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An Analysis of a Home Automation System using Universal Infrared Remote Control Scheme

MaitreyTrivedi[1] ,Pragnesh H Shah[2],Dhaval Tailor[1*]

[1]*Student,A.D.I.TCollege,maitreytrivedi@gmail.com*
[2]*AssociateProfessor& H.O.D (EE),A.D.I.T College, pragneshshah2002@gmail.com*
[1*]*AssistantProfessor, A.D.I.T college,tailordhaval@gmail.com*

Abstract: This paper aims to explain the implications of using multi-standard infrared remote control scheme, if implemented in a home automation system. A discussion on the same in a practical scenario has also been discussed, as it was implemented in our college project. The aspects discussed are oriented towards ease-of-use, design complexity and market acceptance.

Keywords-Infrared, home automation, embedded system

I. INTRODUCTION

Infrared light is the invisible part of the spectrum adjacent to the visible red light. To elaborate, it is of larger wavelength than red light, and has been in use for electronic communication, heating and imaging purposes. It is a part of remote control systems for most of the home entertainment electronic systems like TV, DVD player et cetera.

The requirement of domestic automation is more inclined in the current scenario towards simple control and with the amount of ease with which the user can operate the system. Home automation is not just a means for making the lives of physically challenged people, but a luxury that every common man can afford. Many complex communication systems exist today that can provide with precise controls on different electronic media such as SMS, Bluetooth, Internet, Wi-Fi and the list is endless. But, IR remote control system makes a good candidate due to the reasons that follow.

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II. PREFERENCE TO THE IR REMOTE CONTROL SYSTEM

1. Familiarity to the IR remote system

IR remote control is a comparatively older technology, and its use for data transfer protocol (IrDA) is almost on the verge of extinction. On the contrary, IR remote control technology is still not considered outdated and widely used in home entertainment electronics. This makes IR remote control a familiar device in the eyes of a user, whether s/he accepts newer technology or not. The use of the remote need not be taught to the user like using a computer or a smartphone, especially in case of the used being uneducated, old in age, or who cannot adapt easily to modern technology withoutintensive practice, as have been observed in our country quite frequently

2. Minimum design complexity

IR remote control works on the principle of modulating IR light beam, which can be simply implemented using an IR source and a microcontroller or infrared encoder/modulator chip. Generation of the signals does not require highly complex accurately tuned RF modulators. Similarly, on the receiver end, a photodiode or IR demodulator module is enough to obtain the original signal back. The circuit is small enough to be held in the hand.

3. An economical solution

Since the components used in the circuit are commonly available, IR remote control is an economical solution. There is no specific need of modulators, demodulators or tuning circuits that have to be made specifically.

4. Data transfer complexity can be increased

IR remote hardware is simple to design, but to increase the security and number of controls, software complexity can be easily incorporated. Even signaling complexity can be increased by using various line encoding schemes on the IR hardware. For example, QPSK, BPSK, ASK, OOK are the line encoding schemes that IR remotes can use. Even software algorithms can be used to encode the data that is being transmitted. For example, data can be sent in Binary, ASCII or even any encrypted format that can be applied to a stream of data.

III. A CASE STUDY

Here the proposed operating scheme is discussed briefly in two modes of the operation

1) Mode 1: Manual remote mode

There are many IR remote data formats like RC 5, RC 6, Sony, Sharp, etc., but this circuit is capable of receiving and decoding any kind of remote transmission.
Furthermore, many preset modes will be provided so as to change the ambience (the environment) of the room. For example, if a person has a party at home, he can turn on the 'party mode' to change the lighting arrangement accordingly.The various proposed modes are as follows and are prone to certain amount of change as the project advances.

2) Mode 2: Automatic lighting mode

In this mode, lighting of a room will be switched ON or OFF based on the presence of the number of people. Whenever a person enters the room, the IR sensor light will be interrupted, and the controller will decide whether to switch on or switch off the lights. This applies for lighting loads only.

Following Table shown another additional mode that we had simulated. According to our requirement we have to press specific mode.

Mode	**Load**					
	fan	***Party Lights***	***Soft Lights***	***Tube light***	***TV***	***Music System***
Normal	✓ ✓	×	×	✓	×	×
Happy	✓	×	×	✓	✓	×
party	✓	✓	×	×	×	✓
clam	✓	×	✓	×	×	×
Sleep	✓	×	×	×	×	×
Special	✓	×	✓	×	×	✓

IV. WORKING

The microcontroller is the heart of the entire circuit, which is responsible for almost all decisive tasks that occur in the system. The IR receiver is connected to the input capture pin of the microcontroller, which detects the

presence of coded infrared signals. This is manipulated digitally and accordingly control action is performed by switching the relays or providing gate fire pulse to TRIACs. The decoding of the infrared signals is done by the infrared remote library designed by Ken Sherriff for the Arduino platform. This library contains all standard international code formats and supports raw IR codes too. Thus, programming becomes easier from the designer's point of view.

