Advanced Remote Control and Thermal Zones Design of a Modern Smart Home

M.Papoutsidakis
Dept. of Industrial Design and Production Eng.
University of West Attica
Athens, Greece

A.Chatzopoulos
Dept. of Industrial Design and Production Eng.
University of West Attica
Athens, Greece

C.Drosos
Dept. of Industrial Design and Production Eng.
University of West Attica
Athens, Greece

D.Tseles
Dept. of Industrial Design and Production Eng.
University of West Attica
Athens, Greece

***Abstract*— Technology has become an integral part in individuals' life, in which the rapid development of smart systems is widely applicable in all different aspects of daily life in order to facilitate, serve and offer quality in everyday reality. At the same time, the quantitative technological development coexists with qualitative technological advancement, offering increasingly more complex, effective and safe applications. In modern age, given that time is valuable, all technological processes aim at saving time, by presenting various possibilities like robotic systems, automated processes, remote control, wireless systems and other technological inventions that achieve time management and saving. In the present thesis, the design of a sophisticated system of remote temperature management and control for adapted zone heat installations will be presented. This presentation, within the framework of the Master Program, involves the combination and use of automated systems, wireless networks, the design of automated communication systems along with the analysis and study of technologically advanced applications. The system, via a central unit that will classify the different data, will perform temperature control and management of each zone heat installation separately. Through the use of a PC, laptop, tablet, or Smartphone, each user will be able to connect to the central unit that will be managing the system's data (input-output), thus allowing temperature control in specific spaces. The innovation of this concept resides in the fact that the central unit of the system will be installed in a platform, custom-made by myself, to allow different possibilities for its users. First, I will present the design of the system that will include all the different components and fittings in order to examine, adjust and finally select the most optimal and suitable ones. Then, the design and the connection of the system's platforms will be performed and the printing of the system's boards will follow. Finally, the source code for the different platforms will be created in order to adapt to the system's data and contribute in the most efficient way to the application's remote control and administration.**

Keywords*— Smart home, Interior automations, Temperature system, Remote control

I. Introduction

A. *Problem formulation*

Initially, we must look into what kind of sensors exist as well as which kind is most suitable for our system. Then, all types and kinds of microcontrollers must be determined in order to select the most appropriate one, with the closest desired features applicable to the system. Furthermore, a study must be conducted regarding the communication structure between the platforms and which method would be the best for the wireless, two – way communication among them. Then, the best solution must be chosen regarding the system – user communication. An important as well as necessary part, that great attention must be paid to, is the electrical wiring of the accessories ultimately leading to the manufacture of the printed circuits. Finally, each system as well as each platform will be programmed separately.

B. *Microcontroller's technology*

The first microcontroller was built in November 1971. Intel, the manufacturing company, launched in 1971 the model 4004. It was back then characterized as "having the whole package", since 2.300 transistors were integrated in its circuit. Its main features were an internal timing clock, internal memory in the form of registers, arithmetic logic unit ALU, 4 bit, with speed of 740kHz and the ability of simultaneous process of 46 commands. The word microprocessor stands for an entire IC circuit, which contains only CPU within it. For instance, Pentium I, II, III, IV of Intel. These microprocessors have no RAM memory but peripheral chips in their interior. In order for this system to be functional, extra memory chips must be externally connected. Applications of the microprocessors can be found in computers. Microcontrollers are the exact opposite. Apart from CPU, other additional memories such as RAM and ROM are incorporated. Hence, they are characterized as mini computers. They are designed to perform specific tasks. Applications where balance of inflow – outflow is pre – determined, such as mouse, keyboard, washing machine, car, mobile phone, etc. The reason is that these applications require less resources for RAM and ROM memory as well as I/O ports. All the above can be integrated in a microchip so as to reduce size and lower the cost.

C. Remote control

To achieve remote control or communication among devices, a specific method of communication is required which will transfer each piece of communication. Nowadays, many methods of wireless communication have been developed, with the most popular being Wi – Fi, Bluetooth, RF System, nRF System and Li – Fi.

1) Li-Fi

Li-Fi (Light-Fidelity) uses the electro – magnetic spectrum for data transfer. However, instead of radio signals, Li – Fi transfers data in binary code, using VLC (Visible Light Communication) which utilizes LED light. The systems work based on the traditional Morse code, using visible light which travels in speeds too high to be detected by the naked human eye (frequencies between 400 – 800 THz). This makes Li – Fi 100 times faster than its opponent Wi – Fi. Nonetheless it hasn't been able to replace Wi – Fi completely (up until today, that is).

