Thesis Portfolio

Creation of a localized temperature regulation system for pet care

(Technical Report)

Sensenet: A community-driven environmental monitoring project

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2020

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Sociotechnical Synthesis

The use of computers in everyday life has exponentially increased, as we can find microcontrollers and IoT machines inside our phones, cars, and household appliances. Automation is also finding its way into pet care, as work obligations and other restrictions on time prevent people from taking care of their pets. What little time there may not be properly used as pet care can be quite tricky to get right. Additionally, few low-cost devices exist for hobbyist temperature regulation in smaller scale areas like aquariums, reptile enclosures, etc. that provide easy, accessible, transparent control mechanisms.

The technical component of this thesis explored the design of an automated heating system for reptiles. Expanding on previous work in the area, this project presents an opportunity for individuals to reduce power consumption by efficiently regulating the heat of a localized area and provides an easy way to monitor and control this localized temperature area both remotely via a smartphone and locally via a user knob. Although temperature regulation devices exist, none of them feature the modern IoT touch and real controllability in real time.

Ultimately, this project achieved efficient heating of localized areas and consumed little extra power. By dimming through duty-cycled, line-synchronized operation rather than directly duty-cycled AC, this system achieved remarkably low line noise figures as switching occurred at the zero crossings of 120V AC, leading to reduced transient currents and thus less wear on components, less heat generation, and less average wattage as current consumption was isolated to the switching transients happening for very short instances of time.

The STS project took a step back and considered the implications of IoT-enabled devices that sense and transform their environments in potentially intangible ways. While this system was interactive and quite literally transparent as every component was visible with very clear physical effects, increasingly miniaturized and physically intangible automated systems raise critical issues of black-boxing. At what point does automation become sufficiently advanced that it is no longer transparent or really tractable for people to understand? How can the expected operation of IoT devices be guaranteed when current work has a tendency to steal data and do extra things behind the scenes? With the skepticism of professionals (who are responsible for the vast technical complexity of IoT systems) by the community, how can citizen trust be won? The

STS project investigated the research question ‘can community-centric agile IoT design processes break knowledge transfer gaps and encourage newfound interest and insight into IoT technology by the community?’

The STS project’s research found that knowledge gaps were not a consequence of lost trust or confidence; rather, barriers to IoT knowledge transfer came from citizen interests diverging from scientific interests. While scientific views of community participation are deeply technical and design-focused, it was found that community members were more goal-oriented and interested in solving immediate problems with technology in ways that scientists may find outlandish, rather than immersing themselves in literature and future opportunities for study that necessitate detailed design understandings and solid documentation. Thus black-boxing is acceptable to some level, but only if there is proper community trust that the systems are making real changes in people’s lives, enough for citizens to overlook and abstract away some of these flaws. In the same way that non-technical users do not need to know everything about the internals of a car to use it and likely choose not to focus on the inherent problems of black-boxed, expensive car parts because the end product is useful, transparency in IoT means unveiling the results and consequences, in detail, of IoT systems rather than their internals.

Both components of the thesis show that automation is a tricky thing to get right - too complicated without justifying its complexity means there is a problem, and too simple, so simple that the product does not meaningfully solve a problem is also a problem. For the end user, a careful balance between abstraction and transparency *can* be struck, but it requires community input in some capacity, and continual community reassurance in some way, physical or nonphysical.