Airport Signs and Markings Recognition for Enhanced Runway Incursion Avoidance

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Motivation

A runway incursion is defined as any occurrence in the airport runway environment involving an aircraft, vehicle, person, or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing, or intending to land.[1] Multiple factors could contribute to runway incursion, including pilots' failure to accurately and swiftly recognize runway markings, pilots' multitasking while taxing, failure to comply with air traffic control's clearances, complexity of major airports and low visibility under adverse weather conditions. Situations are further exacerbated when pilots lose their situational awareness when they are fatigued, pressured, distracted or confused. Small general aviation airports are most susceptible to such situations where they are typically not equipped with ground radar as most major airports are to monitor aircrafts' operation on the airport ground.

Goals

Since prior efforts to prevent runway incursion are primarily focused on pilot education and airport ground control and therefore no assistive onboard devices are yet available to readily help pilots detect possible deviation from safe flight operations, we propose to develop an application to help pilots keep track of their locations by recognizing airport signs and markings and alert them when deviation from safe flight operations has been detected, which will be particularly beneficial with regard to runway incursion prevention in complex airports. The signs and markings that will be detected and recognized are hold position signs (taxiway, runway intersection, ILS critical area), locations signs (taxiway, runway), boundaries markings (runway safety area, ILS critical area, taxiway) and direction signs. Some examples from reference 2 & 3 are shown in figure 1. The application that we develop will be used to detect the following deviations.

1. Deviate from taxiway / runway center line
2. Taxi into closed runway / no-entry area
3. Cross movement-nonmovement boundary / ILS critical area boundary / runway hold short line w/o stop

Figure 1: Template Signs and Markings of Interest

Implementation

1. Develop methods incorporating denoising, sharpness enhancement, thresholding, segmentation, template matching that can accurately detect and recognize airport signs and markings on still images. Methods from reference 4 & 6 will be studied. Standard airport signs and markings from Federal Aviation Administration(FAA) publications[2,3] will be used as templates for detection and recognition. Still images with various resolutions, relative sizes of signs and markings, lighting conditions, noise levels and etc. will be used to test the robustness of the methods.

2. Implement logic criteria among a series of still images to determine if deviation from safe flight operation has occurred. For center line deviation detection, methods from reference 5 & 6 will be studied. Actual video frames from aircraft ground operations will be used to test the implementation since one of the team member is a licensed pilot.

3. Implement these methods on an **Android phone** to test the concept in real operation. The device will be carried on a small general aviation aircraft and it is expected to correctly recognize airport signs and markings, label them on the screen and alert pilots when deviation from safe flight operation has been detected. Contrary to common knowledge, it is acceptable to use mobile devices at airports. We will use Palo Alto Airport(KPAO) and Sacramento Executive Airport(KSAC) as our testing sites. A typical scenario that involves runway signs and markings detection to avoid runway incursion is shown in figure 2.

Figure 2: Real Airport Signs and Markings

References

1. Pilots Handbook of Aeronautical Knowledge, FAA-H-8083-25A, pp.13-18

2. Standards for Airport Markings, FAA AC 150/5340-1J

3. Standards for Airport Signs Systems, FAA AC 150/5340-18D

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