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Design topology of a sustainable remote-controlled fan regulator for developing countries

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ABSTRACT

Based on the need to use remote devices against the traditional wall-mounted fan regulators to switch and control the speed of fans, this review paper conveys the fundamental theory that governs the operation of remote-controlled fan regulators. From state-of-the-art in the research, the basic steps in the design and construction of remote controlled fan regulator were presented. Upon implementation of the circuit using locally available materials, discussions based on its working principle, applications and cost breakdown of the work were provided. A number of research goals which guided the work were executed based on an experimental research design. Findings reveal that the factory installed speed regulation of a ceiling fan can be easily duplicated upon implementation of the remote control device, with a digital display unit incorporated for precise speed control. To maintain sustainable production of the remote-controlled fan regulator, it is recommended that there should be a reduction of the size and weight of the set-up for greater marketability by using a triac instead of an autotransformer in the set-up. Moreover, improving the capability for omnidirectional speed control as against the unidirectional control of existing schemes is another way. In all of these, the advantage for commercialization is greatly advanced.

1. Introduction

Remote-controlled fan regulator is one of the applications of electronics to increase human convenience, whereas a fan is one of the unavoidable electronic equipment in our daily life. It has become an essential electronic element without which people cannot lead a smooth life. The presence of a fan in a house or office is presently not considered as a luxury as it included in the basic requirement of life. For example, it may be difficult for the old and physically handicapped person to get up from a position of comfort in order to control the speed of the fan. By controlling the speed of the fan using a remote, it adds comfort to everyday living, thus removing the inconvenience of having to move around to operate a stationary fan regulator.

The use of new electronic control theories have been developed by experts to improve existing electronic appliances leading to the production of sustainable and efficient devices [1]. To this end, the operation of a fan is improved when controlled by a remote device. This work concentrates on remote-controlled fan speed regulator, which may be useful in homes and offices. Remote control facilitates the operation of fan around the home or office from a distance.

The remote-controlled fan regulator had always been designed using infrared (IR) [2–6]. Since infrared remote control use light, they require line of sight to operate the destination device. The signal can however be reflected by mirrors, just like any other light source. If operation is required where no line of sight is possible (for instance when controlling equipment in another room or equipment installed in a cabinet) IR extenders can be used. Most of these have an IR receiver, picking up the IR signal and relaying it via radio waves to the remote part, which has an IR transmitter mimicking the original IR control. Infrared receivers also tend to have more or less limited operating angle, which mainly depends on the optical characteristics of the photo-resistor [6].

However, it is easy to increase the operating angle using a matte transparent object in front of the receiver [5,6]. Other suggestions state the need for the power supply to be improved, where a step-down transformer would not be used, thereby reducing the entire size of the project. Also, micro soldering could also be used in order to further reduce the size of the equipment [3].

Because the average individual these days probably picks up a remote control at least once or twice a day to turn ON or turn OFF his/her appliance such as fan, a good and reliable fan regulator circuit

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should be cheap, assembled with ease and hence very economical. Basically, a remote control works in the following manner. When a button is first pressed, this completes a specific connection which produces a Morse Code line signal specific to that button. The transistor amplifies the signal and sends it to the LED which translates the signal into infrared light. The sensor on the appliance detects the infrared light and reacts appropriately.

It is anticipated that this review study will demonstrate the design and construction of a device that provides comfort to everyday activities which involves living, learning and working by removing the inconvenience of having to move around to operate a fan regulator. This methodology in this work would be of immense benefit to various establishments and institutions to provide seamless control to electronic devices. The technique in this work is also useful in industries for switching purposes and for control purposes of machines in automation. However, the scope of the study is confined to the speed regulation of ceiling fans using remote controlled device sourced from available local materials.

In the meantime, the following areas are intended to be addressed in this paper:

- Simplifying the remote control circuit.
- Adapting available local materials in the design and construction of the remote control device.
- Reducing the effective material cost of the remote control device.
- Highlighting the advantage of the remote control device over some other conventional system of control.
- Regulating the remote control device to perform variable speed functions.

