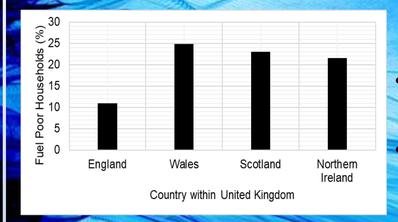
Artificial Intelligence-based system to lower the energy use for thermal comfort

LIVERPOOL JOHN MOORES UNIVERSITY

(I) Introduction



- Fuel Poverty rate in the UK can reach up to 25% (2020) even before the energy price rise.
- This condition can be worse in other countries.
- Heating contributes to 25% of total energy consumption for UK homes
- Energy price rise makes this problem worse.

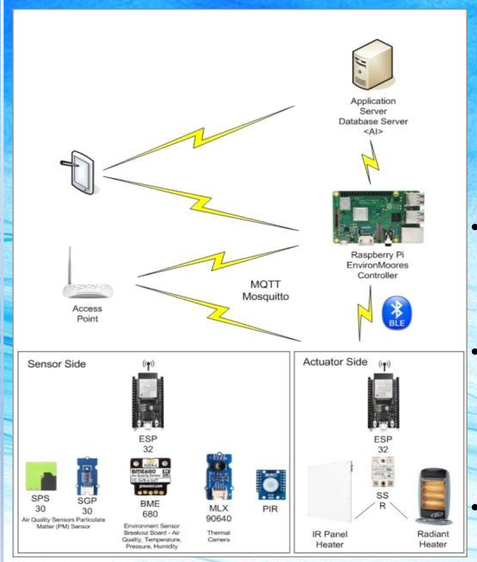
- There should be a breakthrough to support the Sustainable Development Goals.


Heat or eat: The choice many will face this winter

Leading charity issues stark

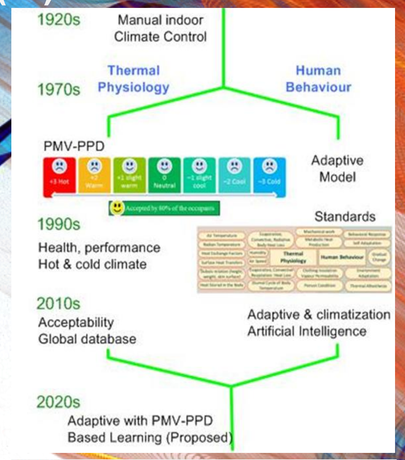

'IT'S EATING OR HEATING'

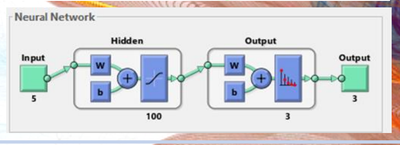
(II) Aims



- Develop a novel solution based on the fusion of sensors and artificial intelligence
- Developed with an adaptive approach to accommodate personal thermal preference
- Attempt to lower the energy use

(III) Methods





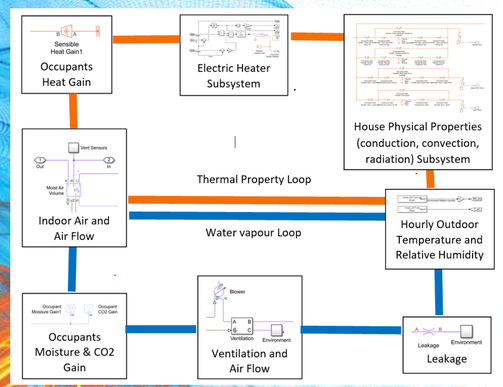
- Literature study on the Development of Thermal Comfort Methods
- Identify the novelty and planning review
- Development of Model for heating
- Development Framework for thermal comfort
- Use The Multiple ASHRAE Database for AI shallow supervised training
- Filter and Semantically Augment training data
- Develop Artifisial Neural Network based system
- Testing the prototype in the laboratory and BRE exemplar House

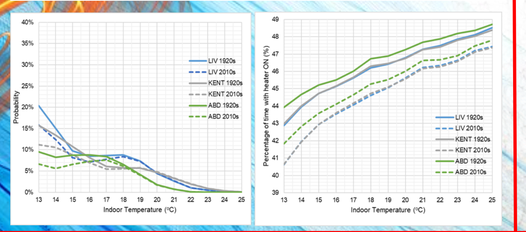
(IV) Results and Discussion

The simulation result shows that the 2010s' dwelling has an advantage of decreasing energy for heating compared to the 1920's.

