The Smart Fan

An Assessment of Human Motivations on Smart Home Assistant Development

A Thesis Prospectus
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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

The technology I will be investigating for my prospectus and STS project is the smart home assistant. Commonly referred to as virtual or AI assistants, some of the first smart AI home assistants of the past decade included Amazon's Alexa, Google Assistant and Apple Siri. These AI assistants connect with other devices within the home including lights, fans and appliances. In the scope of this prospectus I will examine both Amazon Alexa and Google Assistant. Interestingly, these devices have lost significant general consumer demand as in 2022 it was reported that Amazon's Alexa lost roughly 10 billion (Chen, 2023), yet their development, growth, and subsequent fall-off are important to consider for the future of smart homes. In this prospectus, there are two individual components: the STS project and the technical project.

The human motivations behind the development of smart homes assistants are the focal point to the investigation of my prospectus to dissect the industry thoroughly. For my research, I will break up the specific factors to examine how smart home assistants Google Assistant and Amazon Alexa have transformed households while consequently scrutinizing the specific controversies. The core questions I am examining are why do we have smart home assistants and how have we shaped the direction of smart home assistants? I will investigate the development of smart home assistants and the socio-economic influences that have shaped this technology. My initial hypothesis is that smart home assistants have been driven by the need for those to be connected and seek convenience, but has subsequently led to controversies of dataprivacy and over energy consumptions as the technology has begun to decline in specific markets.

For the technical project, I will be developing a portable desk dyson fan with automated motion detection capabilities with a team of four. This technical project is directed towards those

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without adequate AC allowing for optimized comfort during the ever-increasing hot summer months. In the context of my prospectus, my technical project would not fall under the technical description of a "smart assistant" device since it does not include any element of AI powered software. However, it does portray qualities of smart connected devices in that it automatically tracks motion without any user input. This product my team is developing could easily be scalable to falling under the label of an Internet of Things (IOT) or smart connected device if simply connected to some external connection. This product has important implications as it provides for those without AC a comfortable alternative, yet is also a device that will take up a lot of power and energy to run and actively collects internal data within a home. In the following pages, this prospectus will describe my technical project in detail while also road mapping the research of my hypothesis through the STS lens.

Technical Project

As global temperatures climb due to climate change, more households are turning to air conditioning systems for relief. However, this growing reliance on air conditioning comes at a cost. On average, households see their electricity bills increase by 35% to 42% when they use air conditioning. Surprisingly, approximately 20% of the world's total electricity consumption is now devoted to air conditioning, exacerbating our overall energy consumption, and placing significant stress on the power grid. (Randazzo, 2020). Electric fans offer a cost-effective and energy-efficient alternative to air conditioning. They are affordable, portable, and consume little energy. Their efficiency is further enhanced by the fact that they only circulate air in a specific area where it is needed.

However, this efficiency comes with a drawback in convenience. A user must point the fan towards the part of the room they are occupying, and re-orient it if they move around. Moreover, when leaving the room, they must either remember to switch off the fan manually or let it continue running, which increases its energy consumption. This project addresses these common issues associated with conventional fans available in the market today. It is equipped with IR sensors that enable it to detect and track people in a room, it can rotate a full 360 degrees providing the user with a constant cool breeze wherever they may be in the room. If multiple users are detected within its visible range, this product will oscillate between both individuals. It will also have a knob so that a user can dictate the desired speed of the fan. Unlike an axial fan, this design will implement the centrifugal design with a brushless motor. A centrifugal fan design is the desired design approach to simulate air conditioning systems, which our fan is attempting to substitute for. All mechanical movement and functionality will be pre-programmed through the microcontroller, with power distribution set through the PCB. The Smart Fan is intended to be a portable desk device, with all the hardware and electronics embedded within the base of the fan with only the sensors and camera exposed. The figure on the right provides a block diagram of the components of the product. As shown, there is a printed circuit board responsible for power distribution to motors, potentiometer and the microcontroller. The three motion
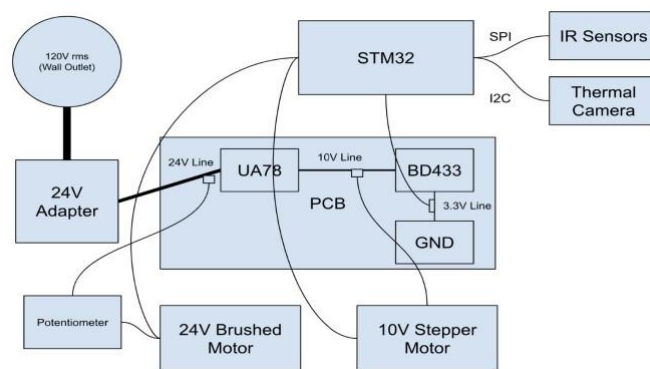