2) Wi-Fi

Wi – Fi is a term used to define WLAN devices with IEEE 802.11 specification and frequency broadcast at 2,4GHz. Wi – Fi is widespread used regarding local wireless networks.

3) RF Home

Another approach to networks, with comparatively less junction points, is the RF Home model. It combines enough elements of the 802.11 model, based on European model of digital wireless communication, thus creating a more affordable data transfer package, with speed up to 2Mbps. It broadcasts at 2.4GHz.

4) nRF

Based on the transmitter – receiver RF home, nRF is a much more improved version, where a significant decrease in energy consumption has been accomplished, without interfering or altering its additional abilities. As a more advanced version, it is applied in the industry, medicine as well as science department.

5) Bluetooth

It's an industrial model regarding wireless networks among devices. All the devices using Bluetooth can freely communicate with each other, since it broadcasts at 2,4GHz. Bluetooth is based on a method, called "frequency hopping", which makes use of the spectrum spread, thus allowing it to make up to 1.600 frequency interchanges per second.

D. Need for the suggested system

It is widely known and thoroughly established man's need of saving time in his everyday life. In an effort to create applications that better facilitate him in managing more quickly and easily devices in accordance with today's technology, the matter of a more affordable solution to meet his needs has arisen. In the present thesis, an advanced remote control temperature system for adjusted thermal zones will be presented. The primary goal of the system is to fully meet the needs it was designed for but also to become the most affordable option in the market. This will be achieved through the system's design and implementation on platforms, which are based on boards manufactured solely for this application and only.

II. The System

The temperature control will be conducted separately for each zone heat via a central unit which will process all data, though a computer, tablet or mobile phone. The user will have access to the central unit, responsible for the inflows and outflows of the system. As inflow is defined the temperature in real time for each zone heat. As outflow is defined the system or systems which can interfere with the heating process of each room. For instance, an electric valve that isolates the desired circuit. Air go we can achieve control temperature for each space individually. The innovation of the aforementioned system lies on the fact that the central unit will be installed on a platform solely designed and adjusted to the data of the system. Three circuit boards, each one for a specific application, will be manufactured.

A. Central Unit

The central unit will be responsible for the user's communication and at the same time it will manage and process all the data according to its programming. One of the main conditions is the wireless communication unit among the central unit and the platforms. Due to low cost, low energy consumption, less space and more flexibility the nRF unit has been chosen. A microcontroller will also be used, which will handle all the requests. System – user communication is achieved via Wi – Fi which will be installed in the central unit. It will act as an access point which the user can connect to and have a two – way communication with the system. This translates into knowing the actual temperature of each thermal zone as well as adjusting it.

B. Temperature Measurement Platform

This platform will receive the data from each temperature sensor and transmit it to the central unit in real time. In addition, the design of the circuit allows it to be low – cost when it comes to energy consumption and also be energy efficient using its battery, thus not in need of wired supply energy. As far as the two – way communication with the central unit is concerned, the nRF unit is also chosen based on its compatibility with the platform. A temperature sensor and a microprocessor should also be installed in the board. The latter will collect the data through the temperature sensor and via nRF will transmit it to the central unit.

C. Thermal zone adjustment platform

This platform will be responsible for intervening in the thermal zone located in the same thermal area as the temperature measurement circuit, by using its output, the relay. nRF is once again chosen regarding the two – way communication with the central platform. The circuit's output will be the relay, which through an outer source of 230volt will handle the electric valve or any other mean for the management of the thermal zone.

D. System's hierachy

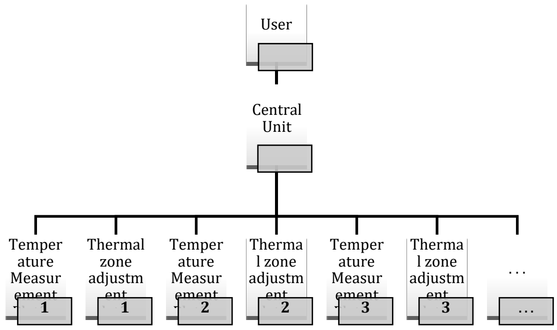

Fig. 1. System hierarchy

The hierarchy of the system is demonstrated in the above diagram. The user through the two – way communication with the central unit can receive information in reference to the system's condition. He is able to see the temperature of the thermal zones, which of them are in operation and if they have reached the desired temperature, with the help of an electronic device of his choice. To continue, the central unit processes all the data and collects information from the energy platforms. It then compares it to the desired outcome, defined by the user, and activates any inflow or outflow platform to meet it. It is perquisite that in each thermal zone at least one temperature and one thermal zone adjustment platform exists. In case of user's further demands, it is estimated that the central unit can easily operate with over 40 auxiliary platforms.

