Novelty Journals

ISSN 2394-7314

International Journal of Novel Research in Computer Science and Software Engineering
Vol. 8, Issue 1, pp: (1-6), Month: January - April 2021, Available at: www.noveltyjournals.com

IMPLEMENTATION C++ MICROCONTROLLER FOR SAVING ENERGY IN SPLIT UNIT AIR CONDITIONER

Mohammed Hussain Dilemi[1], Yazeed Al Moaiad[2], Najeeb Abbas Al-Sammarraie[3]

[1,2,3] Al-Madinah International University, Malaysia

[1] mediuphd@gmail.com, [2] yazeed.alsayed@mediu.edu.my, [3] dr.najeeb@mediu.edu.my

Abstract: **By the nature of the electricity, the energy consumption is accompanied by heat, so the temperature monitoring and measurement is a good approach to energy saving. Most of the transducers and sensors of parameters are electronic components, so a temperature sensor can do the main job of temperature monitoring, with an electronic microcontroller, will achieve an efficient energy waste reduction. There are other variables like light, humidity, voice, infrared, and others, some of them will be monitored as well by their respective sensors. In this paper, the typical educational microcontroller Arduino board will be discussed. For sure, other complicated microcontrollers, like Microchip PIC products or even Siemens and Allen Bradley PLCs and SCADA systems, are possible to be used with projects that are more complicated. The energy has different forms, such as heat, light, force, mechanical movement, and other forms, these forms are convertible from a form to another by Transducers. The controllers are programmable to perform a specific monitoring function, based on an algorithm, to give alerts of any energy waste. The controller, as well, will help to predict the loss, which is coming up due to unprogrammed energy consumption change.**

Keywords: **Energy saving, smart home, microcontroller, Arduino, temperature sensor.**

I. INTRODUCTION

The electronic sensors manufacturing technology has witnessed great advance to manufacture addressable digital sensor, connected to a single line. The C++ programmable microcontroller is used to read the ambient environment and variables, like temperature and pressure. The energy consumption and waste, consequently the global warming, is one of the most issues that alerting the world to the necessity of taking serious measures to reduce as much as possible the huge losses of energy, to save people lives efforts and time, money, and many other risks the world is vulnerable to, due to energy losses.

The studies show that residential energy consumption is distributed as in fig 1.1, as per the US government energy official website (Department of Energy - USA Building Energy Data Book, 2011).

The waste reasons can be categorized as follows:

- Insulation deficiency
- Performance issues
- Misbehavior of users
- Others

International Journal of Novel Research in Computer Science and Software Engineering
Vol. 8, Issue 1, pp: (1-6), Month: January - April 2021, Available at: www.noveltyjournals.com

The figure shows that the HVAC appliances are the main portion of the energy consuming appliances including space heating and cooling. Space heating and cooling appliances consist of compressors and condensers, which is the main cause of performance deficiency and hence the energy waste [1].

