into:

– Honeywell Advanced Visual Docking Guidance (HAVDG) which is non-contact. A video surveillance system with a built-in video sensor is used, which detects an arriving aircraft using a sensitive graphics processor and compares the resulting image with the aircraft images available in the 3D database. The docking controller processes the image and provides tracking parameters, which are displayed on a special display for pilots installed on the terminal, for stopping the aircraft in the parking lot near air terminal. All installed A-VDGS devices are connected to a central computer and, through it, to all other ground systems.

– The system displays the azimuth guide, providing the pilot with information starting from two hundred meters from the stand and until the moment of turning perpendicular to its center line. The device also provides data on the distance of approaching the stopping point, and generates a stop signal. The azimuth guide uses a laser beam to measure the distance to a stop. A laser with a pulse frequency of 9.6 kHz and a wavelength of 1 cm allows the aircraft to stop in the required position and does not depend on atmospheric conditions.

– The Safedock Safegate system provides 10 centimeter aircraft positioning accuracy using infrared lasers. The red and yellow arrows show the pilot the correct direction of maneuver to align the aircraft with the centerline. Also, the system has a variation that indicates the position of the aircraft relative to the center line. In both cases, the central band disappears as you approach the stop line [2-3].

As you can see, the vast majority of docking systems require continuous interaction with the aircraft pilot. The authors propose a system that will fully automate this process. For this, it is proposed to use light line sensors, which are widely used in various modern electronic devices. They are easy to operate, cheap and reliable.

The use of such sensors involves the application of special markings on the taxiway, as shown in Fig. 1. Lane markings shall be applied in a color that is most contrasting with the color of the runway and remains so in adverse weather conditions.

A retractable device with a strip of line sensors is installed on the aircraft landing gear, which has access to the landing gear control system. It is switched on by the pilot after the aircraft has landed when the aircraft is taxiing into the taxiway.

The device “captures” one of the lines drawn on the runway and guides the aircraft along it to the parking area.

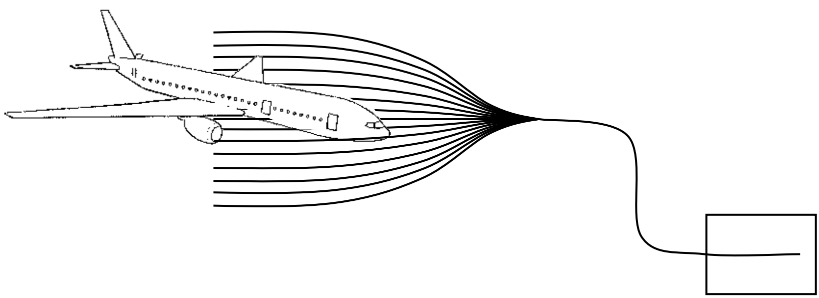

Figure 1. Scheme of aircraft docking marking

To take into account the error in calculating the position of the aircraft after landing, the number of lines is proposed to be selected approximately ten pieces.

We will show the principle of operation of the device using the example of installing six sensors on a strip (Fig. 2-4). The figure shows conditionally the sensors installed on the strip, as well as the parking line and their relative position.

If the middle two sensors "are seeing the line", then the plane is going forward (Fig. 2)

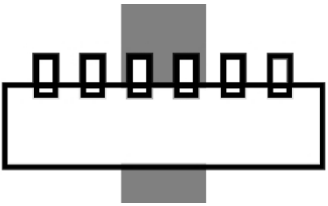

Fig. 2. Drive straight

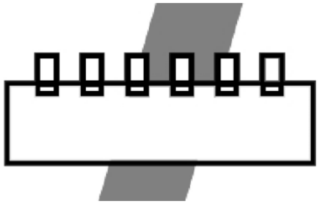

Fig. 3. Smooth turn

If another sensor, on the right or on the left, sees a line, then the plane smoothly turns to the right (or to the left, respectively) (Fig. 3).

If the center left (right) sensor stops identifying the line, then the plane turns more in the corresponding direction. (Fig. 4).

When the aircraft leaves the parking line for one reason or another (Fig. 5), its trajectory is stabilized by turning in the appropriate direction opposite to the direction of its rotation.

The aircraft turning speed depends on the speed of its movement along the taxiway and is selected as optimal depending on the aircraft type.

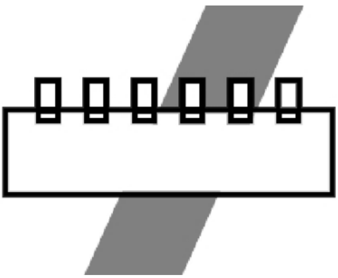

Fig. 4. Sharp turn

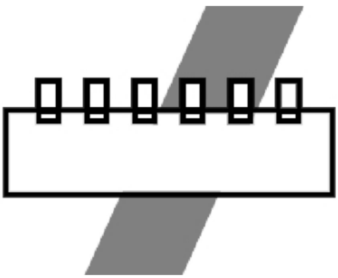

Fig. 5. Leaving the parking line

The more sensors are installed on the device, the more accurately it will guide the plane along the line to the parking spot. Choosing a specific number of them requires practical experimentation.

Thus, the aircraft parking system is fully automated and no human participation is required. Although, of course, the pilot of the aircraft at any stage will be able to turn off the proposed parking machine and take control.

Conclusions

The authors believe that the proposed system is very promising from the point of view of its simplicity, reliability, the possibility of refinement and improvement by installing more sensitive and reliable sensors, as well as improving the program code. The system is new and not yet implemented anywhere.

References

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