ROOM OCCUPANCY SENSING USING A THERMAL TRIPWIRE

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BOSTON UNIVERSITY

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Summary

The efficiency of HVAC (Heating Ventilation & Air Conditioning) systems can be improved by making them adaptive to the number of people in a room. Automatic adjustments to room ventilation and temperature based on room occupancy reduces energy use and is more cost efficient. In order to a estimate a room's occupancy level, the Occusense Senior Design team has created a reliable, thermal sensor system to capture the motion of people through doorways. We aim to develop a reliable, real-time algorithm to detect the direction of motion of people passing through in order to track the number of people in the room.

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1 Introduction

In modern efficient buildings, controlling the HVAC system preemptively can be a huge cost saver. Therefore, a senior design team at Boston University is working towards developing sensing technology and algorithms to count the number of people in a room so that the system is always conscious of room occupancy and can adjust system parameters, such as ventilation, accordingly before feedback sensing technology can detect abnormalities, such as rising temperatures of a crowded room. There are a number of ways to detect occupancy. However, this project assumes that if a room has a low number of entry points, counting people can be done at the entries based on who is entering or leaving the room. As such, there would be a continuous knowledge of the number of people in a room. The senior design team has implemented a privacy-inclined low resolution thermal sensor with a field of view of 30x120 positioned at the top of the door frame and looking perpendicularly down. It is capable of capturing a 16x4 pixel array at frame rates of 0.5 to 512 Hz. Using this information, our project is tasked at developing algorithms to count the number of people entering or leaving a room. Specifically, this algorithm will 1) detect the presence of a moving person in the frame and 2) determine the direction of motion.

2 Literature Review

Many background subtraction algorithms have been developed to detect changing pixels in a series of images. A brief review of the more common change detection algorithms can be found in [1]. The most successful amongst these incorporate a background model into the algorithm. The use of a model allows for thresholding of probabilities instead of pixel intensities and is therefore more robust to some variation in the background scene. In addition, foreground models can improve the sensitivity of the change detectors [2]. McHugh et al. suggested a foreground model algorithm that is more general as it is based on spatial neighborhoods. To further improve the discrimination, they also suggest a Markov model so that labels are more spatially coherent [3].

3 Problem Statement

And this is the first section of this chapter.

4 Implementation

4.1

Section goes here ...

5 Experimental Results

5.1 Another section

Section with a figure (Fig. 1).

6 Conclusions

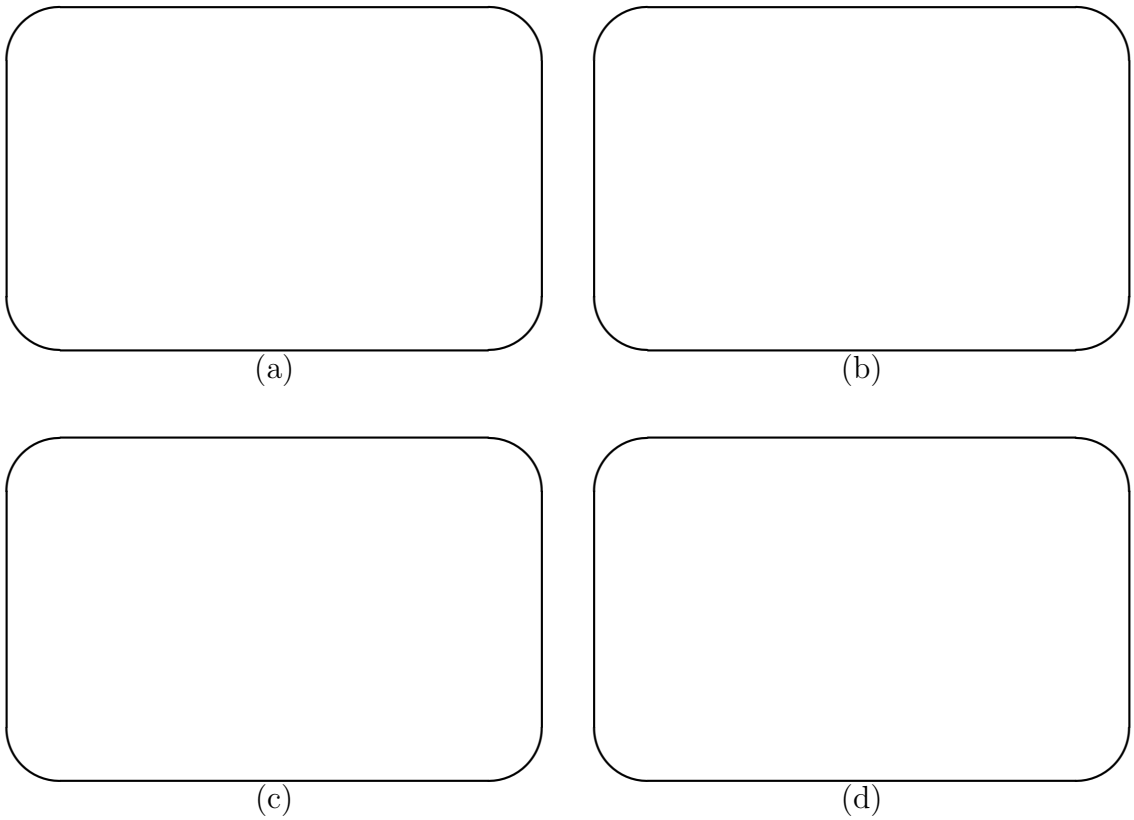

Figure 1: Block diagram: (a) one; (b) two; (c) three, and (d) four.

References

[1] N. Goyette, P. Jodoin, F. Porikli, J. Konrad, and P. Ishwar, "A Novel Video Dataset for Change Detection Benchmarking," *IEEE Transactions on Image Processing*, vol. 23, pp. 4663-79, Nov. 2014.

[2] A. Elgammal, R. Duraiswami, D. Harwood, and L. Davis, "Background and Foreground Modeling Using Nonparametric Kernel Density Estimation for Visual Surveillance," *Proceeding of the IEEE*, vol. 90, pp. 390-393, July 2002.

[3] J. McHugh, J. Konrad, V. Saligrama, and P. Jodoin, "Foreground-Adaptive Background Subtraction," *IEEE Signal Processing Letters*, vol. 16, pp. 390-393, May 2009.