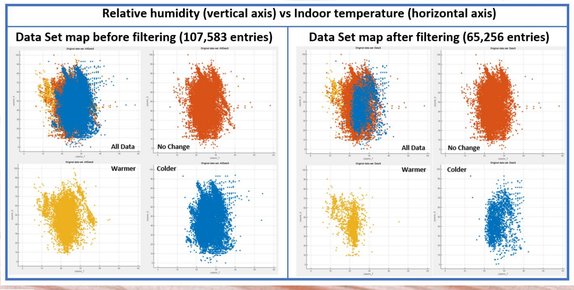
The number of occupants within the dwelling does not significantly reduce the energy required for heating 1920s' dwellings but can reduce energy requirements for heating 2010s' especially in lower setpoint temperatures.

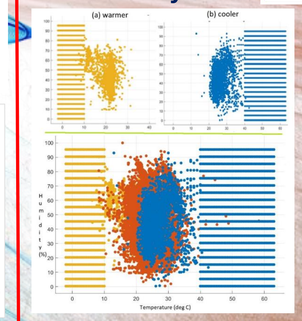
The indoor temperature is demonstrated to be efficient in the range between 16ºC - 20ºC.



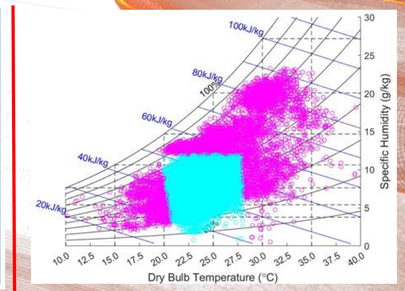


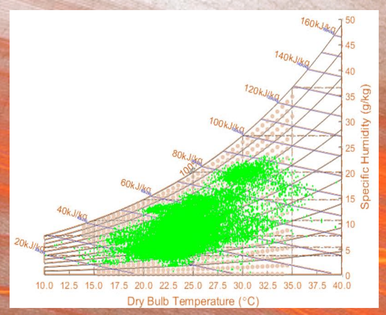
Previous researches only use pinpointed data to get higher training results while this research use all data filtered for consistency.





The ASHRAE database is one of the most reliable databases for thermal comfort. The use of all data will benefit the system to be able to capture the adaptive notion of human thermal comfort. The data is then semantically augmented to introduce the uncomfortable area in the data set. This work focus on five major parameters that influence human thermal comfort.





The left image shows that the comfort zone defined in ASHRAE standard 55 is just a part of the whole comfort zone that human feels based on ASHRAE databases. This work proves that the AI model can perform well in the thermal comfort zone prediction and can potentially reduce the energy for thermal comfort due to it can recognize the wider comfort area which can be associated with lower heating energy in winter and lower cooling energy in summer. This is shown in the left figure with the orange dots generated by the model and the green dots are generated from the ASHRAE database items.

(V) Conclusion

- Thermal model can benefit in the research of the human comfort
- Lowering the set point temperature is possible to reduce the energy consumption for comfort
- The filtering and semantic augmentation was successfully implemented to acquire ASHRAE multiple databases for shallow supervised learning
- The thermal comfort prediction can acknowledge a wider comfort zone other than that defined in ASHRAE 55 standards which use the PMV PPD approach and Givoni.
- The physiological, psychological and behavioural approaches can be acknowledged in the single system and share common benefits among the three approaches.

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