The power supply consists of a simple rectifier followed by a 7812 and 7805 applied at appropriate circuit supply points. The TRAIC control circuit is designed using an opto isolated switching TRIAC. It just provides galvanic isolation to the microcontroller from the TRIAC's mains voltage surges and spikes. A snubbernetwork is also made using an RC filter to prevent damage of TRIAC from rapid surges and spikes. An LED is connected at every relay and TRIAC to indicate whether the load is switched on or off. Working of VESAS shown in the below figures.

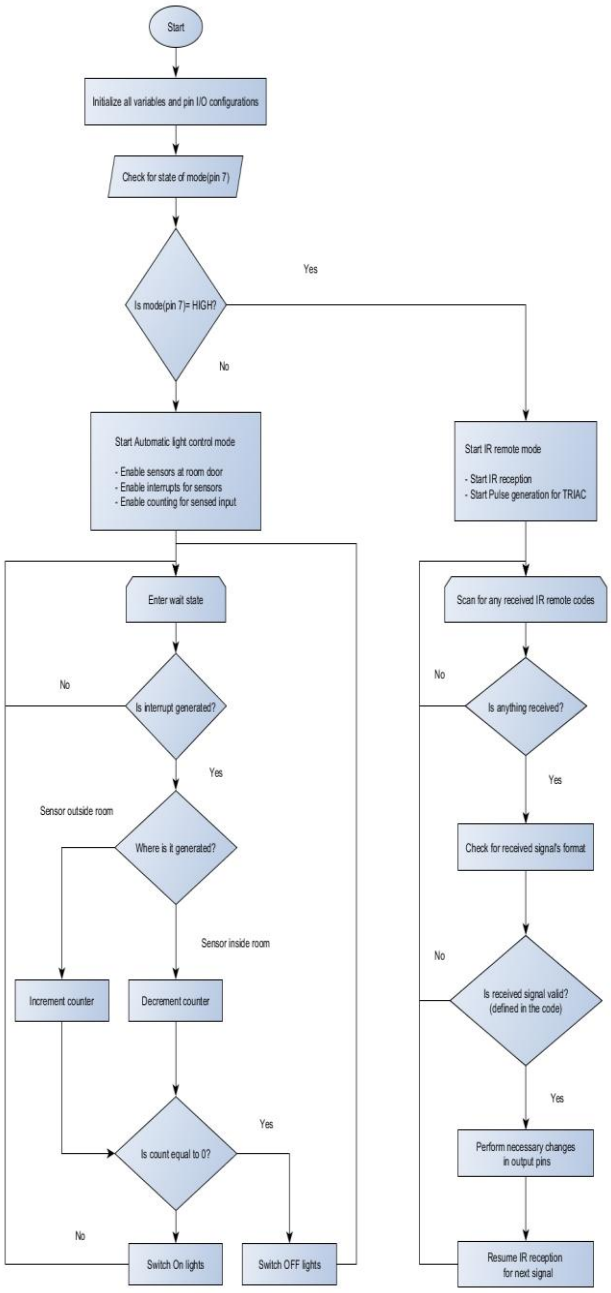

Figure 1-flowchart for VESAS

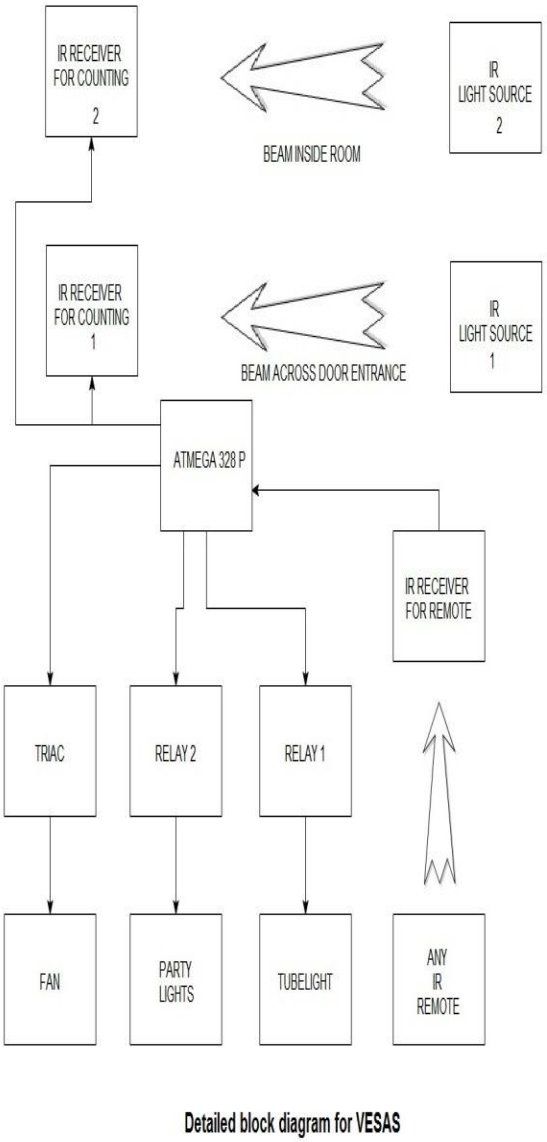

Figure 2-Detail block diagram of VESAS

V. ABOUT IR REMOTE

In most remote control transmission systems, only small data rates are transmitted to control the functions of home entertainment equipment. Most important is the safety of transmission where an incorrect interpretation of the transmitted code is not Permissible. Unintelligible signals must be ignored. Usually, commands are repeated until the remote controlled device reacts as desired. The operator can directly observe the result of pressing a key by visual feedback. Because there is only a short period of data transmitting at each key press there is no necessity for regulation of the coding in the frequency band between 30 kHz and 60 kHz and also at 455 kHz.