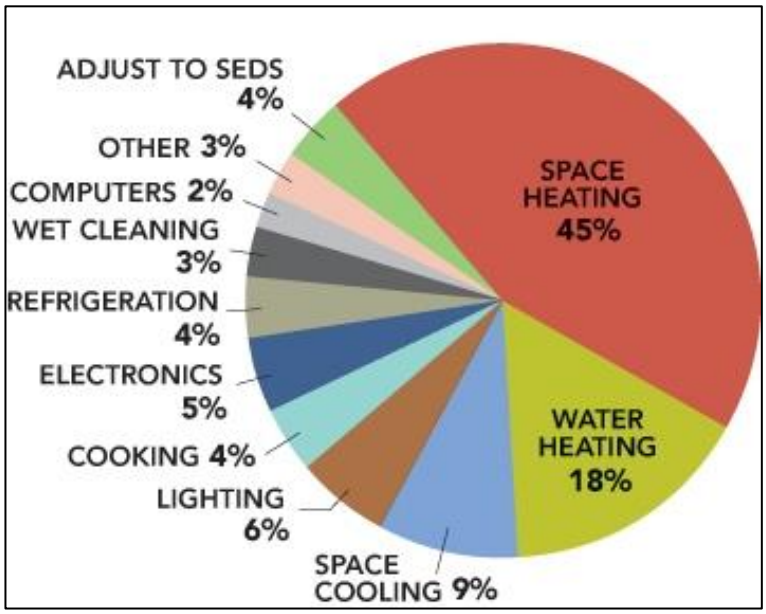

FIGURE 1: ENERGY DATA BOOK, SECTION 2.0

The condenser and evaporator fan motors blow the air at the condenser and evaporator to absorb the heat from the gas in the condenser and evaporator pipes respectively and dissipate it to the ambient. Therefore, the earth and other contaminants, by time, accumulate on the pipes, causing poor heat exchange with the ambient and consequently poor performance causing increasing energy waste (The Importance of Cleaning Coils - the Australian Institute of Refrigeration, Air Conditioning and Heating).

There are various signs and symptoms of this accumulation of contaminants on the pipes, but the increase of temperature degree and heat accumulation in the heat exchangers is the main sign and the easiest way to diagnose by putting sensors on the pipes to monitor the temperature and take the action accordingly.

Normally the compressor is compressing the gas raising its pressure and consequently its temperature degree according to the combined gas law [2].

Charles's and Boyle's laws are the basic laws the air conditioning industry depends upon, so the accumulation of heat in the condenser will increase the pressure inside the condenser, leading to overloaded compressor and may be to be damaged.

The compressor draws a rated amount of electric current; this current will increase with the gas temperature and pressure, causing substantial energy consumption to increase and losses, which is referred to in this paper as unprogrammed change in the energy consumption.

The combination of sensors readings of different components of the air conditioner will lead to diagnose the deficiency reason, helping the end users to manage their consumption of electricity energy, and act against any failure or maintenance need [3].

Habits are another cause for wasting energy at homes, the programmed control boards can remind and even take actions to stop or reduce the wasting.

Lighting can be fully controlled by the controllers to reduce the energy consumption to minimum.

All these different factors can be linked together by the controller to reach the smart home target [5].

International Journal of Novel Research in Computer Science and Software Engineering
Vol. 8, Issue 1, pp: (1-6), Month: January - April 2021, Available at: www.noveltyjournals.com

II. PROBLEM STATEMENT

In the houses and residential units, the energy loss is mainly happening in the HVAC appliances, and secondly in the lighting, as shown in fig 1. Buildings Energy Data Book, Section 2.0 Department of Energy – USA 2011, Compressors, heaters, motors, and lamps are the main energy consuming items.

Lighting: waste in lighting is coming due to wrong habits of the users and use of high wattage old products in place of energy saving modern lamps. (Energy Saving Through Smart Home) [4].

The misbehaviors of the user cause to lighting energy waste, such as leaving the lighting equipment on while spending a long time outside the room or having a half an hour of bath [7]

III. RESEARCH OBJECTIVES

1. How? To investigate current temperature related methods of energy consumption monitoring tools.
2. To develop a temperature detection module that can detect energy loss in electrical appliances using programmable micro controllers and temperature, light, infrared, and other sensors.
3. Why? To evaluate developed energy loss detection module.

IV. METHOD

A. Introduction

The principle of smart home is to provide an environment, which is safe for the people to live. It, as well, helps for energy saving, healthy, and a place, which is comfortable, in the new perception of safety and health, for the people to live in. the principle is a combination of information system with mechanical and electrical engineering. Most of such systems, currently available, are products that put the user's satisfaction on the top of their priorities than the main needed goals, which are the more serious issues like energy saving. The manufacturers are focusing on the power dissipated and current drawn by the appliance, because it leads to more sale of their products [11].

In this research the approach is to continuously monitor the appliance while it is running, which is a real saving of energy one can achieve, just as important as the amount of power dissipated and current drawn.

Only the information system side will be studied in this research. The proposed system, which is open source, is the Arduino microcontroller. It is an open-source controller will be used to perform the functions of reading the temperature sensors output to achieve the smart homes target.

This microcontroller is typical electronic system, consists of the following functions: input, output, and energy monitoring functions. Detailed information of this controller is discussed in this chapter.

