

Thesis Project Portfolio

Hope this won't take too Delong: Smart Pet Feeding Station

(Technical Report)

Understanding Smart Home Adoption: The Roles of Users, Engineers, and Mass Media in the Social Construction of the Smart Home

(STS Research Paper)

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Sociotechnical Synthesis

With recent advancements in sensor-based technologies and the accelerated growth of the Internet of Things (IoT), the number of smart home technologies (SHTs) that are being incorporated into the home environment is rising each year. The diffusion of smart technologies into different domains of the domestic space promises to provide users with a host of health-related, environmental, financial, and psychological benefits. Despite these potential benefits, the observed adoption rate of SHTs is relatively low as society is currently struggling in its transition from the early adopter phase to the early majority phase of smart home adoption. This issue necessitates increased development in SHTs and an analysis of the different user groups and their current perceptions regarding SHTs. The technical paper attempts to further the development of SHTs, specifically in the domain of smart pet care. More specifically, the technical paper outlines the design, implementation, and testing of a smart pet feeding and watering system. The issue of low SHT adoption is analyzed by the sociotechnical paper, which explores the mechanisms by which technology is adopted in society, the current perceptions of SHTs by various social groups, the barriers to adoption, and potential solutions to bolstering adoption.

The Smart Pet Feeding Station is a device intended to be used by pet owners who are unable to consistently feed their pets on a regular basis. The device follows the portion-controlled feeding regimen, whereby pets are provided fixed amounts of food during specific times of the day. Pet food and water are stored within the device's separate food and water storage containers. The contents of these containers are dispensed into food and water bowls, which contain sensors that allow precise amounts of food and water to be dispensed. Water is transferred from the water container into the water bowl using two peristaltic pumps. The water bowl contains two optical water level sensors, which detect when one of two user-selectable

water levels has been reached. Food is transferred from the food container into the food bowl using a gravity fed dispenser containing a stepper motor, which rotates a disk with evenly spaced holes that allow food to periodically fall into the food bowl. The weight of food within the bowl is measured using a load cell weight sensor. Integral to the design of this device was the selection of the MSP430FR2355 microcontroller for controlling the device's functionality. As part of the design of the device, a printed circuit board was designed for supplying power to the different components of the device, interfacing the microcontroller with the sensors and actuators, and connecting an LCD display and buttons to the device for user interaction. After designing and constructing the device, software, hardware, and system-wide tests were performed to verify the design.

The STS paper examines the current state of smart home adoption as a whole. The current state of smart home adoption is identified using the Diffusion of Innovation (DOI) theory, which explains how an innovation diffuses through a population or social system over time. The theory is also used to show how communication channels, including mass media sources and word-of-mouth, are the primary mechanism under which innovations diffuse. The Social Construction of Technology (SCOT) framework is used to identify relevant social groups in the development of SHTs and each group's interpretive flexibility of the technology. The framework is also used to show that the engineer has a responsibility to listen to each user group's concerns when embedding values into technology. The paper examines the unique perceptions that each of the identified social groups has regarding SHTs. As an example, elderly user of SHTs value controllability of smart home devices since controllability provides users with greater autonomy. Elderly users are also more likely to perceive less security risks related to SHTs. From the common perceptions shared among the relevant social groups, the

sociotechnical barriers to SHT adoption are derived. Next, it is shown that communication channels act as a double-edged sword in smart home adoption, and consequently, heighten the adoption barriers. It is concluded that proper communication channels should be maintained between engineers and users to allow users to voice their perceptions and concerns regarding SHTs. While the paper is thorough in its analysis of the different user groups of SHTs, the paper focuses on the smart home as a whole rather than specific smart home devices and services. Thus, more research should be carried out to identify ways of bolstering adoption of specific smart home devices and services within different user groups.