Faculty of Electrical and Electronic Engineering Technology

THE DEVELOPMENT OF ELECTRICAL CONTROL SYSTEM USING POWERLINE COMMUNICATION TECHNOLOGY

WAN SYAFIQAH ALYA BINTI WAN MAZUWINE

Bachelor of Electrical Engineering Technology with Honours

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THE DEVELOPMENT OF ELECTRICAL CONTROL SYSTEM USING POWERLINE COMMUNICATION TECHNOLOGY

WAN SYAFIQAH ALYA BINTI WAN MAZUWINE

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in partial fulfillment of the requirements for the degree of
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DEDICATION

This project work is dedicated to my husband, Mohamed Zaki Bin Mat, who has been a constant source of support and encouragement during the challenges of study and life. I am truly grateful for having you in my life. This work is also dedicated to my parents, Maziyah Binti Mat Daham and Wan Mazuwine Bin Wan Mohamed @ Wan Mazelan, who have always loved me unconditionally and have taught me to work hard for the things that I aspire to achieve.

ABSTRACT

In particular when the system has a number of control points and switches, the traditional electrical control requires extensive wiring. This may lead to expensive wiring and maintenance costs. Powerline Communication (PLC) technology can solve this issue by controlling numerous points with just two wires which is the live and neutral wires, in which all points and switches are attached onto the cables. To overcome these problems, an electrical control system is designed and developed using powerline as a medium of communication. The prototype is developed by using two Arduino Uno as the main controller with a pair of KQ-330F power line carrier module which will act as the transmitter and the receiver of the control system to establish connection through the powerline to allow powerline transmission. The PLC transmitter produces and modulates a high frequency signal into the power line. The PLC receiver receives the high-frequency signal and activates the electric point to provide electrical power. To verify its effectiveness, the designed device will be tested at home electrical system. As a result, maintenance costs may be reduced and helps reduce issues of extensive and complicated wiring whenever needed.

ABSTRAK

Dalam sesebuah sistem pendawaian mempunyai berbilang titik kawalan dan suis, pendawaian elektrik memerlukan sambungan pendawaian yang banyak. Hal ini akan menjurus keada pendawaian elektrik dan kos pembaikpulih yang sangat tinggi. Teknologi komunikasi talian kuasa dapat menyelesaikan masalah ini dengan mengawal beberapa bilangan titik kawalan dengan hanya menggunakan dua jenis wayar iaitu wayar hidup dan neutral, diamana kesemua titik kawalan dan suis telah direka untuk bersambung kepada kedua jenis wayar tersebut. Bagi mengatasi isu tersebut, sebuah sistem kawalan elektrik telah direka dan dihasilkan dengan menggunakan teknologi talian kuasa sebagai medium komunikasi. Prototaip projek ini dihasilkan dengan menggunakan dua Arduino UNO sebagai pengawal utama bersama dengan modul talian kuasa KQ-330F dimana modul tersebut akan berfungsi sebagai penghantar dan penerima data dalam projek ini bagi menghasilkan sambungan melalui talian kuasa untuk melaksanakan transmisi talian kuasa. Modul talian kuasa penghantar akan menghasilkan dan memodulasi signal frekuensi yang tinggi kedalam talian kuasa. Modul talian kuasa penerima pula akan menerima frekuensi tinggi tersebut dan mengaktifkan titik kawalan yang dikehendaki bagi menghasilkan tenaga elektrik. Bagi memastikan keberkesanan projek ini, prototaip yang telah dihasilkan akan diuji terhadap sistem pendawaian rumah yang diguna pakai kini. Dengan itu, kos pembaikpulih akan dapat dikurangkan dan dapat menyelesaikan isu pendawaian yang banyak dan rumit apabila diperlukan.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Houses usually have many types of house wiring, involving lighting and power distribution wire, permanently mounted and detachable devices, telephone, heating or ventilation systems and more. Before the walls are completed, all electrical services may be simply wired. Installing a new system, such as a security system or home theatre, in an old structure may need extra work to do concealed wiring. Multiple unit buildings, such as condos and apartment houses, may have extra installation difficulty in utilities inside a property.

Powerline Communication (PLC), is a type of communication that utilises existing electrical infrastructure to transport both data and alternating current (AC) power. There are several applications for powerline networking. It is mostly used in the house for home automation (smart home) and internet access, but it is also utilised in industrial and commercial contexts, such as by utility companies for remote metre readings. The powerline may transport data by superimposing a low-energy information signal on top of the power wave, allowing them to flow through each other without interfering. To guarantee that the power wave does not interfere with the data signal, data is delivered at a minimum of 3 kHz. The home's electrical wiring may carry signals at a number of frequencies. Electricity typically travels at 50/60 Hz rates, allowing data to use the same cables as electricity but at a much higher frequency, ensuring that the two do not interfere.

