Automatic Dog Feeder Design Project

An Analysis of Market Successes and Failures in Engineering Designs for the Disabled

A Thesis Prospectus
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Bachelor of Science in Electrical Engineering

By
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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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"Convenience for you is independence for me" said Todd Stabelfeldt, the quadriplegic CEO of C4 Database Management, in a Zoom interview about Smart Home Devices (as cited in Cericola, 2021, para. 1). People with severe disabilities have a much harder time doing basic things around the house and in some cases must rely solely on a friend or caregiver. As an engineer, I believe a part of love for neighbor must involve designing and building systems that provide a greater level of independence and dignity to people with disabilities. I want to investigate what it takes to build such a system as well as what has successfully been built in the past. For the Technical Capstone Project, my team will design and build an automated pet feeding station, where the user will be able to control feeding times/frequency, amount of to be dispensed, and water level to be maintained. The research project will look at and attempt to define common attributes of many of the home automation products which attempt to alleviate some of the burden on the disabled.

Automatic Dog Feeder Design Project

The goal is to build a working automated pet feeding station, which will dispense the user specified amount of food and water at the user specified time. The user will be able to interact with the system through a custom six button interface and a 20x4 character LCD display. An MSP430 Microcontroller will control the control the entire system based on this user specified data as well as information from the sensors. A load cell weight sensor is going to be placed under the food bowl and two water level sensors will be attached to the water bowl so that the microcontroller will know the current state of the system. The food dispenser will consist of a stepper motor attached to a modified candy dispenser design. Two twelve volt peristaltic pumps

will be utilized in dispensing the water. The frame of the device will be built out of a plywood sheet and long wood screws.

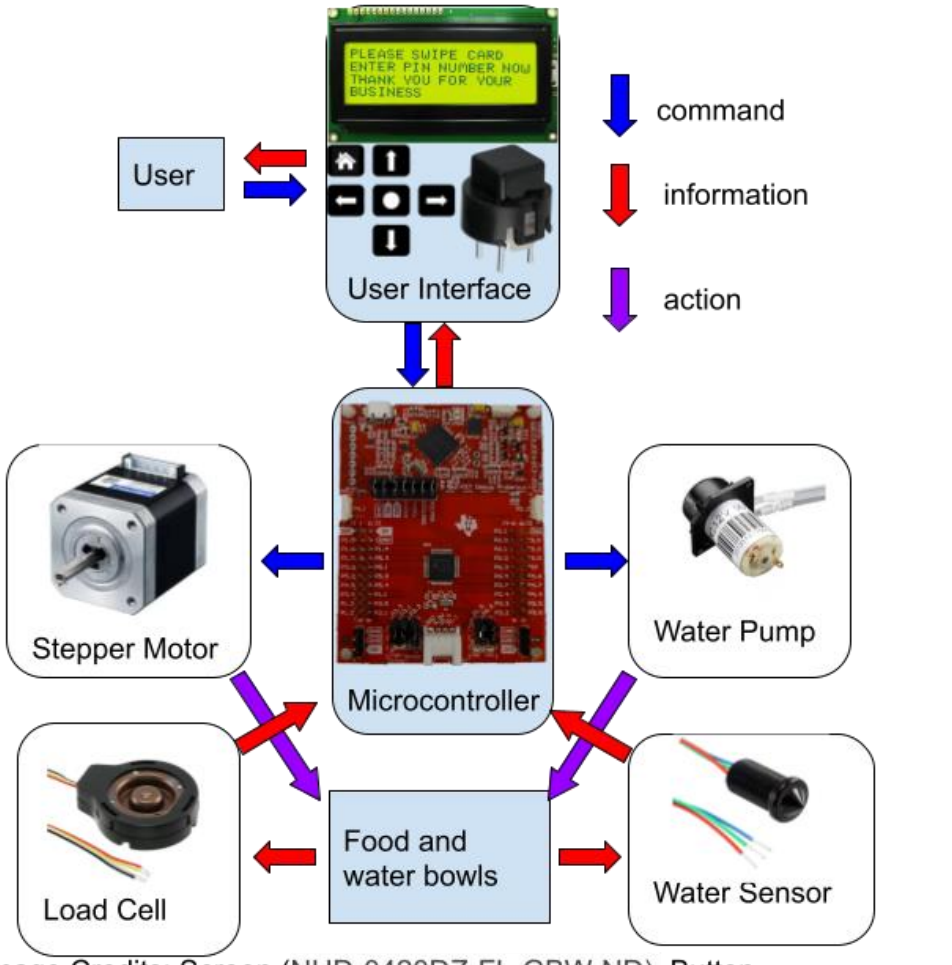

Image Credits: Screen (NHD-0420DZ-FL-GBW-ND), Button (401-1988-ND), Motor (2300-SF2424-10B41-ND), Pump (1528-1404-ND), Load Cell (223-1776-ND), and water sensor (725-1284-ND) come from the Digikey online electronics supplier at www.Digikey.com with the part number in parentheses

