A WEARABLE PYROELECTRIC INFRARED (PIR) SENSOR SYSTEM FOR THERMAL SITUATION PERCEPTION

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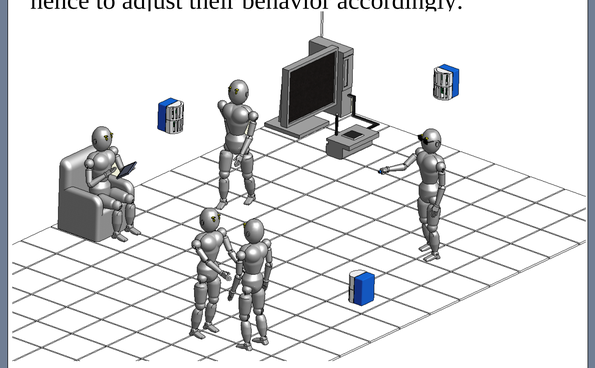
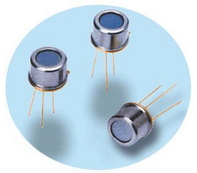
Context

We propose a wearable PIR thermal sensor system that can help users to perceive the surrounding environment from a thermal perspective. Wireless PIR sensor network technology has been developed to track and recognize multiple moving human subjects, as well as understand their activities. However, the PIR sensor is a kind of motion sensor: it can detect moving thermal targets only. Therefore, a wearable PIR sensor system is capable of detecting/identifying static thermal sources by utilizing the random movements of PIR sensors worn on users' arms or hands. Such a technology would assist visually challenged users to understand their situations from a thermal perspective and hence to adjust their behavior accordingly.



PIR Sensors

Today, PIR sensors have been widely installed in many buildings for human motion detection.

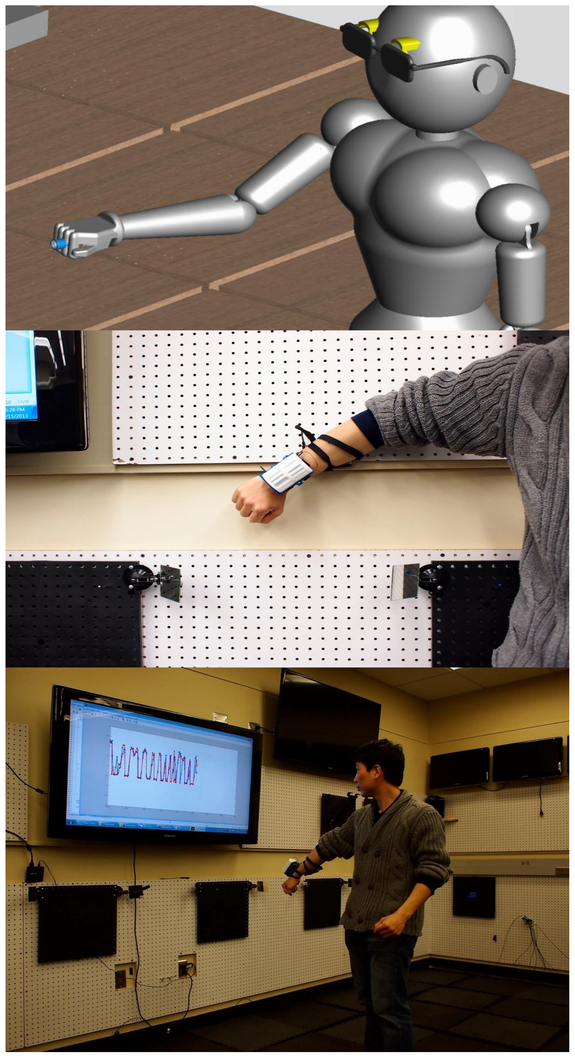


The advantages of using PIR sensors include:

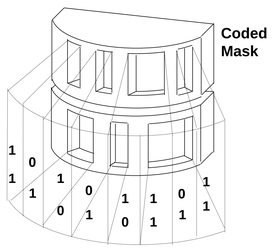
(1) low hardware cost
(2) low power consumption,
(3) low data throughput, and
(4) protection of privacy.