E. Sensor Description

The sensor used is DHT11. It has the ability of measuring temperatures from 0 up to 50 degrees Celsius. Its most important features are stability and precision.

F. Arduino Description

1) Central Unit Description

The demands the central unit is called to meet have to do not only with the connectivity with the other two platforms (temperature measurement, thermal zone adjustment) but also with the two – way communication with the user. Storage for the code, data and the process power should also exist. Compatibility with all the demands of the application is of utmost importance, as well as managing nRF, Wi – Fi and having the ability of extra inflows and outflows for future improvement.

Based on all the above demands, the microcontroller of an integrated circuit AVR by ATMEL, atMEGA2561-16au has been chosen. In reference to the communication among the platforms, the nRF24L01 unit has been selected and regarding the central unit – user communication the Wi – Fi ESP8266MOD unit.

2) Temparature measurement and thermal zone adjustment platform description.

Regarding the temperature platform inflow the microprocessor ATMega 168-20p by ATMEL has been chosen. Turning to the two – way platform communication the nRF 24L01 unit has been selected. Last but not least the relay chosen is SPDT 5V 10A by RATEX ELECTRONIC.

G. Central Unit Assembly Description

The central unit design will be based on the information collected above regarding the connectivity as well as compatibility of the components. The main priority will be the rational connection of the components. A program which will provide us with the appropriate environment and the ability to transfer the design to a circuit board will be selected. Eagle Professional, one of the most updated programs, which is utterly compatible with circuit board printing companies, is used in our design, thus enabling us to achieve the rational connection of the components.

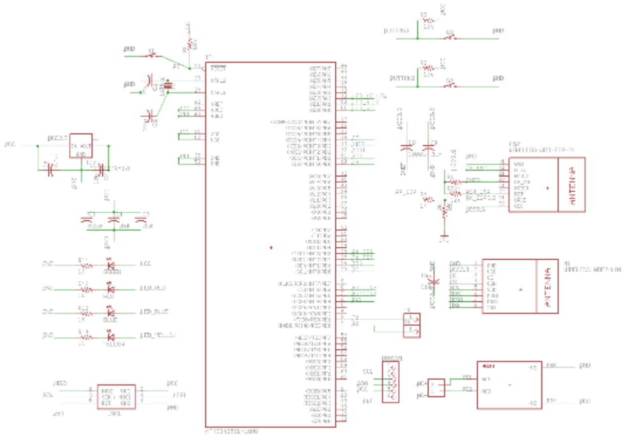

Fig. 2. Schematic Central unit assembly description

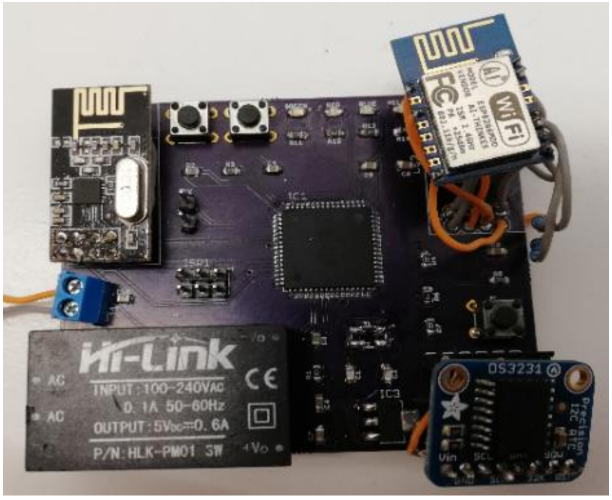

Fig. 3. Central unit assembly description

1) Temprature measurement board

Using the methodology mentioned in the above section, via the design program we proceed to the design of the circuit board.