This project can be enhanced even further by combining the PLC technologies to electrical wiring system that will result in less wire than a convensional wiring system Furthermore,since powerlines may link over long distances, a PLC-based wiring system can have a broad range of control, which is beneficial for remote applications.

1.2 Problem Statement

According to Flammini et al (2009), in the last several years, wireless technologies have surpassed the traditional networking sector. These technologies, however, can only be employed up to a certain point. As a result, by utilising existing powerlines, the communication range may be extended as far as the powerline will allow. Powerline communication can minimise wiring in medium and large-scale control systems with a high number of sensors and actuators, decreasing development costs. For systems with controllers, sensors, and actuators that are separated from one another, these savings will be considerable. In term of electrical wiring system, PLC technology can significantly reduce and simpling the wiring installation, and also capable to control the electrical appliances from afar. Simple wiring system will result in low maintenance expenses and ease to troubleshoot if there is any occurrences of wiring fault.

1.3 Project Objective

The main goal of this project is to create a basic prototype that shows how to use powerline communication to control an electrical system. The following are the objectives that will be met at the conclusion of this project:

a) To design PLC-based electrical control system for home electrical system

b) Verify the efficacy of the developed system

1.4 Scope of Project

The project's limits were briefly discussed, with an emphasis on powerline communication, microcontroller programming with the Arduino IDE, circuit design, and the goal of creating the hardware. The following is a list of the project scopes in detail:

a) 240V Single Phase Home Electrical System

The single phase wiring system will be used as the medium to transfer the data from the transmitter to the receiver of the PLC module.

b) Powerline Communication

The Power Line Data Communication Module will be used to transport broadband data over a power line, making it ideal for both residential and business power line network applications.

c) Circuit Design

The circuit is designed to allow powerline communication, with Arduino micro controllers serving as servers and powerline adapters connecting to the power line.

d) Program Development

Arduino Uno is the micro controller utilized in this study thus the Arduino IDE software was utilized to setup the Arduino micro controller to allow communication.

e) Development of prototype

To ensure that the intended circuit is efficient, a hardware prototype is created. The developed device will be applied to the wiring for switches, switch socket outlet and lighting.

CHAPTER 2

LITERATURE REVIEW

2.1 Traditional Wiring for Home Wiring

Homes usually include various types of home wiring, including lighting and power distribution electrical wire, permanently fixed and portable devices, telephone, heating or ventilation control systems and, increasingly, household theatre and computer networks. Entry ports into the residence and a site for connection equipment are usually required for power and telecommunication services. A cable is routed overhead or underground into a distribution board in the residence for electric power distribution. Before the walls are built, the wiring for all electrical services can be easily installed. Installing a new system, such as a security system or a home theatre, in an old building may necessitate extra effort for concealed wiring. Multiple unit residences, such as condominiums and apartment buildings, may have more installation complexity when it comes to distributing utilities within a home.

2.2 History of traditional wiring

Electrical service to American houses began in the late 1890s and peaked between 1920 and 1935, when 70% of households were linked to the electrical utility grid. Several major advances in the procedures for putting wire in those dwellings occurred during the next 200 years, all aimed at increasing the safety of electrical systems.

2.2.1 Knob-And-Tube Wiring

From 1890 to 1910, the knob-and-tube wiring system was the most common method of installation. For the time, it was a solid system, and a surprising proportion of American

homes still have knob-and-tube wiring in place, frequently alongside more contemporary upgrades.

Individually conducting wires are placed in stud and joist cavities, kept in place by porcelain knob insulators connected to the sidewalls of framing members, and protected by porcelain tube insulators where the wires pass through framing members in knob-and-tube wiring. For safety, hot and neutral wires were routed independently in this wiring scheme. Long circuit lines may also be built using the technique by connecting together lengths of wire. To do this, the insulation was removed, a second wire was coiled around the revealed bare wire, and the splice was soldered together before being taped up. The disadvantage was that the cable was exposed and no ground wire was utilised.

