
# *Researching Noise and Overheating Tolerance*

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# Abstract


- Aim is to investigate the indoor noise level from external sources that may be acceptable to occupants on a short-term basis when the alleviation of overheating is required.
- Preliminary studies of the human response to, and inter-dependence of, acoustic and thermal comfort in dwellings.
- Using laboratory studies on relatively small groups under closely controlled conditions.

# Introduction

- Lack of guidance is resulting in residential developments with poor indoor environmental conditions where residents are not able to achieve thermal and acoustic comfort at the same time
- Giving rise to unnecessary sleep disturbance and adverse health effects due to poor indoor air quality in an increasing population of people.
- Therefore, there is a need to develop optimal solutions for noise and ventilation in residential developments

# Introduction

- Collaborative, interdisciplinary project exploiting two unique world-class sets of expertise and experimental facilities from the University of Salford:
  - The Acoustics Test Laboratories
  - Energy House.
- Pilot study data and proof-of-principle for a large externally funded project

# Methodology

- Human response using physiological measurements
  - heart rate,
  - respiratory rates and blood oxygen levels,
  - fidgeting
- Affective transfer
  - how the subjective rating of the noise changes due to changes in ventilation
  - determined by questionnaires and interview
- Cognitive impact
  - negative effect on task performance
  - measures the ability to inhibit irrelevant distractors

# Physiological Measurements

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- Interactive computer periphery
  - Microsoft Kinect
- Advantages:
  - totally non-invasive for a participant (no probes)
  - comprehensive selection of measurements
  - dynamic temporal measure
- Developing software
  - track body and limb movement
  - facial emotion recognition
  - eye tracking
  - head tracking
  - heart rate