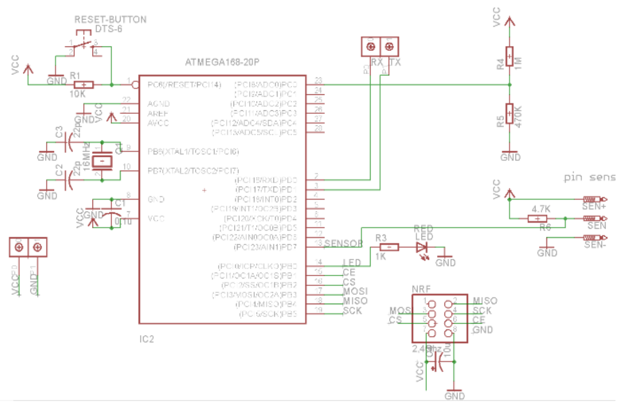

Fig. 4. Temperature measurement board

Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 5 Issue 10, October - 2018

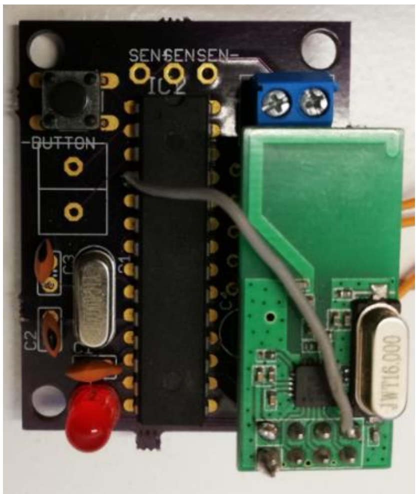

Fig. 5. Temperature measurement board

2) Thermal zone adjustment board description

The most basic components are the ATMega 168 – 20p microprocessor, nRK 24L01 and Wi – Fi ESP8266MOD. Regarding the outflow, SPDT 5V 10A relay by RAYE ELECTRONIC is used.

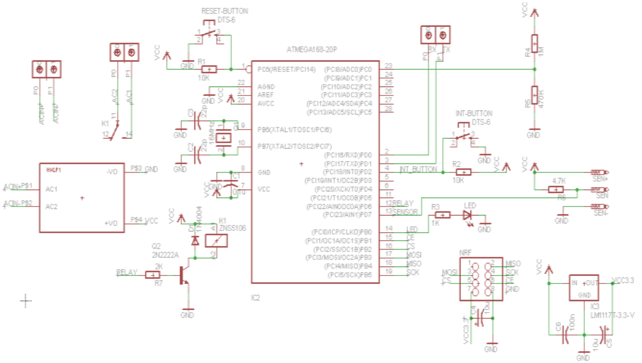

Fig. 6. Thermal zone adjustment board

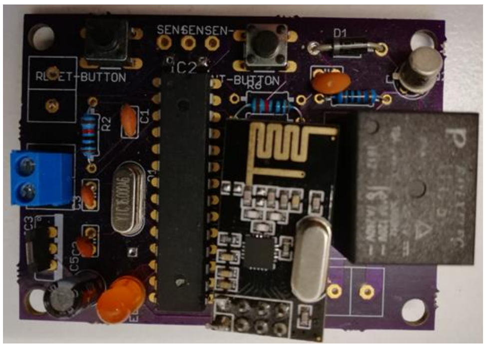

Fig. 7. Thermal zone adjustment board

H. System Code

The code will be developed in C++ interpreted language. Then, by means of ARDUINO platform as well ARDUINO 1.8.5 software we will transfer the code to the platforms.

III. CONCLUSION – FUTURE IMPROVEMENTS

For the implementation of the system, certain materials depending on their features were used. Connectivity and compatibility among them were of most importance for their selection. Nevertheless, other materials could have been used for the implantation of the system. For instance, the temperature sensor could be a thermistor instead of DHT11 that was originally chosen for our system. Moreover, nRF 24L01 could be replaced with the two – way communication RG 2,4 GH unit.

The system presents a lot of potentials, since it is based on one platform. In the future, it could apply to many other functions not just the thermal zone adjustment. For instance, it could control room lighting. That can become possible by changing bits in the code so instead of a thermostat, a button on the mobile phone or a key on a tablet or a computer will be the system's inflow.

IV. ACKNOWLEDGEMENTS

Authors would like to acknowledge the University of West Attica postgraduate program of studies "MSc in Industrial Automation" for supporting this research project.

REFERENCES

[1] G. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955.