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Solid state switching using wireless network in home automation

R. Karpagam [a], G.K. Sathishkumar [c,*], V. Megala [b], J. Lydia [a], N. Priya [a], T. Abhishek Dheeven [d]

[a] Department of Electrical and Electronics Engineering, Easwari Engineering College, Chennai 600089, Tamil Nadu, India
[b] Department of Electronics and Communication Engineering, SRM Institute of Science and Technology, Ramapuram Campus, Bharathi Salai, Ramapuram, Chennai 60089, India
[c] Department of Mechanical Engineering, Loyola-ICAM College of Engineering and Technology, Loyola Campus, Chennai 600034, Tamil Nadu, India
[d] UG Students, Department of Electrical and Electronics Engineering, Easwari Engineering College, Chennai 600089, Tamil Nadu, India

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ABSTRACT

The globe is presently perusing technologies that entirely automate the processes with negligible losses. To achieve this, the world has initiated their automation from private bodies like home, school, etc. Thus, our paper is created to aid their process. This paper describes the solid-state switching using wireless networks. The proposed paper deals with the replacement of solid-state device instead of application of relays in home automation, as the performance of relays are not very effective in switching at higher inrush currents and they require an adequate environment for its better performance. Solid state devices have advantages like less power consumption, better life span, easy control, etc. Thus, the use of solid-state devices improves the performance of the entire home automation system. This proposed paper uses a protocol DALI (Digitally Addressable Lighting Interface) which controls switching of light resistive loads and improves communication. The soft switching operation of the circuit operates with the wireless network and improves the ability of carrying loads and has a strong controlling ability. The design and circuit framework can be adapted to any of the switch-controlled circuits which is relayed on solid state device.

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1. Introduction

The automation of switching is one of the recent trending research fields [1–5]. This paper is our ideology in the field of automation. Here in this paper we have promoted solid state switching using wireless network. This paper replaces traditional relays by DALI. DALI is a common platform enables the equipment's to be connected together [6–10]. It consists of mainly controllers and lighting devices and acts as a medium of communication. The Solid state in the paper represents the electronic devices, components and systems that are completely build on the semiconductors. In a solid-state device, the current is confined into solid substance and crafted to switch and amplify it. Various papers were studied before taking up this idea. Lighting Control System based on DALI and Wireless Sensor Networks was incorporated in a new remote management system for street lighting [11,12]. Now a days High performance solid-state switches using series-connected SiC-MOSFETs is widely used for high voltage applications [13–18].

2. Proposed system

The proposed system consists of three modules 1) Transmitter 2) Receiver 3) Switching Device. Each module is explained in depth below.

2.1. Transmitter

The diagram below is the block diagram of the transmitter end where the DALI device is being used and the signal is being converted from one form to another [19–24]. The digital input (0 or 1) is being given to the controller which is of 16 bits [25–28]. The digital signal is sent to the encoder where it generates a message signal from 4 bits which is being carried to the modulator. Here the modulator removes the carrier signal and sends the message signal to the antenna as shown in Fig. 1.

* Corresponding author.
E-mail addresses: dr.g.k.sathishkumar@gmail.com, sathishkumar6742@gmail.com (G.K. Sathishkumar).

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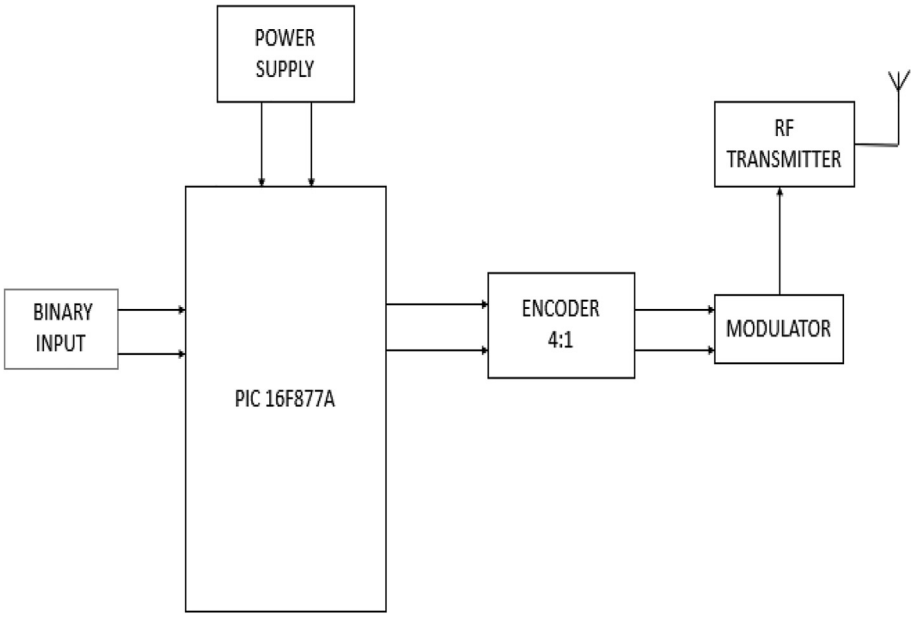

Fig. 1. Block Diagram of Transmitter.

2.2. Receiver

The signals from the transmitter end are received. From the receiver end the signals are sent to the demodulator from where the decoder enables 1 bit to 4 bits of data. This is sent to controller where the 16 bits signal is passed on to switching device. This is later sent to the desired load output as shown in Fig. 2.

2.3. Switching device

To trigger the gate terminal of the TRIAC, Opto TRIAC is being used which is represented in the diagram. This Opto TRIAC gets the power supply directly from the 230 V AC supply. It triggers the input of 20 mA, 5 V for the working of the output. With the help of optical device, the fluctuation gets reduced as a reason of which Opto TRIAC is being used here as shown in Fig. 3.