Figure 1. Block Diagram of TSF

detection sensors are connected directly to the microcontroller. Our chosen sensor configuration includes one forward-pointing infrared camera. This camera produces images with a low

resolution (32 x 24 pixels), which will reduce cost and processor load while still being precise enough for our purposes. However, the camera only has a 110º field of view. To supplement it, we will add two infrared sensors mounted towards the back of the device, one on the left and one on the right. Each offers a 150º field of view, so that when combined with the forward camera they will cover the entire 360º range. The PCB will include two voltage regulators to control a steady voltage output of 10v (for the stepper motor) and 3.3v (for the microcontroller).

Due to the properties of this design it is subject to regulations that are important to follow. This includes The printed circuit board for this project will be manufactured in accordance with IPC-A-600. This is a general standard that applies to all Printed Circuit Boards (PCBs) and will ensure that the final product matches with our intended design. The power adapter we will use conforms to UL 60950, a standard for electrical devices that plug into a wall outlet. This standard is important to ensure that our device can be used effectively and safely

with power outlets across the country. Because our device is an electric fan, it is also subject to UL 507, a standard pertaining specifically to electric fans and related safety issues. This project will use passive sensors and not communicate wirelessly; therefore, compliance with regulations concerning electromagnetic radiation is unlikely to be an issue. A computer aided design (CAD) design of the final deliverable is shown on the right.

Figure 2. Final Design

STS Project

For my STS investigation, I will be examining the innate human values of the home and how they have affected the development of smart home assistants. Much of the world today is more interconnected than ever. According to Shahrokh Nikou in *Factors driving the adoption of smart home technology: An empirical assessment*, there are "more than four billion people around the world using the internet" (Nikou, 2019, Pg 1.). This connection has brought increased applications such as the developments of smart home assistants. For this prospectus, to narrow the research question at hand is: how have human motivations shaped the development of smart home assistants and do these align with our values of the home? This is an important and current topic for a variety of reasons. For one, smart home technology is continuing to grow in communities with regulation lagging behind. According to Benjamin K. Sovacool in *Policy Mixes for More Sustainable Smart Home Technologies*, the smart home assistant regulations that have been put in place "occur in a fragmented manner across different silos such as smart meters, smart grids, or the IoT." (Sovacool, 2021). This in turn leads to a weakened overall system when it comes to robust regulation. Furthermore, it is fascinating that the smart home assistant market has lost general popularity in markets. In *How Siri, Alexa and Google Assistant Lost the A.I. Race* mentions these devices as "command and control" systems only helping with rudimentary requests (Chen 2023). Perhaps not want people are desiring within their home and the agency they possess within it. Additionally, there is a concern with data-privacy and the rise of digital capitalism. The idea that businesses are trying to secure data through these virtual assistants at the expense of one of the more sacred home values: privacy.

With these drawbacks it is important to understand how human motivations dictated the stunt in smart home assistant growth. However, it is not just consumers, but smart home assistant designers as well that play a vital role in the shaping of smart home assistants, which this paper intends to examine through the lens of STS.

Methods and Frameworks

This paper will consider the Social Construction of Technology framework to observe the developments of smart home assistants. The SCOT framework, introduced by Trevor Pinch and Wiebe Bijker, challenges the notion that technology has a profound impact on human nature and lives. SCOT asserts that technology is developed and shaped by human actors and that the development of said technologies is solely dependent on the desires and characteristics of these actors. Human users put worth on technological artifacts ultimately determining if these artifacts are adopted into society. It is also important to note that these same human users can also reject certain technological artifacts from society which is what this prospectus addresses. In the context of this prospective study, the SCOT framework will be applied to two sets of human actors. The actors that will be examined are the consumers and the design engineers of the smart assistant Amazon Alexa and Google Assistant products. Both parties according to SCOT make up the necessary actors that shape the developments and rejection of smart home assistants, thus making it imperative to understand their motivations.

Research Methods

For this prospectus, the primary research methods will be an assessment of research journals and articles on the topic discussed in the previous paragraphs. Using Sergio Sismondo's *An Introduction to Science and Technology Studies* along with other literature on SCOT, I will examine the consumer influence of smart home artifacts and its parallel with the engineers focus on smart home consequences. Furthermore, I will do an in-depth analysis on my key texts along with mapping the citations of these works to achieve a thorough analysis on my research topic.

