The Smart Pet Feeding Station

(Technical Paper)

The Motivations of Smart Home Technology Adoption

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In recent years Americans have begun to adopt smart technologies into the home with approximately 32% of households having at least one smart device in 2020, with that figure expected to rise to 57% by 2025, despite the implications of this rapid adoption, positive or negative, being unclear (Vigderman, 2020). The devices come in a variety of shapes and sizes, but all ultimately have one goal for the user: to be available at all time as a technological assistant. The user simply gives the device a verbal question, or request, and it returns to you whatever you asked of it; whether that may be a weather report, or to turn the lights on. The capabilities of these devices far exceed these examples, and are growing all the time. By interfacing with online servers, or other in-home devices, just a few smart home devices can offer users significant control over many of the machines in their home.

The STS portion of this prospectus will be looking into what impacts these new technologies may have as they become more integrated into homes. There are many social aspects for which you can analyze the topic through, but this prospectus will focus on the motivations of the public to adopt these devices, and if the negative exposure they have received is having an impact of their continued adoption. The technical portion of this prospectus is my own capstone project, a “Smart Pet Feeding Station”. The primary purpose of the product is to offer a product that could allow you to be gone for extended periods of time without worrying about needing to feed your pet. With this current design, the device is already bringing additional automation into the home. If the project were be to be continued in the future, our first goal would be to make the device wirelessly compatible with smart home devices in order to make it more widely useful, and more easily used. Therefore, if it were to be mass produced, it would be

subject to the implications intended to be topics intended to be researched in the STS portion of this prospectus.

Technical

As all pet owners know, a major responsibility of ownership is providing an adequate amount of food and water to their pet in order to ensure that it remains healthy. For dogs, this means that they should be provided a daily amount of water equivalent to about 1 ounce of water per pound of body weight (Editorial, P. M. D.). It is also important for many dogs that they be fed on a consistent basis, which is especially beneficial to adult rescue dogs and puppies that have not been taught household manners (Llera). Although owners recognize these factors, it is often inconvenient or difficult for them to find the necessary time to consistently feed or water their pets throughout the day. These inconveniences are especially true for full-time college students who may have classes during critical pet feeding and watering times that constitute a consistent feeding schedule. Some individuals may also find it difficult to provide food and water to their dogs due to certain disabilities that affect the user's mobility or mental standing/forgetfulness. The capstone team is designed and prototyping automatic pet feeder and waterer aims to solve these problems by allowing pet owners to program specific feeding times throughout the day that do not require the owner’s presence or additional input. The device also ensures that pets receive an adequate amount of water since a constant level of water within the water bowl is maintained throughout the day.

Automatic pet food and automatic water dispensers are not novel ideas as many versions of these devices exist. For example, WOPET’s Chimp II Automatic Cat & Dog Feeder is a Wi-Fi enabled pet feeder that is capable of dispensing up to eight meals a day, twenty portions (5 grams per portion) per meal, and can play 10-second voice recordings to get a pet’s attention (Wopet

Chimp II Automatic Cat & Dog Feeder WIFI 8-Meal). A current automatic water dispenser design is PetSafe's Drinkwell Everflow Pet Drinking Fountain, which is a 192 fluid ounce fountain that connects to a standard garden hose, has an adjustable water level, and automatically turns off when the desired water level has been reached (PetSafe). Although similar to current automatic dispenser designs, our pet feeder and waterer is a two-in-one design since the device is capable of dispensing both pet food and water, which is a feature that was not present in any of the currently available automatic dispensers. This means that the dispensing of food and water can be easily synchronized since the same timer is used for both dispensers. The team's device also uses sensor feedback to determine when the appropriate amount of food or water has been dispensed, which for pet food dispensers, is not observed in current artifacts.

The design and construction of this automatic food and water dispenser will require the extensive use of previous coursework. The custom PCB that is to be built will require the use of circuit design principles that were introduced in the Electrical Engineering Fundamentals Series (ECE 2630, ECE 2660, and ECE 3750). Since a MSP430 microcontroller is going to be used to interact with various sensors and actuators, embedded programming knowledge from the Introduction to Embedded Computing Systems (ECE 3430) course will have to be utilized. These sensors, actuators, and microcontroller will also operate using feedback loops, which will use knowledge from Linear Control Systems (ECE 4850). Many of the sensors will require amplifiers since they output relatively small signals in the millivolt range. For example, the compression load cell sensor, which measures the dog food weight in the dog bowl, outputs two relatively small voltages from a Wheatstone bridge, thus instrumentation amplifier design principles from Electrical Engineering Fundamentals III (ECE 3750) will be used. Since stepper motors will be used for the dispenser actuators, some of the motor related material from

Electromagnetic Energy Conversion (ECE 3250) will also be used. The power circuitry, which relies on the use of a voltage regulator and conversion of AC power to DC power, will use material from both ECE FUN III and EM Energy Conversion. Finally, the preparation of documents and files for PCB manufacturing will use the process introduced in ECE FUN III.

