WESBES: A Wireless Embedded Sensor for Improving Human Comfort Metrics using Temporospatially Correlated Data

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Overview

• Introduction
• Subjective Data Collection
• Modular Wireless Sensor Design
  – System Design
  – Hardware Design
• Development and Verification
• Future Work
• Summary
INTRODUCTION
Human Comfort in EMS

Motivation

• Effective EMS operation requires a balance between system efficiency and occupant comfort.

• While system efficiency can be improved using information from collected sensor data, optimization of human comfort can be more difficult due to the lack available feedback.

• In addition, even when human comfort data is available, it is still difficult to define meaningful metrics for optimization due to the subjective nature of the feedback.

Objective

• Augment the subjective feedback with temporospatially correlated objective sensor data in order to define more meaningful metrics of human comfort.
Temporospatially Correlated Data

- EMS
- Wireless Sensor
- HVAC
- Subjective Feedback
- Correlated Comfort Metric
SUBJECTIVE DATA COLLECTION
Subjective Data

- Android app allows subjective comfort data to be collected.
Subjective Data

- Feedback reports are written to a SQL database using PHP.
MODULAR WIRELESS SENSOR DESIGN
Modular Wireless Sensor Design

Design Goals

• Modular design
  – Use common interface for all peripherals
  – Allow sensors to be added or removed without changing the base hardware/software
  – Allow wireless protocol to be changed without affecting the existing system (Bluetooth, ZigBee, IEEE 802.11, etc.)

• Simple physical interface.
  – Offer easy reconfiguration of the hardware

• Minimize the footprint of the system
**System Layout**

- Peripheral devices use a common bus for power and communication
- Specific sensors are polled using device addressing
Modular Hardware Interface

Inherent Flexibility

- interchangeable Peripheral modules
- System can be easily expanded or reconfigured
- Common pinout allows larger modules to span full board length
- Modules share a common power and communication bus
- Common pinout enables modules to be stacked vertically
- Header pin interface allows fast and easy reconfiguration
DEVELOPMENT AND VERIFICATION
Proof of Concept

To test the idea, a bread-boarded prototype was assembled. The prototype was used to demonstrate the following functionality:

- Take sensor readings for humidity, temperature and light.
- Read and process data using a PIC microcontroller.
- Transmit data from the PIC using both UART Bluetooth and USB.
- Connect directly to Android phone via Bluetooth.
Proof of Concept
CAD Design

- Schematics based on the bread-boarded circuit where laid out using CADsoft Eagle
CAD Design

- The prototype PCBs were generated from the schematic and arranged to form a single 10cm x 10cm board.
Printed Circuit Board
Finished Prototype
Finished Prototype

- Central processing board
Finished Prototype

• Central processing board
• Bluetooth module
Finished Prototype

- Central processing board
- Bluetooth module
- Light module
Finished Prototype

- Central processing board
- Bluetooth module
- Light module
- Temperature module
**Finished Prototype**

- Central processing board
- Bluetooth module
- Light module
- Temperature module
- Battery
Next Steps

- Reduce cost via integration of surface mount technology
- Contract third party manufacturer
- Deploy sensors and distribute Android app
- Collect data
- Analyze/mine data and formulate correlated comfort metrics
Summary

The WESBES system is a versatile environmental sensing platform that offers a modular design that can be easily reconfigured/customized, and allows direct temporospatial correlation between sensor data and subjective user comfort reports.

The system also offers

- A choice of wireless protocol based on application (Bluetooth, ZigBee, IEEE 802.11, etc.)
- Flash programmable MCUs for customized software and onboard processing.
- Smartphone and PC connectivity via Bluetooth or USB.
Questions?