Key Texts

For this prospectus, a variety of texts will be examined and analyzed to illustrate this rejection of smart home assistants and the traditional home characteristics and desires of the individual. Subsequently, these texts address the concerns that have been raised through the development and engineering of smart homes. In order to understand the origins of Alexa and Google Assistant it is important to examine the values placed on the home. Kirsten Gram-Hansen's *"Home is Where The Smart Is",* examines four key distinctions of a home: security and control, activity, relationships and continuity, and control. These aspects in my research paper will be scrutinized in the approaches and ideas to smart home assistants. To address the question of why smart home assistants, it is important to examine how human demand has adapted and shaped the responsibilities, acceptances and hefty rejections of smart home assistants. In *A Review on Smart Home technology*, Shruthi Suresh mentions "People with chronic illness, disabled, and old people are mostly benefited by smart home assistant application" where "Telecare schedule visits with health staff and community health workers automate collection of clinical findings"

(Suresh, 2015, Section III). With longevity increasing, there is a growing demand for means to

help take care of this demographic. The research paper following this prospectus will examine

these actor's relationship with smart home assistants in greater detail. Furthermore, Charlie

Wilson in *Benefits and Risks of Smart* examines the perspectives of the UK consumer market in

regards to consumer insights on smart home development. The results of some of the research is
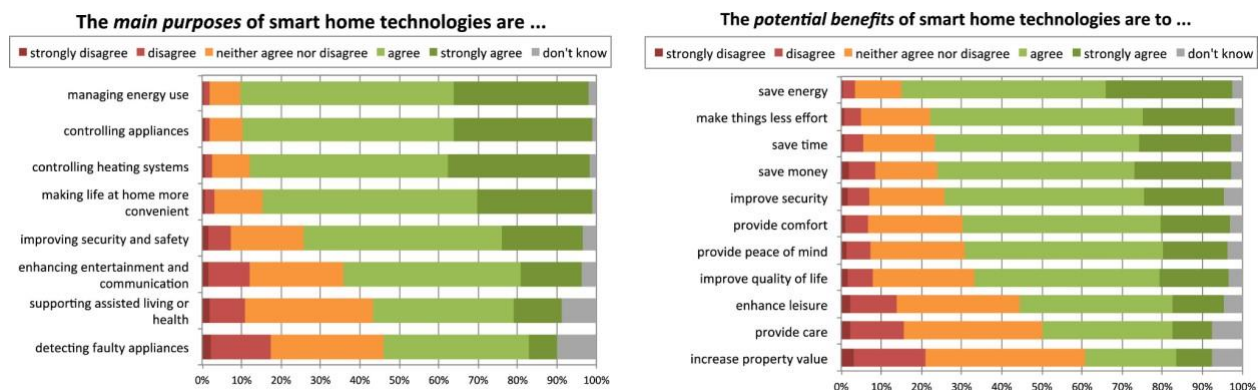
shown in the figure below.

Figure 3. Purpose & Benefits Smart Home Survey

Many of the opinions lead to smart homes that manage energy, promote convenience, and

improve security and quality of life. These reasons will be further investigated with an analysis

of the chronological developments of smart homes assistants Alexa and Google Assistant.

Considering the potential drawbacks of these virtual assistants, security is at the forefront of

consumer preferences. Wenda Li in *Motivations, Barriers and Risks of Smart Home Adoption*

states that for all potential of smart home assistants, there is still distrust and resistance much

stemming from security. She states that "the research found that one of the main barriers to

adopting smart home was with its basic component - the smart device itself lacks users' trust"

(Li, 2021, Pg. 20). This trust issue is largely driven especially in western cultures due to the

mainstream values of personal freedom and individualism. It is vital in this investigation to

examine how design engineers contemplated this philosophy and their response to these

drawbacks in modern culture. Both of these investigations influenced by SCOT will be used to

test my hypothesis of the fall of smart home assistants in mainstream markets.

Conclusion:

To conclude this prospectus, it is important to recognize the motivations for technologies so that

they can be shaped in a manner that ensures the benefits are for the best of society. This

prospectus highlights both an investigation into Smart Homes Assistants origins, growth, and

inevitable decline while illuminating through a physical design the importance of Smart Home

applications. The technical design of the smart fan will occur during the fall semester while the

research paper will occur during the spring semester following. This prospectus is an overview of

the research paper and provides context on the technical project.

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