Electronic Aid for Elder and Sick People

IR-Remote Controlled Switch Board for Changing State of Electrical Appliances

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***Abstract*— This paper propose a wireless switch board for easy-accessibility in an hospital-like environment for controlling various electrical appliances like light, fan, etc. without interference with similar wireless switches in adjoining room. The data signal is communicated to receiver wirelessly by IR Remote Controller. The receiver consists of IR Receiver, TSOP1838, to read data signal operating at 38 kHz and a microcontroller to process data and communicate trigger signal to change the state of switch.**

Keywords- IR Remote Controller; IR Receiver; Wireless Switch.

I. INTRODUCTION

In hospital and various health-care institutions, the patients are usually advice to take bed rest and rely on others for changing the state of electrical appliances surrounding them. This is so because switch boards are placed away from patients to avoid detrimental accidents. Similar is the case with elder and sick people who find it difficult to change the state of a device due to their weak physical condition.

This paper proposes a wireless switch design particularly pertinent to sensing the state of an operator controlled switch where hard-wired signal communication is unwanted and the range for wireless switching is to be restricted to a particular room. This paper concerns to the area of wireless control circuits based on IR, and more particularly to a circuit for altering the state of a variable state device such as a switch.

In this paper, the term disabled hereafter have been collectively used for elder, sick and handicapped people.

II. RELATED WORK

In the last few decades, various electronics aid have been built for helping disabled people. Each aid have its own advantages and caters to meet and empowered the disabled to become self-dependent in one way or the other.

Some aids endows one to operate computer by tracking eye-movement [1]. On the other hand, some aids are based on based on hand gesture recognition [2]. Various other aids like [3] and [4] are based on computer-vision.

This paper proposes low cost wireless switches for operating various electrical appliances as aid to disabled people.

III. INFRARED AND RADIO FREQUENCY FOR WIRELESS SWITCH

Radio Frequency (RF) and Infrared (IR) are two commonly used medium for wireless control and lie in range of 3kHz – 300GHz and 300GHz – 30THz in electromagnetic spectrum respectively.

RF modules receive/transmit radio signals and hence can penetrate through obstacles like wall. This makes them useful for signaling or actuating a switch through obstacles too. E.g. car unlocking system. However, in case of institutions like hospital it is desirable to have a same controller to operate various ward rooms without affecting adjoining rooms. This makes RF communication futile. Moreover, research have shown that RF can lead to various health hazards [5].

In such scenario, communication using IR-Remote Controller can be useful. IR tough invisible to human eye can be sense by cameras and various IR receiver. Thus switching of IR light can be sensed by means of sensors but IR light source and receiver must be in line-of-sight that is a transparent medium is required between transmitter and receiver to communicate. This very disadvantage of IR over RF makes it suitable for design of wireless switch-board in hospital-like environment. Also, it has been observed that IR is normally of no practical concern from a health hazard standpoint [6].

IV. IMPLEMENTATION METHODOLOGY

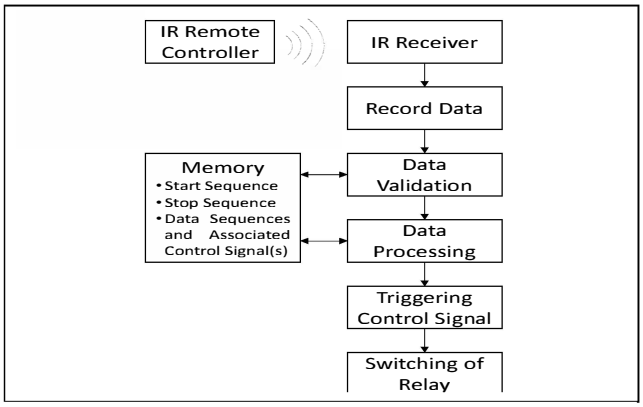

Fig. 1. Overview of Module

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Fig.1 shows the basic working of module. Further section will briefly deal with technical details of each sub-system shown in Fig.1.