# Heart and Respiration Rates

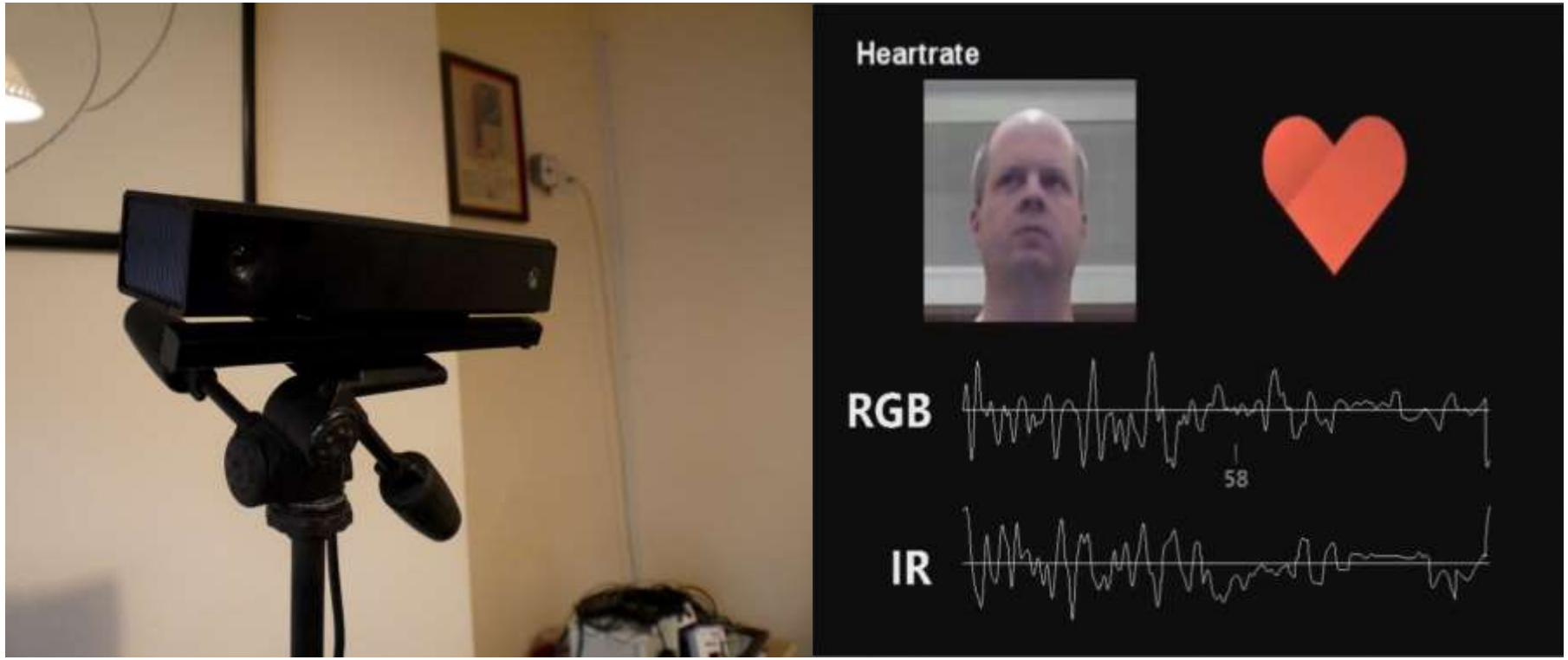


Fig 1 – The RGB and IR cameras can measure slight changes in skin tone intensity, measuring a participant's heart-rate and any increase from stress or discomfort.

# Fidgeting


Fig 2 —Kinect Skeletal tracking allows highly accurate tracking of 25 points of the body. We shall be tracking knee, hand/arm and shoulders for indication of fidgeting due to an uncomfortable environment.

# Positive and Negative Affect Schedule

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This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word.
**Indicate to what extent you feel this way right now, that is, at the present moment.**

Use the following scale to record your answers:

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| *very slightly or not at all* | *a little* | *moderately* | *quite a bit* | *extremely* |

| | |
|---|---|
| _____ | interested |
| _____ | distressed |
| _____ | excited |
| _____ | upset |
| _____ | strong |
| _____ | guilty |

# Human Response Measurements

- Human responses of
  - cognitive (Flanker test)
  - physiological (HR, respiratory, fidgeting)
  - behavioural (Positive and Negative Affect Schedule )
- Human responses to
  - varying *noise* levels (road: 50dB, 60dB, and 70dB)
  - varying *heat* levels (21, 24, and 27 degrees Celsius)
  - combined effects of *heat and noise*

# Thermal Comfort

- Measurements
  - Air and mean radiant temperature,
  - Humidity
  - Airflow
- Measured in accordance with ISO 7730:2005

# Results and Analysis

- Performance on the cognitive task
  - Accuracy
  - Response times
- Physiological measurements
  - Heart rate
  - Level of movement (fidgeting)
  - Respiratory rate
- Subjective response
  - Positive affect and negative affect

# Very Early Analysis

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- There was a small but statistically significant effect due to noise level,
  - Highest noise condition (70dB) raised HR by ~3bpm
- There was a statistically significant interaction between noise and heat
  - This may be a sample size artefact, there were only three participants in the 24 and 27 degree conditions
- More analysis will be presented at ICSV24

# Further Work
## HEMAC Sandpit, Glasgow 25 April 2017

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- What noise characteristics are best suited for mechanical ventilation (MV) systems for sleep?
- Research Objectives
  - Identify acoustic triggers and mitigating action by occupants on their MV systems
  - Determine the ranges of ventilation system noise characteristics best-suited for bedrooms for sleep, living rooms, and bathrooms.
  - Diagnose problem noise sources and characteristics
  - Inform policy and practice through guidance
- Contractors minimise costs by providing minimum requirements of regulations

# HEMAC Sandpit - Work packages

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| Work package | WP overview |
|---|---|
| 1 | Occupant perception survey of installed systems, including measurements of the noise levels and recording of noise signal for laboratory studies. |
| 2 | Larger-scale survey of as-built mechanical ventilation noise levels, to characterise the potential extent of the problem when correlated with data from occupant perception survey and lab tests. |
| 3 | Physical survey of problem sources and resultant noise characteristics: design, installation, operation and maintenance. |
| 4 | Laboratory study of subjective testing and optimisation of MV noise characteristics for sleep, and for relaxation, using measured source data. |
| 5 | Mapping pathways to impact - implications for policy and practice |

# Conclusions

- There is a need to develop optimal solutions for noise and ventilation in residential developments.
- A starting and important step to achieve optimization is to study the human response to, and inter-dependence of, acoustic and thermal comfort in dwellings.
- Related work is proposed to define noise characteristics best suited for mechanical ventilation (MV) systems for sleep


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