

Prospectus

Development of a Multi-purpose Lamp that Adjust Brightness Automatically

An Examination of the Advantages and Potential challenges introduced by Smart Home Technologies

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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Introduction

Lamp is a piece of furniture that exists widely in our homes. This widely used lighting tool has many sub models developed for a certain purpose: reading lamps are bright but only illuminate small area; floor lamps are made to light up the entire room but not capable of moving around; night lamps lights are useful at nights but lose all its brightness at daytime. In order to gain sufficient light at different scenarios, more than one lamp must be purchased in a single room. Thus, our capstone project aims to design a multi-purpose portable lamp ideal for both daytime and nighttime illumination. It is our hope to replace all kinds of lamp in the room with a smart lamp. With the word "smart" in mind, this lamp can be definitively categorized into the family of smart home devices. It is obvious that these smart home devices provide benefit by making our life easier. The question naturally comes in what degree does the smart home facilitates and are there any potential challenges hidden under these benefits.

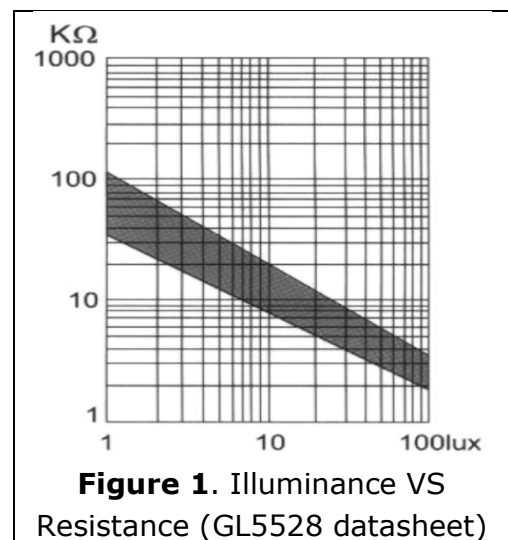
Technical Topic

The average number of lamps per household in United States has reached 7.9 and a 15 percent of respondents from a consumer server spend up to 50 dollars a year on light bulbs (Tiseo, P., 2018; Statista Research Department, 2019). A considerably large number of lamps are used in one room to produce sufficient need for different scenarios. There are many products available commercially trying

to integrate multiple functions into one lamp: Soarz has produced a plug in Led floor lamp with manual brightness adjustment and automatic illumination work in multiple rooms (Soarz, 2020). The MAX-TEK Store has produced a plug in Led night light with manual brightness adjustment and automatic illumination (MAX-TEK, 2020). Under the guidance of Harry C. Powell Jr, Ph.D., Associate Chair of Undergraduate Programs in the School of Engineering, and Adam Barnes, M.D., Senior Lecturer, our team will develop a multi-purpose lamp that can reduce the number of lights needed in a room.

Our lamp differentiates itself with the existing products by having both manual and auto brightness control. The light can change from a reading lamp to night lamp by pressing a switch. The core component for the auto-light adjusting system

is the Light Depend Resistor (LDR). This resistor changes its resistivity according to the light intensity (see in Figure 1). The resistance of the LDR decreases exponentially as the light intensity increases. In We have designed a set of circuit used in combination with the LDR to transform the variance in light intensity to a



voltage signal from 1-3V range. This voltage signal is transmitted into a microcontroller for further process. The microcontroller then adjusts the output

voltage to the LED lights based on the input signal. Daytime mode and nighttime mode have different algorithms to process the LDR signal. The recommended lighting level for reading is around 300-500 Lux, which is the target range for our lamp to auto adjust to when daytime mode is on (Archtoolbox.com, 2020). When the lamp is set to nighttime mode, the lighting level is set to 3 Lux, which is a little less than the 5 Lux maximum value for sleeping (sleepscore.com, 2020).