Figure 1, Overall System Block Diagram

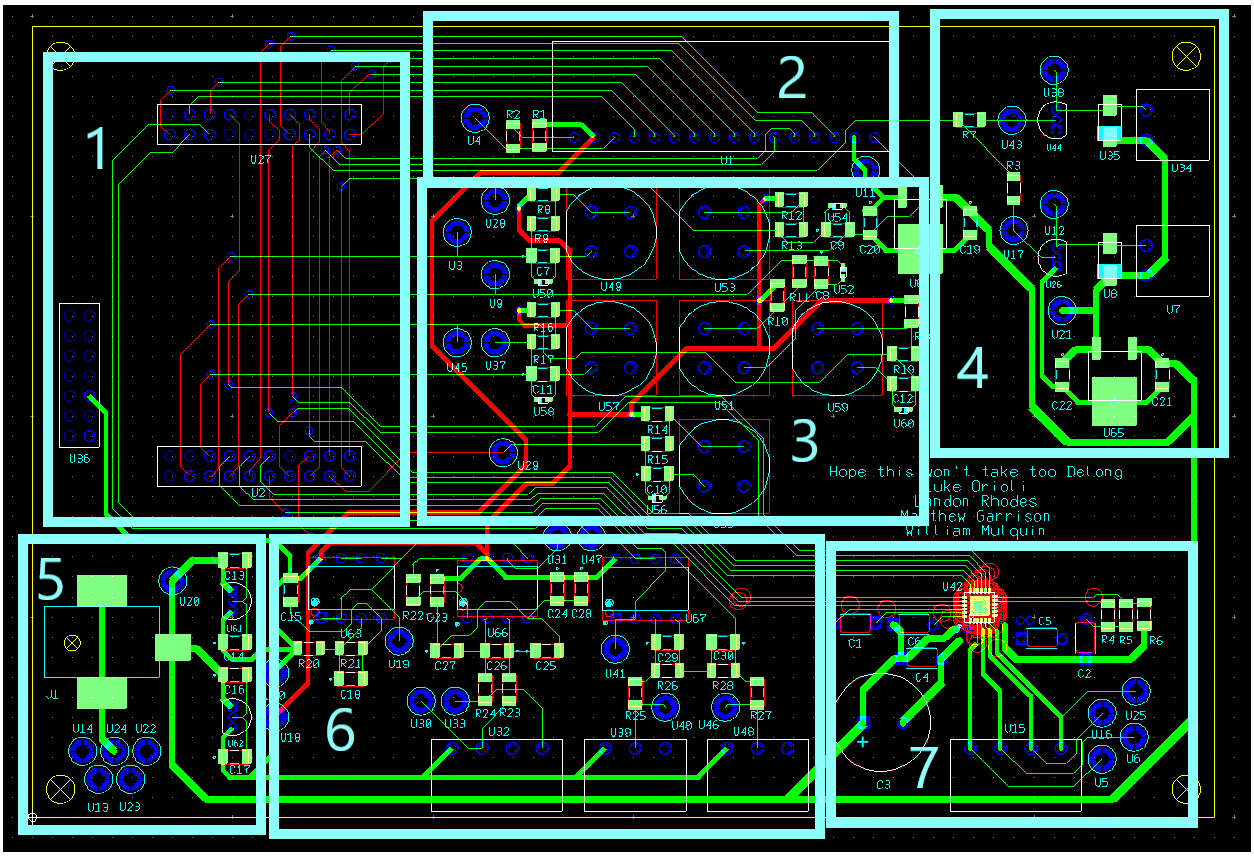

Figure 2 Printed Circuit Board Schematic

Figure 1 shows the overall block diagram of the system, and the colors in the arrows correspond to the type of signal being transferred. The red arrows say that the sensors collect information from the bowls and send it along to the microcontroller which may or may not be sent to the screen. The Blue arrows show which way the commands flow through the system and the purple arrows show where the commands turn into the real-world event of filling up the bowl. Figure 2 shows our printed circuit board design segmented into seven regions based on function. Block 1 connects to the microcontroller below the board and block 2 connects to the screen via a ribbon cable with 16 wires. Block 3 shows the arrangement of the six buttons in the user interface. Block 4 interfaces with the two peristaltic water pumps. Block 5 shows the power system input and the fat green wires leading away from this block are routed all around the board

supplying power to each component. Block 6 connects the three system sensors to the microcontroller through an amplifier stage. Finally, block 7 exhibits the stepper motor driver for the food dispenser.

One of the most useful resources available to our team is the weekly meeting with Harry Powell in the department of Electrical and Computer Engineering. We are also able to ask for help from Todd Delong and Avik Ghosh in the ECE department and multiple graduate teaching assistants. Each Capstone group is given a spending limit of $500 to purchase everything for the project. The 3D printers in the Mechanical Engineering department have been made available to us at a reasonable rate if we ever need a custom part. Finally, we are all given anytime swipe card access to the NI circuit design laboratory to work on our project.