This module is ready to be used with various systems, each system has its variables, temperature, light, pressure, and others, each of these variables can be measured by a transducer, which is giving an electrical output signal [12].

B. Arduino Electronic Module

Arduino is an electronic, open-source, controller. It is easy to program from the Windows laptop or even Android tablets. Arduino boards can read inputs as electrical signal. These signals are obtained by transducers, which are transferring heat, light pressure, and other forms of energy into an electrical signal.

The controller can receive the fingerprint or eye print as well, and convert it into a Twitter message, or even an email or an SMS. The output signal is normally a 5V or 3.3V, which can activate a relay, an electronic circuit, or even a low power motor, turning on an LED, or publishing something on the web.

The user can control the board by writing a sketch, which is a set of instructions, and sending it to the microcontroller board. The instructions are written in C++ language. The user uses the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing [6].

Over the years, Arduino has been expanding to be the core controller of tens of thousands of projects, ranging from simple projects to complicated projects of scientific instruments. Arduino is being used in robots, industrial controllers, monitoring and alarm systems, and many other applications that fit its specifications. Arduino boards are using the

Microchip microcontrollers MEGA series, as an easy tool for fast prototyping. The Arduino is now using a software consists of a standard programming language compiler and a boot loader that executes on the microcontroller [9].

Modern IoT applications and projects are using the Arduino. All Arduino hardware and software are completely open source, which empowers the users to freely design their own projects and adapt them to their own specific needs and goals.

Arduino is working on Windows, Mac IOS, Linux, and recently a developer has developed an Arduino platform for Android.

C. Proposed Monitoring Method

The temperature increases with the accumulation of the heat in the condenser, this is considered as a malfunction of the heat exchanger i.e., the condenser, hence the heat dissipation through the condenser fins, which is blown by the condenser fan motor blades, will be influenced. The researcher is going to monitor the temperature of the different parts, which are vulnerable and exposed to such heat excess or stumbling heat exchange.

The temperature monitoring process can be changed by changing the algorithm, to get flexible approaches to apply the energy saving on the other appliances broadly.

D. Temperature Measurement

Temperature can be measured via a diverse array of sensors. All of them infer temperature by sensing some change in a physical characteristic. Six types with which the engineer is likely to come into contact are:

- Thermocouples,
- Resistive temperature devices (RTDs and thermistors),
- Infrared radiators,
- Bimetallic devices,
- Liquid expansion devices, and
- Change-of-state devices.

V. EXPERIMENTS

A. INTRODUCTION

The researcher has done experiments on the different issues that the air conditioner may be exposed to, starting from the regular dirt accumulation on the condenser to the gas leak up to the compressor failure. The researcher stimulated the control system by exposing the sensors to the temperatures expected in case of defect.

FIGURE 2: OUTDOOR UNIT AIR CONDITIONER

B. EXPERIMENT 1: MONITORING THE AIR CONDOTIONER – DIRT ACCUMULATION CASE

Purpose of experiment: to monitor the behavior of the air conditioner parts in case of dirt accumulation on the condenser, to give an alarm for the problem to the air conditioner user, to take the needed action to save the energy.

