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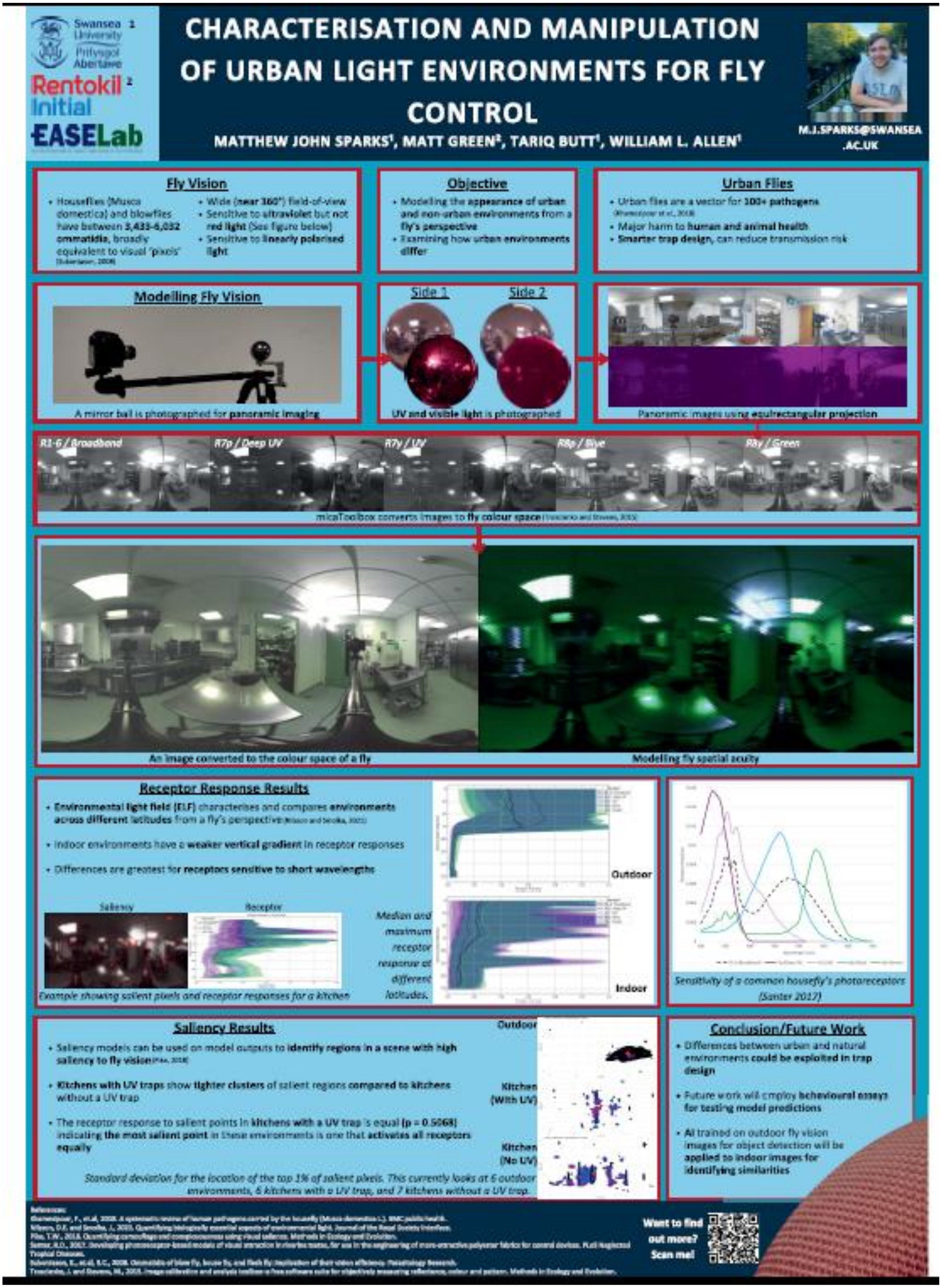
CHARACTERISATION AND MANIPULATION OF URBAN LIGHT ENVIRONMENTS FOR FLY CONTROL