Some methods of modulation have been established. In order to achieve reliable and battery power saving transmission bursts of the carrier frequency are transmitted.
The Vishay Telefunken IR receiver modules are developed and optimized for the use in such carrier frequency burst transmission. Special types for different operating frequencies are available in the range from 30 kHz to 60 kHz. Standard types are available for the frequencies 30 kHz, 33 kHz, 36 kHz, 36,7 kHz, 38 kHz, 40 kHz and 56 kHz. Other frequencies in this range can be realized on request. Beside the different kinds of coding and the different carrier frequencies there are also data formats with and without pre burst, with different number of bits in a command and with different bit length.
Almost all codes have address bits and data bits. For safety reasons some codes send the data twice (inverted and non-inverted). There are different ways to overcome the difficulty to distinguish a multiple key pressing from an interruption of the transmission link (e.g. at the TV channel "1" or channel "11"). Some codes use a toggle bit which change the value at each key press, some codes send an indication for start and stop before and after each command and some codes send the data only once at each key press.Two common data formats are described in more detail now: the RC5 Code and the NEC Code.

A) R C-5 CODE

The carrier frequency is fixed at 36 kHz. The transmission of a word begins with two start bits, followed by a toggle bit. The toggle bit changes its value at each key operation. The five address bits represent the address of the device to be controlled. The six command bits contain the information to be transmitted. Each bit in a data word consists of a burst of 32 cycles with a repetition rate of 36 kHz. The equivalent timesare shown in the pulse diagrams. All Vishay Telefunken photo modules can receive the RC5 Code correctly.

B) THE NEC CODE

The NEC code also works with bursts of a defined carrier frequency which is 38 kHz. All Vishay Telefunken receiver photo modules operate well with this system. The NEC code starts the transmission using a so–called leader code, a burst of a length of 9 ms, followed by the data word after a pause of 4.5 ms. The initial idea of this leader code is to settle the internal control loops in the receiver modules. But for theVishay Telefunken receiver such a pre burst is not necessary.As long as a key is pressed, only the leader code is repeatedly transmitted, followed by a single bit. A specialty of this code is the property of constant word length in connection with a pulse–distance modulation. Both address and command bit are transmitted twice, first as the normal byte followed by the inverted byte. This is shown in Figures 1and 2. The burst defining a bit contains 22 pulses each of a length of 8.77 ms with a period of 26.3 ms. A "0" is represented by a pulse distance of 1.125 ms, the "1" with 2.25 ms, respectively. 8 address bits are used to identify the device to be controlled. A further 8 bits are used for the transmission of the command. As mentioned above, the words are always followed, without a pause, by the inverted words, e.g., the transmission of the address performed by sending the word: "00110111'11001000'00011010'11100101".A special version of the NEC code is with repetitive data. That means that each 108 ms the preburst including the whole data is repeated as long as the key are pressed.

VI. MERITS AND DEMERITS

A) MERITS

The Home Automation System described here has the following advantages

- Easy to use with multiple infrared remote control systems.
- It is a new step towards cheaper and easier home automation.
- The system is immune to noise as it does not use a complex wireless transmission protocol.

- Can support raw infrared codes for custom remotes that do not follow an international infrared data format.
- The user can operate the system easily without having a prior knowledge of the functioning.

B) DEMRITS

The Home Automation System described here has the following disadvantages**:**

- This system is not a reliable system for situations of emergency.
- The automatic light switching mode may not function correctly if people are present inside the room and a power cut and resume occurs. The counter variable will reset to zero, thus resulting into undesirable system behavior.
- The remote codes are predefined the microcontroller's memory, thus it is not possible to replace or store new codes on site without an experienced personnel.

VII. APPLICATIONS

The Home Automation System described here find Various Practical Applications, Some of them are listed below:

- In homes for physically challenged or old people
- In smart homes or offices
- For modern hotel rooms
- In industries for switching of lights according to presence of an operator
- Use in public halls so as to maintain correct lighting and temperature.

VIII. REENGINEERING THE ABOVE SYSTEM

There is a scope for re-engineering the above system in following aspects:

- Implementation of more complex wireless protocols for control.
- Use of a "learning algorithm" – which will be used by the system to learn which remote codes are used frequently and in what format, so as to prevent the calling of an experienced personnel in case the codes have to be changed.
- A better appearance may be provided, inbuilt with graphics LCD and touch screen for use without a remote or buttons.

.IX. CONCLUSION

In a nutshell, this is a basic lighting and fan control system which can be used alone or as a part of a larger home automation system at a lower investment but with robust features and better compatibility with the present room surroundings.

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