2.2.2 Flexible Armored Cable (Greenfield)

Electrical installations shifted to a more protective wiring scheme—flexible armored cable—from the 1920s through the 1940s. Flex, also known as Greenfield, was a great addition to house wiring since the flexible metal walls protected the wires from harm while also providing a metal route that could ground the system when placed properly. This wiring approach had significant drawbacks, despite the fact that it was an upgrade. The elastic external metal jacket functions as a suitable ground only if the metal route is complete all the way to the service entry and grounding rod, despite the fact that the particular wire conductors are shielded. In these setups, there is still no isolated ground wire.

2.2.3 First-Generation Sheathed Cable

A faster installation technique was created in 1930s. Nonmetallic-sheathed cable was born, with a rubberized fabric coated sheath, similar to knob and tube wiring, but with the hot and neutral wires combined in one sheath. Due to the absence of a ground wire, it had certain

limitations, but its progress would eventually lead to considerable innovationEarly encased cable, on the other hand, has a 25-year anticipated lifespan, and while it is still in use, such installations must be updated.

2.2.4 Metal Conduit

The metal conduit era began in the 1940s. Users may pull many separate conducting wires in the same rigid metal tube casing using this innovation. The conduit is a valid grounding technique in and of itself, and the system may also allow another earthing wire to be drawn through it. Ever since, conduit has been the suggested technique for wiring in some situations, such as where wire must be run down the face of basement stone walls or in exposed areas. Conduit is utilized in various sections of most homes, however it is now often composed of hard plastic PVC conduit instead of metal.

2.2.5 Modern NM (Non-Metallic) Cable

About 1965, the newest upgrade to wiring was implemented. The new NM cable had a bare copper earthing wire that connected the insulated hot and neutral wires within the sheathing, which was an improvement over earlier NM cable. Modern NM cable has a highly strong and durable vinyl sheathing instead of rubberized sheathing. The MN cable became more affordable and simpler to instal with this upgrade. It's a versatile product that's found in almost every new house.

2.3 Advantages and Disadvantages of Traditional Wiring

Electrical wiring is necessary since it provides electricity to the home's power circuit and also providing electricity to all appliances. This kind of wiring is safe, and it makes it simple to utilize all of the electrical equipment that are used in houses on a daily basis. It also helps

to minimize excessive wiring because the primary wiring is completed internally and the only wire that remains outside is the equipment wire. The damage also will be lesser since the wires will remain hidden within the walls. This type of wiring also helps to make it easier conduct maintenance and renovations which results in no interruptions due to wires and everyone who is performing the duties is safe. Because all cables are fitted within the walls, there is no chance of shock or other hazards from wires, and there is no risk of touching any of the appliances or switches. Other than that, external elements such as wind, high temperatures, and rain have no impact on it, and therefore these factors might well be ignored because the wires are not vulnerable to them.

However, in order to have a good electrical wiring network, this will result in it to be more costly than using alternative methods to wire a home. Due to the wires are embedded within the walls, it may be difficult to determine where the wires should be fixed if an error or issue occurs. The procedure of adding the electrical wiring while the house is being constructed is also very tough, even relocating switches is not possible. If in later time, the owner of the home wishes a connection or wiring to be made in another room, it is very difficult and complicates the process. Everything should be properly analyzed. All rooms should be thoroughly accessible in accordance with the convenience of the equipment and cabling that should be done.

2.4 Application of Traditional Wiring

The traditional wiring for domestic and commercial premises is usually applied to the following items:

2.4.1 Power Point (Switch Socket Outlet)

Electricity points must be placed throughout the whole home where power is needed. In many places, the setup must be carried out by licensed or trained electricians and in conformity with standards. Power points are usually placed where a telephone, computer, television, home theatre, security system, etc., are situated.

2.4.2 Light Fittings and Switches

The number of lights depends on the type of lights and the lighting needs for each room. The incandescent bulb made domestic illumination feasible, but contemporary houses utilize a broad range of light sources to offer better energy efficiency than light bulbs. The technician can give precise lighting recommendations in a property. The layout of lighting in the house should take account of lighting control since it impacts the cabling. For instance, multi-way switching is helpful for hallways and stairways to allow light to be activated and disabled from two places.

2.4.3 Telephone

Telephone cables between the service entry of the telephone provider and points throughout the residence are necessary. Often a home has telephone ports in the dining, study, living room or bedrooms. Laws of telephone companies may limit the overall number of telephones that can be used simultaneously. Typically, the cable utilizes two pairs of twisted cables connected to a connector. The cable is usually placed as a daisy chain first from point at which the telephone company links to the domestic or the outlets and then connected back to the entry.