An Analysis of Market Successes and Failures in Engineering Designs for the Disabled

The goal of this research project is to investigate market successes and failures in the design of home automation systems for the disabled.

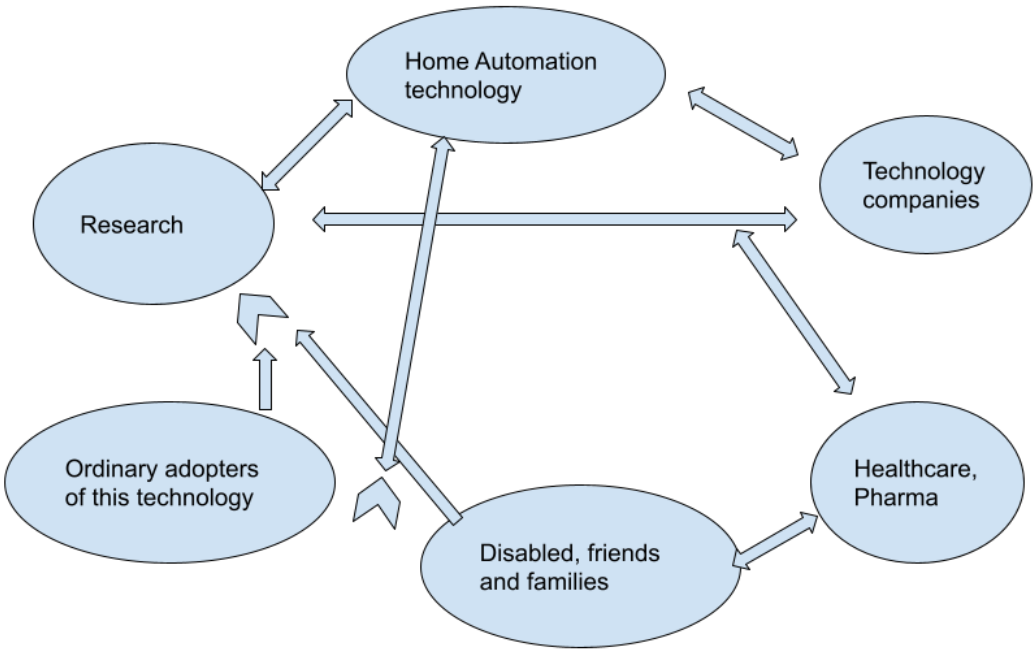

Figure 3 Actors and some obvious network connections associated with Home Automation Systems

Figure 3 above shows a network of actors in the societal system of home automation systems. First of all, the technology companies will manufacture and distribute the home systems to both disabled and nondisabled users and they would send money and requests to Research in exchange for project prototypes. The technology companies could be somewhat at odds with the Healthcare companies because if the disabled person is more independent as a result of home automation systems, then that would necessarily mean less reliance on someone like a nurse for care, causing less income for the healthcare companies. Both groups of technology users would use the home automation systems as expected, the disabled to increase their independence and ability and the ordinary users to increase convenience or something else. Both groups aid in

research by providing them with problems to work on and features to experiment with. Each of these bubbles have a significant role in determining the development, production, and use of these home automation systems.

These are a few examples of current research into this area of disability assistive technologies. The authors Faroom, Ali, Yousaf, and Deen (2016) from the University of Lahore in Pakistan performed a comparison survey of six ways in which disabled people can interact with a machine, including phone applications, Gesture Human-Machine Interface, speech recognition, and Electro-Oculography signals. They organized all of their findings into a table which examined the effectiveness of each interface with different types disabilities. The authors Fan and Liu (2015) at the National Taipei University of Technology developed a system which would allow the computer to interpret commands simply by means of a hand gesture. This system uses advanced image processing techniques to track the hand and the fingers as they move throughout space. This could be an extremely useful system for someone who is confined to a wheelchair but their arms are free to move. Additionally, the researchers Bhemjibhaih, Sanjay, Sreejith, and Prakash (2018) at the BITS-Pilani K K Birla in Goa, India developed a prototype of a system which measures location and orientation of a person in a room as well as neuron attention levels using a Brain Computer Interface and is able to determine what the user is paying attention to in a room and what might the desired task be based on that information. For example they were able to demonstrate turning on a lamp across the room by simply looking at it. This would be a game changing technology for those severely disabled to the point that they cannot move their own limbs.

Linking Technical Work and Research Project

The Technical project to build an automated pet feeding station as a potential aid for the disabled will help me gain a deeper understanding of the many questions that need to be considered when designing a new product. Through investigating previous work done in this area of home automation systems in the research, I hope to gain a greater appreciation for the varied technological solutions which help alleviate some of the struggles that many fellow citizens around us go through on a daily basis. Both of these projects are related by trying to help the disabled with home automation systems.

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