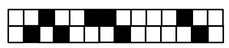
Using our improved hardware platform, PIR sensor nodes can
(1) be powered by solar cell panels, and
(2) have high signal-to-noise ratios despite the target-to-sensor distance

Wearable PIR Sensor



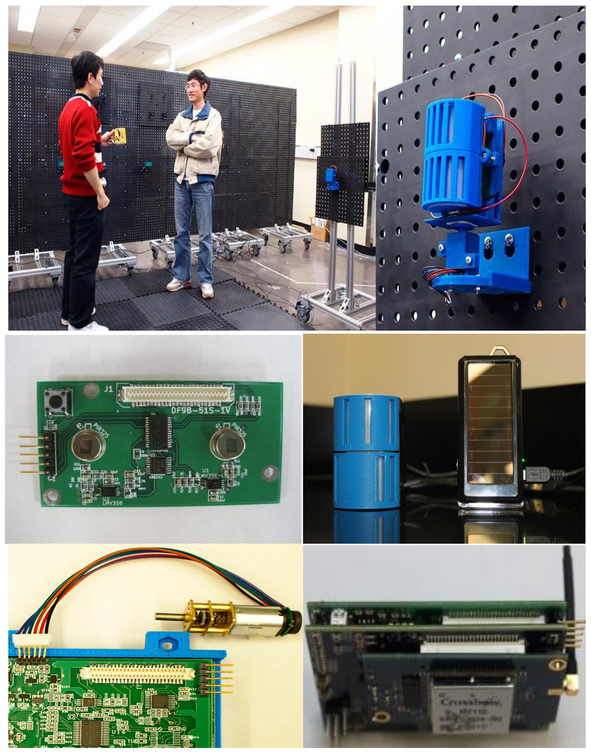
Sampling Scheme





Two binary PIR sensors
Two masked lens arrays
2-D binary measurement

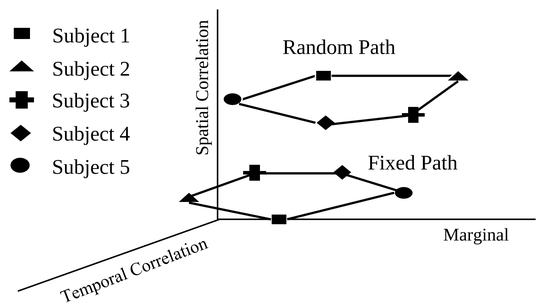
Mobile Sensor Nodes



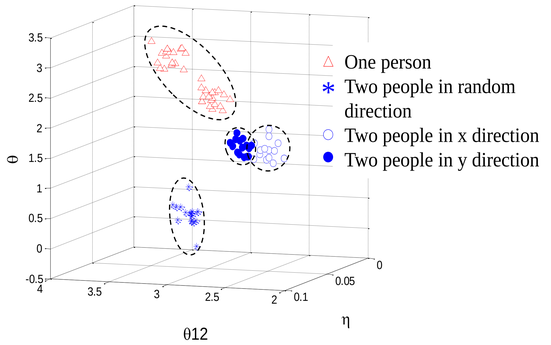
Feature Selection

For a 2-D binary variable, $[P_{00}, P_{01}, P_{10}, P_{11}]$, its orthogonal coordinates are
(1) the marginal densities: $P_{01}+P_{11}$ and $P_{10}+P_{11}$, and
(2) the correlation $\log(P_{00}P_{11}/P_{01}P_{10})$

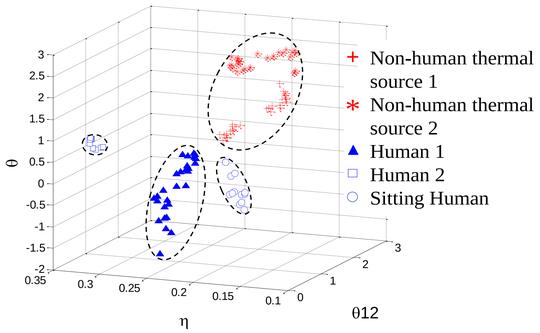
For a 2-D binary sequence, correlations can be both temporal and spatial.



Experiment Results



Scanning results of different scenarios with different static human subject configurations.



Wearable sensing results of human and non-human thermal sources.

Future Work

- Develop a wireless PIR sensor network that can help visually challenged users to understand the activities of moving thermal targets.
- Improve the performance of the wearable PIR sensor system for static thermal source identification.
- Integrate the PIR sensor network and the wearable PIR sensor system to achieve a complete picture of the surrounding thermal sources.
- Smart rings and bracelets with thermal sensing capability.