The LED system is controlled by a transistor. A transistor has three ends: gate, source and drain. When the voltage across source and drain is kept constant, adjusting the voltage at gate will control the current flowing through source and drain. The source and drain are connected in series with the LED system and powered directly by 12 V input power. The gate is connected with the microcontroller. The microcontroller outputs a voltage signal based on the input from the LDR circuit. The voltage at gate will control the current flowing through the LEDs and thus control the brightness of the lamp.

Besides the automatic part, a rotary knob can be used to control the brightness manually. When the switch is in manual mode, the rotary knob overrides the signal from the LDR unit and takes over command.

The lamp is powered by a 3.7 V lithium battery pack. A boost converter converts the battery output to 12 V to supply the LED units. Another 3.3 V output for

the microcontroller is produced by a voltage regulator connected to the battery. The rechargeable battery provides mobility for the lamp.

The next step into the project is to implement the lift to light up mode at night. The purpose is to help people find their way from bedroom to bathroom. The light will turn on automatically when it senses an acceleration, which indicates the user has lifted it up. The light will be on as long as the acceleration sensor senses a motion and dims 1 minute after the last motion is received.

STS Topic

Smart homes nowadays are common items in our homes. There is an explosive growth in the number of smart home products in recent years. The market for smart home products will see dramatic growth over the years. The smart home market in Europe alone, was valued at EUR 529.6 million in 2010, with a 18% increase compared to the market in 2008 (IEA, 2013). A wide range of public-funded projects across the EU aims to facilitate the growth of smart home devices, making the future more and more prosperous (Gangale et al., 2013). The growth of smart home products has brought us advantages as well as challenges.

The emergence of smart homes has benefited users' lives in various aspects.

According to the Energy Efficiency Market Report published in 2013, the deployment of smart homes can reduce between 10% and 25% in electricity demand (IEA, 2013).

A national survey on how prospective users perceived benefits and risks of smart home technologies showed that 86% of the respondents treat them as an energy management lens (Charlie, 2017). Researches above clearly indicate that energy saving is and very likely to be the most important factor for users who bought smart home technologies.

Besides saving energy, smart home devices enable users more control over their home than traditional furniture. Smart home technology combines sensors, monitors, interfaces, appliances and network together to perform automation and remote control of the home environment. Users control smart home technologies by pre-set, scheduling, automated response and user input or adjustments. A national survey suggests that 90% of participants regard control over the domestic environment as the principal purpose of smart home devices. (Charlie, 2017). The ability to control things at home gives users a sense that they are in charge of everything and a sense of owning the home instead of just living in it.

However, smart home technologies do not always provide benefits to users, there are challenges coming along with the advantages provided by them. The first obstacle is time. The installation process could make users realize the systems were

complex and would take time. Other aspects of their daily lives take up the time and prevents them engaging in the boring and obscure installation process (Tom & Charlie & Richard, 2017). Besides the time for installation, the time takes to get used to the entire system is also demanding and could take months. Another challenge comes along with installation for users is the inability to control the system after professionals finished installation. A participant in a research on smart home technologies had complained that she was not able to turn on / off the radiators in living room and bedroom because they are zoned together with the aid of research team during installation and lost control to the zoning function for the first 2-3 months when she was along (Tom & Baldwin, 2015). Users who are unfamiliar with the smart home technologies are not likely to spend time researching on them. There is a great chance that user will lose access to parts of the system without professional help. The partially functioned smart home system could cause discomfort rather than convenience.

Next Steps

The paragraphs above suggest that smart home technologies bring convenience to everyday life by giving users excessive control over the devices in home and thus saves energy. However, if users are unable to control the system, all the functions designed for make life easier will turn backward. Throughout my thesis, I

will analyze on what factors has the manufactory, like Apple Home, Amazon Alexa and Google Home, introduced in their products for easier and better control. On the costumer point of view, I will exam the logic behind how a user uses a product and what users expects the product to be and why some functions are typically confusing and hard to use.

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