A. IR-Remote Controller

A typical IR-Remote Controller uses pulse of InfraRed (IR) to sends an encoded stream of IR light pulse at an operating frequency of 37kHz – 40kHz. The data is in form of Pulse-Code Modulation i.e. PCM. Fig.2 gives an illustration of transmitted PCM signal for three keys of IR-Remote Signal.

The transmitted data of each key on IR-Remote Controller can be divided as: a Start Sequence, a Data Sequence and a Stop Sequence. Start Sequence and Stop Sequence is same for each key on a given Remote Controller and Data Sequence is unique to particular key. The Start Sequence and End Sequence helps to validate the source of signal being received and Data Sequence helps to determine which key on remote was pressed.

B. IR-Receiver

To receive IR signal, TSOP1838 was used [7]. TSOP1838 is miniaturized receivers for infrared remote control systems. It is tune to receive IR signal operating at frequency range of 38kHz. TSOP1838 gives logic low output when it sense IR signal or else the output is logic high.

The TSOP1838 was interfaced to Arduino Development Board (called Arduino hereafter) which was programmed to read output at an interval of 12 microseconds. The interval of 12 microseconds ensured that data is recorded at rate higher than Nyquist Frequency. The signals thus received where stored in form of two-dimensional array of 8-bit unsigned integer. Thus, each value of array corresponded to length of high pulses and low pulses in multiple of 12 microseconds. Fig.3 gives the control flow for above mentioned procedure. As pulses are to be recorded at high frequency raw-pin mapping was used to read signals received by TSOP1838 [8].

The output sequence of all the keys on IR remote was then recorded and stored for further processing in spreadsheet. To maintain immunity to noise, the sample array of various keys were recorded multiple time and maximum error in length of pulse was recorded and thus the error margin for comparing pulse was measured.

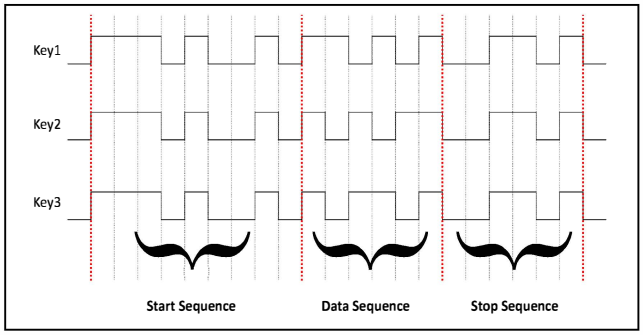

Fig. 2. PCM Signal of IR-Remote Control

C. Data Validation and Data Processing

The IR signals recorded were then segregated into Start Sequence, Data Sequence and Stop Sequence keeping in view that Start Sequence and End Sequence are same for each signal under consideration. This signals were then stored in microcontroller (in this case on ATmega-328P [9]). Also, each key had a particular function associated with it.

For data validation the Start Sequence and Stop Sequence of received signal was matched with that stored in memory keeping error margin in account. Thus, data validation helps to validate the source of signal. If source is not matched, there is no need for further processing.

During data processing, the Data Sequence of received signal is matched with those already recorded in memory. If a match is found, the function corresponding to the matched key is called and corresponding control signals are activated.

