Low-power motion detection and building control using computer vision
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1. Goals

Overview

◆ Abstract
  ▪ Current motion detectors that control lighting and building HVAC systems use passive infrared (PIR) sensors to detect the presence of a person in a room. However, PIR sensors cannot see small amounts of motion in a room and will turn the lights and HVAC system off on the occupants of a room who are sitting and working in the room. To remedy this problem I propose that a low-power computer vision system is used along with a PIR sensor to perform variable frame rate image differencing to detect the presence of people sitting and working in the room.

◆ Low-power, CMUcam4, PIR Sensor, inexpensive

2. System Overview

Big picture

◆ Theory of Operation
  ▪ PIR sensor detects motion
  ▪ Camera takes the difference between images
  ▪ Camera wakes up and takes another picture
  ▪ Camera averages the new image with the old
  ▪ Adjust sleep time inversely with image differences
  ▪ Turn lights off if no motion is detected

3. Approach

Details

◆ Goal
  ▪ Prove that an embedded computer vision system like the CMUcam4 can detect motion like a PIR sensor and consume power comparable to a PIR sensor. In the future, the computer vision system will be able to detect motion better than a PIR sensor.

Summary

◆ Comparable Power Consumption
  ▪ The CMUcam4 uses approximately 11.5 mA of current when motion is detected on average resulting in a power consumption of about 57.5 mW when powered by a 5V source. This is comparable to a standard PIR motion detector that uses 9.3 mA of current when motion is detected resulting in a power consumption of about 46.5 mW when powered by a 5V source.

◆ Effective Hysteresis Control
  ▪ After detecting motion the CMUcam4 will keep the lights on for about 1 minute and 30 seconds before turning the lights off. Any small amount of motion will retrigger the CMUcam4.

4. Results

Plots

◆ Setup
  ▪ PIR Sensor A – Tested for 20 seconds powered with 5V DC
  ▪ PIR Sensor B – Tested for 20 seconds powered with 5V DC
  ▪ CMUcam4 – Tested for 3 minutes powered with 5V DC

References