[1]MATTHEW JOHN SPARKS, [2]MATT GREEN, [1]TARIQ BUTT, AND [1]WILLIAM L. ALLEN
[1]Department of Biosciences, Swansea University, Swansea, UK
[2]Rentokil Initial, Crawley, UK

Abstract Filth flies are a strong mechanical vector for over 100 pathogens and therefore of key importance to human and animal health. Urban environments are a preferred habitat due to abundant feeding and oviposition opportunities and warm temperatures. I will introduce my research on filth fly visual ecology that investigates how flies perceive and respond to visual information in urban environments. I image urban and non-urban environments using multispectral, polarisation, and panoramic photography to record the visual information accessible to filth fly vision. I then use bespoke image processing and visual modelling of filth fly vision to generate a 'fly-eye-view' of how flies perceive urban environments. Results identify visually conspicuous features of urban environments and allow for a better understanding of visually guided behaviour. I highlight potential for manipulation of environmental cues to influence behaviour and limit the spread of pathogens. Specifically, I contrast regular features of non-urban and urban environments, looking at UV intensity at different angles, detection of salient objects, patterns of polarised light, and occurrence of known attractive features. I show how taking a visual modelling approach incorporating features of the focal species visual system can yield new insights into behaviour in urban environments. Future work will use behavioural assays to test predictions arising from the visual modelling and using AI to predict fly visual behaviour. Ultimately the research will allow for smarter trap design and better control of pathogen spread.

Key words *Musca domestica,* Filth flies, Visual ecology, Trap design


Swansea University
Prifysgol Abertawe
Rentokil Initial
EASELab
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MATTHEW JOHN SPARKS[1], MATT GREEN[2], TARIQ BUTT[1], WILLIAM L. ALLEN[1]
M.J.SPARKS@SWANSEA.AC.UK
Fly Vision
Houseflies (Musca domestica) and blowflies have between 3,433-6,032 ommatidia, broadly equivalent to visual 'pixels' (Sukontason, 2008)
Wide (near 360°) field-of-view
Sensitive to ultraviolet but not red light (See figure below)
Sensitive to linearly polarised light
Objective
Modelling the appearance of urban and non-urban environments from a fly's perspective
Examining how urban environments differ
Urban Flies
Urban flies are a vector for 100+ pathogens (Khamesipour et al., 2018)
Major harm to human and animal health
Smarter trap design, can reduce transmission risk
Modelling Fly Vision
A mirror ball is photographed for panoramic imaging
Side 1
Side 2
UV and visible light is photographed
Panoramic images using equirectangular projection
R1-6 / Broadband
R7p / Deep UV
R7y / UV
R8p / Blue
R8y / Green
micaToolbox converts images to fly colour space (Troscianko and Stevens, 2015)
An image converted to the colour space of a fly
Modelling fly spatial acuity
Receptor Response Results
Environmental light field (ELF) characterises and compares environments across different latitudes from a fly's perspective (Nilsson and Smolka, 2021)
Indoor environments have a weaker vertical gradient in receptor responses
Differences are greatest for receptors sensitive to short wavelengths
Saliency
Receptor
Example showing salient pixels and receptor responses for a kitchen
Median and maximum receptor response at different latitudes.
Outdoor
Indoor
Sensitivity of a common housefly's photoreceptors (Santer 2017)
Saliency Results
Saliency models can be used on model outputs to identify regions in a scene with high saliency to fly vision (Pike, 2018)
Kitchens with UV traps show tighter clusters of salient regions compared to kitchens without a UV trap
The receptor response to salient points in kitchens with a UV trap is equal (p = 0.5068) indicating the most salient point in these environments is one that activates all receptors equally
Outdoor
Kitchen (With UV)
Kitchen (No UV)
Standard deviation for the location of the top 1% of salient pixels. This currently looks at 6 outdoor environments, 6 kitchens with a UV trap, and 7 kitchens without a UV trap.
Conclusion/Future Work
Differences between urban and natural environments could be exploited in trap design
Future work will employ behavioural assays for testing model predictions
AI trained on outdoor fly vision images for object detection will be applied to indoor images for identifying similarities
References:
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