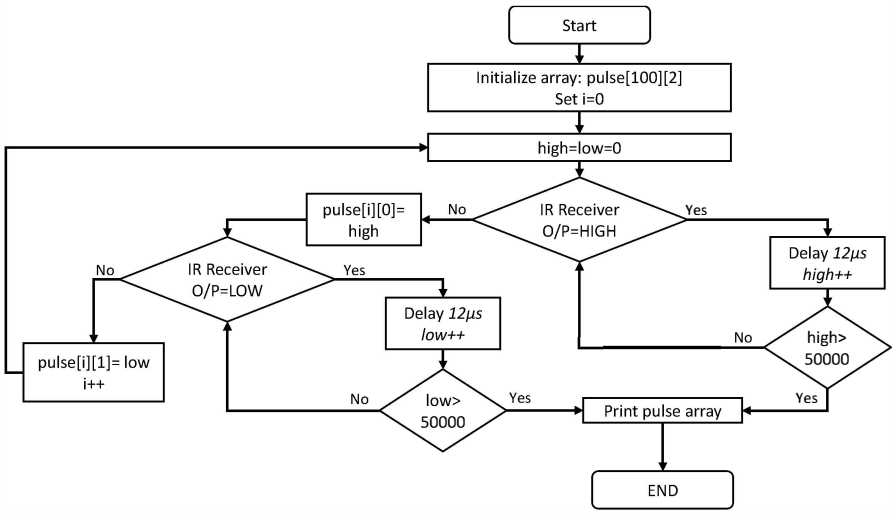

Fig. 3. Flowchart for Reading and Printing IR Pulses

D. Control Signals and Switching of Relay

The control signals were simple high and low voltage which altered the current logical state of input to ULN2803A [10] which finally changed the state of relay-switch. ULN2803A was used so as to meet current requirement of switching relay. In this way the electrical appliance was switched on or off wirelessly using IR-Remote Controller.

E. Sample Circuitry

Fig.4 gives a sample circuit for proposed design. The output from TSOP1838 was fed as input to Digital Pin 2 of Arduino. Also, Data Sequence of four of the keys of IR-remote were programmed to toggle output of Digital Pin 8, 9, 10 and 11. As a backup in case of problem with microcontroller, the staircase-wiring was done with one of the two-way switch as two-state relay thus providing an alternate way to control electrical appliances in failure of proposed circuitry.

V. FUTURE SCOPE

The microcontroller can be programmed for recording and storing the pulse before first use and thus can be calibrated according to need of the user. This can be achieved using EEPROM [10]. Also the number of switched being controlled can be increased by using encoder before passing signal to ULN2803A.

The microcontroller can be interfaced to PC using serial communication to monitor and control all the appliances in institution from a control room.

RF-extenders can be used to control all appliances at a time using single remote. RF-extenders is used to receive RF transmissions from compatible remote controls and rebroadcast them as infrared. E.g. switching off all the lights in all room during day time. However, this may lead to health hazards in medical institutes.