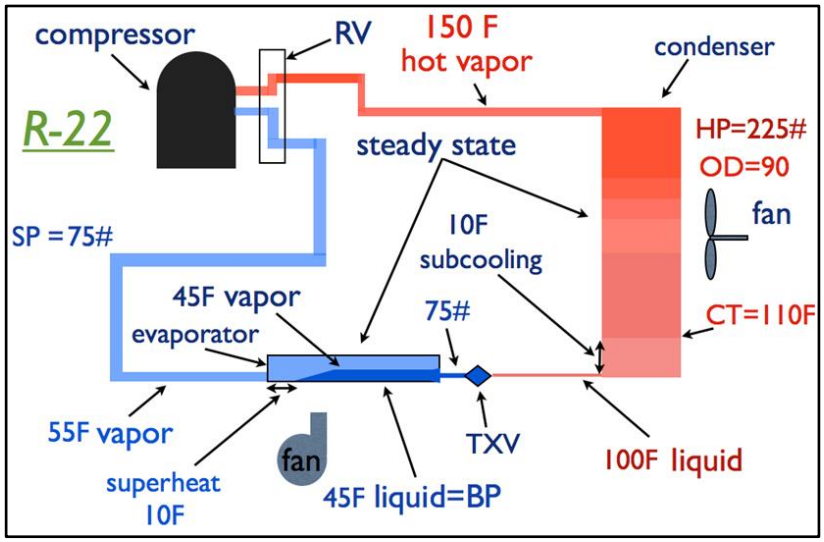

FIGURE 3: EXPERIMENT 1

VI. CONCLUSION

The energy has different forms, such as heat, light, force, mechanical movement, and other forms, these forms are convertible from a form to another by Transducers. The controllers are programmable to perform a specific monitoring function, based on an algorithm, to give alerts of any energy waste. The controller, as well, will help to predict the loss, which is coming up due to unprogrammed energy consumption change. Therefore,

The experiences that have been completed will take into consideration the following issues:

- Make a complete sketch for the whole control of the air conditioner.
- Introducing more complicated mathematics in the control code, so as to save more energy and money.
- Using more complicated control mechanism, that is the Proportional Integral Derivitive Control Mechanism (PID), to save even more energy, hardware, and consequently money.
- Adding more and various types of sensors for the ambient temperature and monitoring as many variables as possible and feasible.
- Merging the proposed control with the main existing control module so that the proposed system can compare the measured temperature degrees with the set points to get results more accurate.
- Electronic circuits design and mechanical parts will be left for future work.
- Monitoring other parts of the air conditioning system, like the ducts leaking or the difference in the temperature degrees between inside and outside the room or the building.

REFERENCES

[1] Attia, I. I., Ashour, H., & Inji, E. (2011). Energy saving through smart home. The Online Journal on Power and Energy Engineering (OJPEE), 2(3), 223-227.

[2] Zipperer, A., Aloise-Young, P. A., Suryanarayanan, S., Roche, R., Earle, L., Christensen, D., ... & Zimmerle, D. (2013). Electric energy management in the smart home: Perspectives on enabling technologies and consumer behavior. Proceedings of the IEEE, 101(11), 2397-2408.

[3] Han, D. M., & Lim, J. H. (2010). Smart home energy management system using IEEE 802.15. 4 and zigbee. IEEE Transactions on Consumer Electronics, 56(3), 1403-1410.

[4] Han, D. M., & Lim, J. H. (2010). Design and implementation of smart home energy management systems based on zigbee. IEEE Transactions on Consumer Electronics, 56(3), 1417-1425.

[5] Zhou, B., Li, W., Chan, K. W., Cao, Y., Kuang, Y., Liu, X., & Wang, X. (2016). Smart home energy management systems: Concept, configurations, and scheduling strategies. Renewable and Sustainable Energy Reviews, 61, 30-40.

[6] Anvari-Moghaddam, A., Monsef, H., & Rahimi-Kian, A. (2014). Optimal smart home energy management considering energy saving and a comfortable lifestyle. IEEE Transactions on Smart Grid, 6(1), 324-332.

[7] Hu, Q., & Li, F. (2013). Hardware design of smart home energy management system with dynamic price response. IEEE Transactions on Smart grid, 4(4), 1878-1887.

[8] Zhou, S., Wu, Z., Li, J., & Zhang, X. P. (2014). Real-time energy control approach for smart home energy management system. Electric Power Components and Systems, 42(3-4), 315-326.

[9] Pau, G., Collotta, M., Ruano, A., & Qin, J. (2017). Smart home energy management.

[10] Liu, Y., Qiu, B., Fan, X., Zhu, H., & Han, B. (2016). Review of smart home energy management systems. Energy Procedia, 104, 504-508.

[11] Twumasi, C., Dotche, K. A., Banuenumah, W., & Sekyere, F. (2017, June). Energy saving system using a PIR sensor for classroom monitoring. In 2017 IEEE PES PowerAfrica (pp. 347-351). IEEE.

[12] Duangmanee, P., & Uthansakul, P. (2018). Clock-frequency switching technique for energy saving of microcontroller unit (MCU)-based sensor node. Energies, 11(5), 1194.