STS Topic

The advancement of microcomputers, the internet, and general "smart" technology in recent years have resulted in a surge of "smart home" products being released onto the market, along with a correspondingly rapid of adoption of such topics by the average consumer (Haney, 2020). Smart home devices are such that utilize microcomputers, a connection to the internet, and cloud computing to provide some service to users within the home at an extremely affordable price (Li, 2021). Such services may include weather reports, voice control over other devices, upkeep of personal calendars, and much more (Balta-Ozkan, 2013). Moreover, smart device capabilities are beginning to come standard with many conventional household appliances such as televisions, kitchen appliances, and security products (Vigderman, 2020). Notably, all with the one caveat that the devices collect incredible amounts of data about their users (Wang, 2018). With this in mind, it is easy to spot the two primary concerns with the mass adoption of such technologies to be a mass compromise of data privacy, and an unknown shift in at home culture, both of which are only exacerbated by the accessibility of the technology (Shin, 2018). While the wake of such cultural impact has been observed before with the rapid adoption of other technologies such as the smart phone, the impact of mass data collection has yet to be observed over a significant time period (Shin, 2018; Schomakers, 2021). Despite the lack of data on mass data collection, studies fear the negative impact it could have (Wang, 2018). This fear is largely due to the reach of the problem being all smart technology consumers, unlike other less

affordable technologies. Due to concerns of this problem, much is being done to predict the likely impacts of mass data collection may have in the near future (Shin, 2018). In fact, the topic is causing such a stir, that in some especially concerned areas of the world, legislation to limit the reach of data collection technologies is being considered in order to preemptively limit the reach of such technologies (Rippy, 2021). Considering this background, I will be investigating how society has influenced the development of and reacted to this particular technology through the guise of the STS principle of SCOT. SCOT being a framework that argues that technology is shaped by the actions and reactions of society (Klien & Klienman, 2022).

Conventionally, there are many easy ways to deal with intrusions on personal data. Popular methods include browsers plugins, internet bypasses, and incognito browser modes. And while these methods are effective, they are neither universal, full proof, nor applicable to newer privacy invading data collection methods (Haney, 2020). Considering this, novel approaches to combat such methods have been considered due to a societal fear of the implications of mass invasions of data privacy. Such approaches include, social backlash in the form of informal boycotts, legislation aimed to deter the reach of these breaches, and even self-limitations provided by software developers. These innovations have stunted the growth of the smart home device industry, but have yet to seriously limit the actual issues at hand due to legal loopholes, and the lack of societal interest (Haney, 2020). Regardless, all these efforts are a valiant starting point if nothing else, and represent the beginning of societal knowledge of the seemingly harmless dangers of the invasion of personal data privacy. If such innovations were to be expanded upon, they could have a more substantial impact of the aforementioned arising issues.

Methodologies

Research Question: Why have people been motivated to adopt blatantly invasive smart technology devices, even as their issues have become more well-known?

To answer this research question, interviews following the guise of SCOT will be used. The background for this question will be significant context of what smart home technologies are, and what they represent in this era of rapidly developing social influences in technology. Furthermore, it will be important to note the rate of their adoption thus far, and any prior research concerning public attitudes towards the technologies. As for data collection, data will be collected from at least four different interviews of four different types. Interviews which would ask key questions alluding to the detriments and benefits of smart home technologies. Such detriments will include data privacy concerns, while benefits will mostly concern personal satisfactions with the devices. From this data there should be some sort of discernable trend, and a prediction from that trend of a public perception of smart home devices. As for what is distinct between the four interviews, there will be an interview with someone who owns a device and is older, as well as someone who does not own a device and is older, and then two more interviews from a younger audience. This way the data collection for the project is kept to a manageable scope, but also allows trends over specific attributes to be determined that would otherwise be unclear with random interviews, or less interviews.

Conclusion

The technical project associated with this paper aims to create an interesting new automatic dog food and water station. The device would be beneficial to really anyone owning a dog for more than just convenience, and would be especially beneficial to people who own a pet

and are disabled, suffer from age related diseases, or find themselves away from home for long hours of the day. This device not likely be realistic to mass produce, but it is personality interesting to the capstone team, and presents an engaging topic for research.

In contrast, the STS portion of this paper is somewhat critical to the nature of smart home devices such as our own. As such, the project aims to determine the motivations and public perceptions of as to why smart home devices have experienced continued adoption, despite their invasive technologies. The possible detriments of these technologies are a growing concern, and this research should hopefully shed light on as to why their mass adoption continues despite the possible malicious purposes.

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