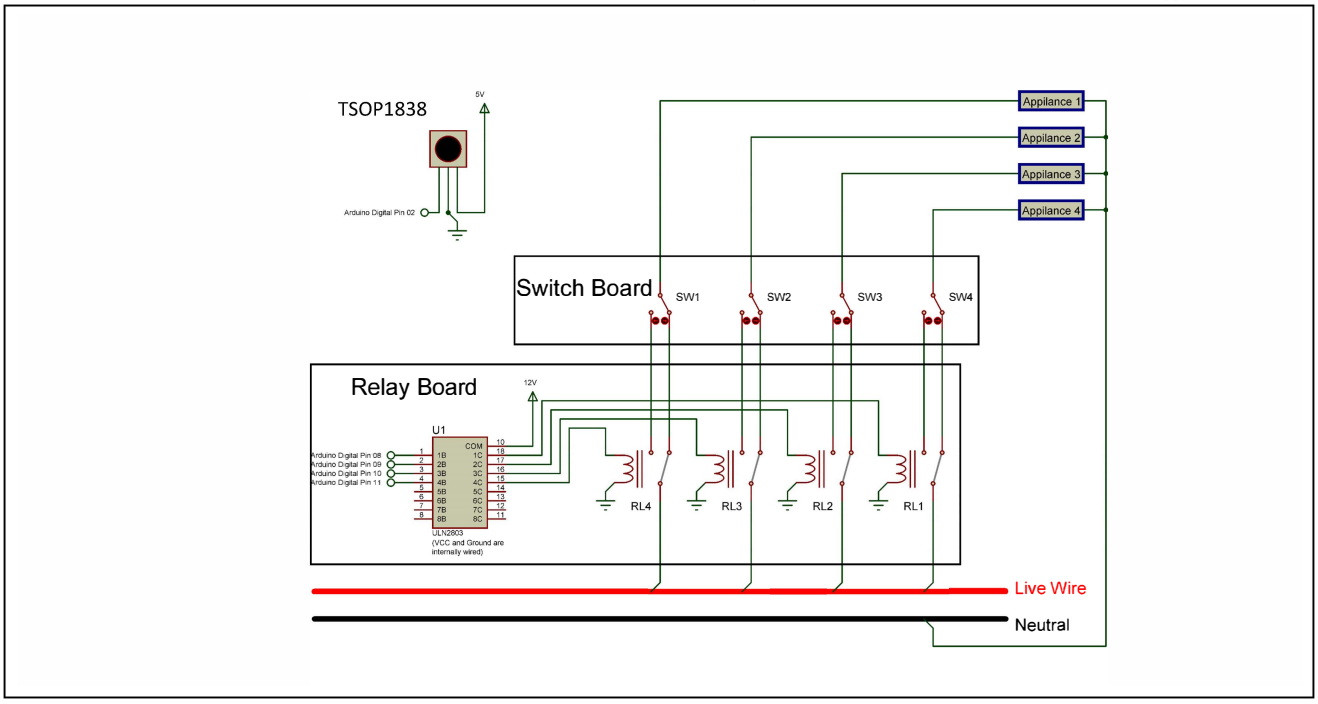

Fig. 4. Sample Circuit

VI. CONCLUSION

The proposed wireless switchboard can be realized at cost as low as 1 USD per switch. Also, the module can be used for controlling electrical appliances in a smart home.

REFERENCES

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

[1] Chern-Sheng Lin, Hsien-Tse Chen, Tien-Gern Lin, Mau-Shiun Yeh and Cheun-Lin Tien, "Development and Application of An Infrared Eye-mouse Control System," Journal of Medical and Biological Engineering, vol. 26, no. 1, pp. 15-19, 2005.

[2] A. Chaudhary and J. L. Raheja, ABHIVYAKTI: A Vision Based Intelligent System for Elder and Sick Persons.

[3] Mu-Chun Su, Shi-Yong Su and Gwo-Dong Chen, "A Low-Cost Vision-based Human-computer Interface for People with Severe Disabilities," Biomedical Engineering: Applications, Basis and Communication, vol. 17, pp. 284-292, 2005.

[4] J. Varona, C. Manresa-Yee and P. J. Francisco, "Hands-free Vision-based Interface for Computer Accessibility," Journal of Network and Computer Applications, vol. 31, no. 4, pp. 357-374, 2008.

[5] J. R. Jauchem, "Effects of low-level radio-frequency (3 kHz to 300 GHz) energy on human cardiovascular, reproductive, immune, and other systems: A review of the recent literature," International Journal of Hygiene and Environmental Health, vol. 211, no. 1-2, pp. 1-29, 2008.

[6] International Commission on Non‐Ionizing Radiation Protection, "ICNIRP Statement on Far Infrared Radiation Exposure," Health Physics, vol. 91, no. 6, pp. 630-645, 2006.

[7] Vishay Telefunken, Photo Modules for PCM Remote Control Systems.

[8] Arduino, "Arduino - PortManipulation," [Online]. Available: http://arduino.cc/en/Reference/PortManipulation. [Accessed 19 December 2013].

[9] Atmel, Datasheet: ATmega48PA/88PA/168PA/328P.

[10] Texax Instruments, ULN2803A Darlington Transistor Arrays.

[11] Arduino, "Arduino - EEPROM," [Online]. Available: http://arduino.cc/en/Reference/EEPROM. [Accessed 19 December 2013].