2. Previous works and anticipated contribution

As follow-up to previous works, a critical analysis of the state-of-art in the theory and design of remote-controlled fan regulators were looked into. Other recent advances in relevant areas were also considered, along with well accepted traditional theory and principles associated with the proposed design. A simple design and implementation of remote controlled fan regulator was presented in [3], however the infrared sensor could not filter out surrounding bright light. Also, an IR remote controlled fan regulator is implemented using IR sensor, monostable multivibrator, decade counter, transformer, comparator, opto-isolator and TRIAC in [2], but the authors concentrated only on the receiver circuit. In [1], a new intelligent home control system is designed and implemented, but the system is much complicated, perhaps expensive, due to fact that it is meant to control various home appliances using smart sensors/actuators and wireless communication technologies.

Construction of remote-controlled fan regulator is still gaining momentum in the literature. In addition, several works studied so far

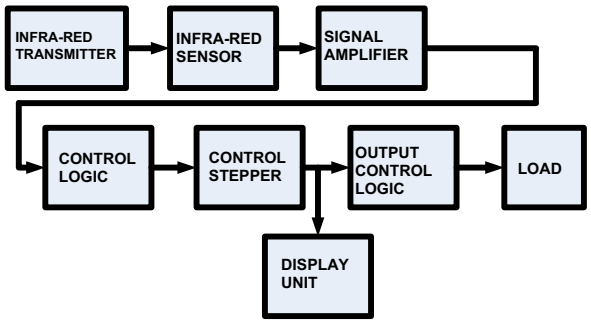

Fig. 1. System block diagram of remote-controlled fan regulator.

[1,5–7]; reveal that the researchers used more of imported circuit components which are costly and also not locally available in a developing country. To this end, in the current configuration, the researchers attempted to improve on the existing achievements and deal with some of the limitations in order to get a better and more reliable result. A typical limitation as well is that the fan speed cannot be apparent to a user without a display showing the current rate. This and other modifications were realized by focusing on the control logic, switching and display of the fan speed with the aid of a remote device based on locally available materials. In addition the results of this work will create an update in the literature which will add to the theoretical efforts of researchers.

3. Methodology

The approach used in this work is the modular approach where the overall design was broken into functional block diagrams, where each block in the diagram represents a section of the circuit that carries out a specific function [2]. The system was designed using 8 functional blocks, as shown in the block diagram of Fig. 1.

3.1. System design and analysis

1) Transmitter: The remote control device has the task of sending the infrared signal, which is received by the infrared sensor. The mode of operation can be better understood given the circuit diagram shown in Fig. 2. When the soft touch switch is pressed or held down, the circuit of the transmitter is completed and the 555 timer IC configured a stable multi-vibrator, oscillates at a frequency determined by:

$$F = \frac{1.44}{(R_1 + 2R_1)C_1} = \frac{1.44}{(1 + 2*3.33)0.000022} = 977Hz. \quad (1)$$

The output is supplied as +Vcc to the 4060 oscillator IC. The output at pin 6 turns on the 2SC945 NPN transistor via R_5 to complete the

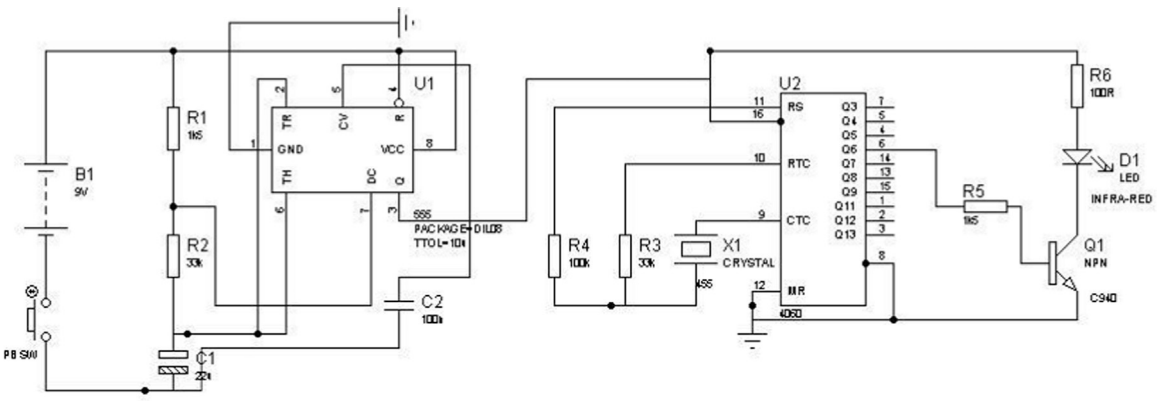

Fig. 2. Circuit of a remote device.