CES Final Report

Southern Illinois University

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Project Description

The precise detection of runways is crucial for safely landing aircrafts because more than half of the accidents occur during the final approach and landing stages [1,2]. Instrument landing systems which provide precise landing guidance are not available at all airports. The challenge, therefore, is to assist pilots using visual flight landing rules to detect runways accurately in varying weather conditions. The runway and horizon detection and enhancement approach introduced in this study is based on exploiting information from enhanced vision system (EVS) and synthetic vision system (SVS) images of the runways. The goal is to generate image frames that contain enhanced runway and surrounding information by fusing the EVS and SVS images. The resulting image frames can be incorporated into head-up displays (HUDs) to assist pilots in safely landing aircrafts.

Objectives

Develop a sequence of novel algorithms to safely land aircrafts by registering the runways in EVS and SVS images and fusing the registered images so that the information from both images can be displayed optimally.

Industrial Relevance

The techniques developed in this project will not only lead to the development of novel landing heads-up display systems but will also be applicable to a vast range of problems involving image registration and image fusion.

Project Outcomes

Successfully developed a novel procedure to accurately detect runways and horizons and also enhance surrounding runway areas by fusing EVS and SVS images. The primary focus was on fusing EVS and SVS images of the runway while an aircraft was in the final stages of landing. A registration procedure was introduced to align the EVS and SVS images prior to fusion. The most notable feature of the registration procedure was that it was guided by the information extracted from the weather-invariant SVS images. Four fusion rules based on combining DWT sub-bands were implemented and evaluated. The resulting procedure was tested on real EVS-SVS image pairs and also on image pairs containing simulated EVS

images with varying levels of turbulence. The subjective and objective evaluations revealed that the runways could be detected accurately even in poor visibility conditions due to severe levels of atmospheric turbulence. It was also demonstrated that different aspects of the EVS and SVS images can be emphasized by using different DWT based fusion rules. The modified rule was judged to yield the best fusion results for the problem under consideration. Another notable feature is that the entire procedure is autonomous throughout the landing sequence irrespective of the weather conditions. That is, the fixed parameters are set initially and the variable parameters are determined automatically from the image frames during operation. Given the excellent fusion results and the autonomous feature, it can be concluded that the fusion procedure developed is quite promising for incorporation into head-up displays (HUDs) to assist pilots in safely landing aircrafts in varying weather conditions. Furthermore, the procedure developed can be easily modified to fuse image pairs in different applications. The observations and results can also serve as a guide for selecting different fusion rules for a given application. Examples of registration and fusion results are shown below [1,2].

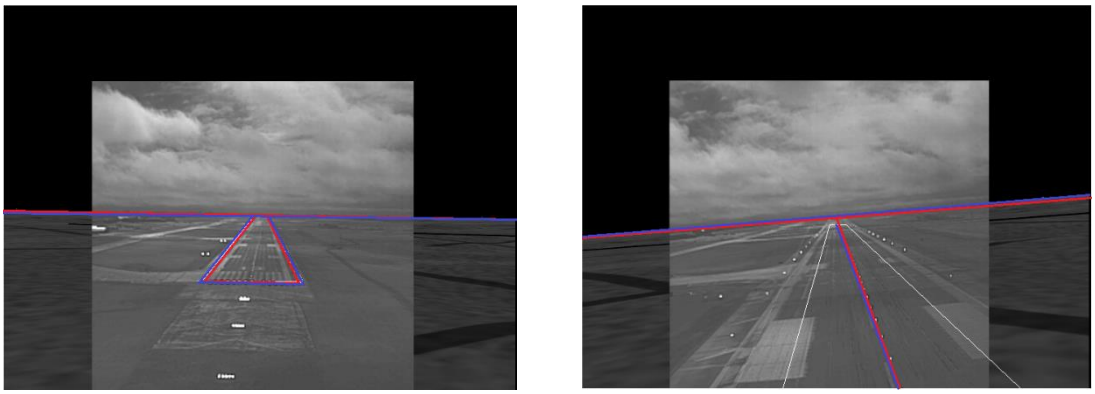

Fig. 1 Examples of EVS-SVS image fusion with registration

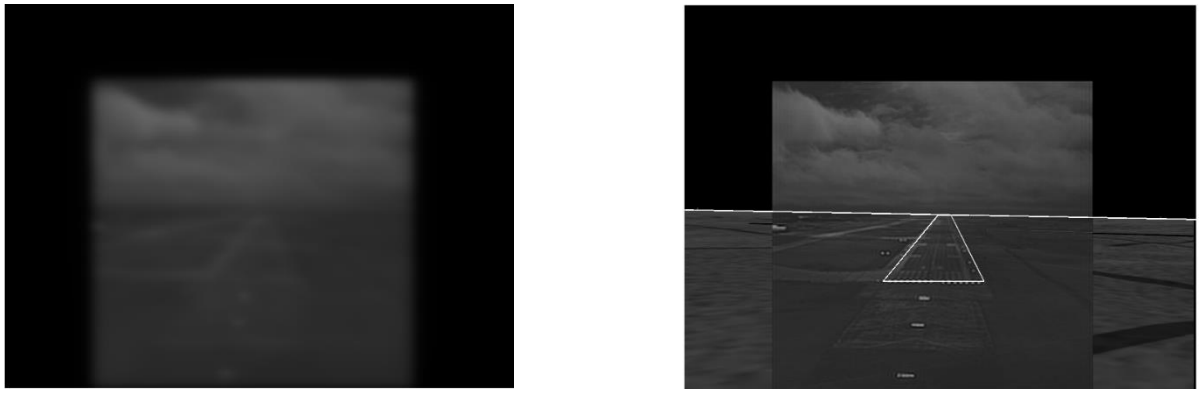

Fig. 2 Examples of EVS-SVS image fusion (high turbulence)

Research Team

Lalit Gupta is a Professor at SIU, Raghuveer Kanneganti and Ahmed Fadhil were Ph. D students while they were working on the project.

References

1. A. Fadhil, R. Kanneganti, L. Gupta, “Runway and Horizon Detection through Fusion of Enhanced Vision System and Synthetic Vision System Images” IPCV'14 - The 2014 International Conference on Image Processing, Computer Vision, and Pattern Recognition, Las Vegas, USA.
2. A. Fadhil, R. Kanneganti, L. Gupta, “Fusion of Enhanced Vision System and Synthetic Vision System Images for Runway and Horizon Detection, Submitted to Pattern Recognition Journal.