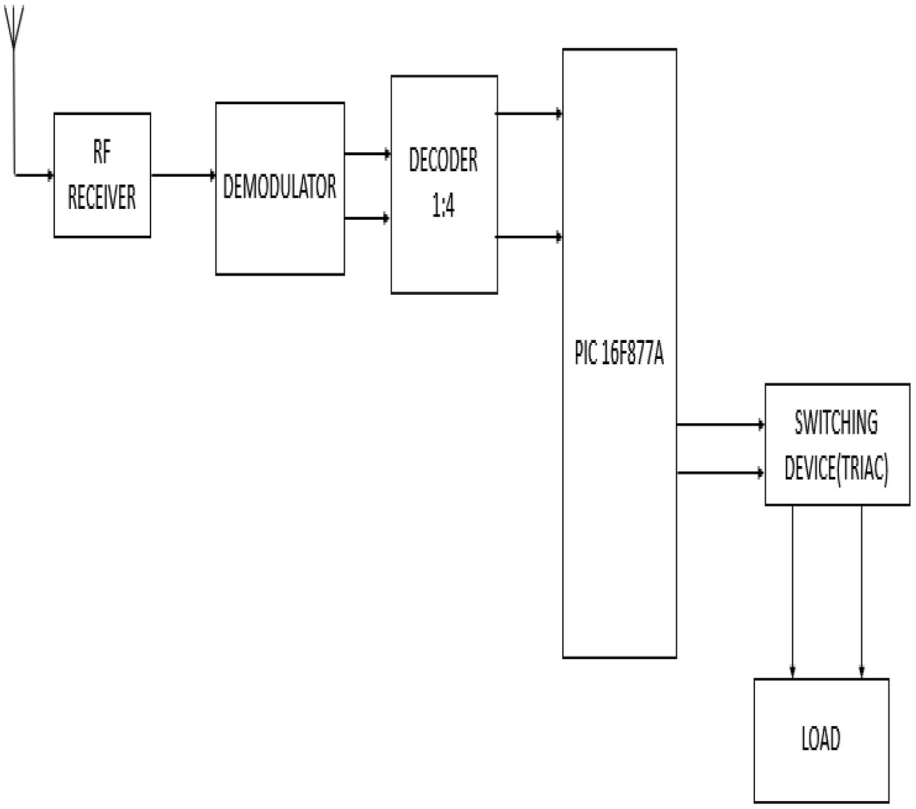

Fig. 2. Block Diagram of Receiver.

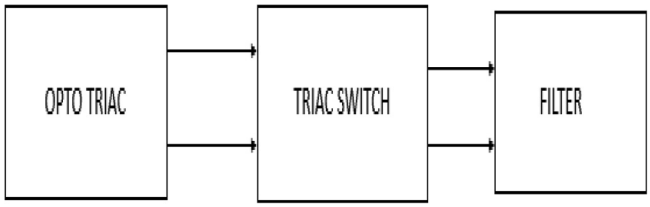

Fig. 3. Diagram of Switching Device.

3. Advantages of proposed system

1) The work of the proposed system is inadequate in a frame relay, unless it is utilized in a circumference where the endpoints are intelligent, and transmission facilities are high in speed and qualities. All this are rectified by the solid-state devices. 2) They are faster than electromechanical relays i.e. their switching duration is proportional on the time needed to power the LED on and off, of the order of microseconds to milliseconds. 3) Output resistance remains stable and constant. 4) Clean, bounce less operation. 5) No spark is generated during switching.

4. Hardware

The hardware comprises interconnected electronic components that perform analog or logic functions once received and locally stores the data to produce output or stores resulting new information or to demand control for output actuator mechanisms [29–31].

4.1. Power supply

Most electronic circuits require a DC power like battery. Since the mains supply is AC, it should be converted to DC supply to be used in powering electronics. This is the function of a power supply.

Each of the blocks in a power supply is compassed and recited below,

4.2. Transformer

It is a static device that steps up or down high voltage AC to low voltage AC. The center tap transformer is one of the components in the power supply unit [32–34]. Two diodes along with a center-tapped transformer act as a centre tapped rectifier that transforms both half-cycles of the AC wave to direct current, making it more reliable than a half-wave rectifier.

4.3. Rectifier

Rectification is the process in which alternating current (AC) is converted to direct current (DC). A full wave rectifier is used here. Since the transformer is center tapped, it is referred to as a center tapped full wave rectifier. IN4001 is used for constructing this rectifier.

4.4. Filter

DC is not stable from a rectifier and it is pulsated. Hence, the pulsations are filtered by passing them through a smoothing circuit, the simple form of filter uses a capacitor and resistor.

4.5. Regulator

78L05 is the regulator used for the regulation of the DC output from the filter. It produces 5 V output. LM317 is also used for the regulation of the DC output from the filter. Along with a few resistors, it produces 3.3 V. With tolerable heat sinking the regulator can produce 100 mA output current.

4.6. TRAIC (Triode AC switch)

A TRIAC can perform conduction in both directions. The TRIAC, a bidirectional thyristor with three terminals. It is used for control of power in ac circuit

4.7. RF transmitter

RF transmitter is framed to achieve the system wireless. This is done by transmitting the frequency output of the LM331 to the computer which includes initializing the transmitter by passing 5 V and the input frequency is transmitted to the receiver using Frequency Modulation as shown in Fig. 4.

4.8. RF receiver

The receiver module is used to implement wireless communication. The receiver section uses antenna to receive the data from the transmitter and pass it to a microcontroller which is then converted to a digital data. The receiver module is used to implement wireless communication. The receiver section uses antenna to receive the data from the transmitter and pass it to a microcontroller which is then converted to a digital data. First, the receiver by passing 5 V. Then, the input frequency from the transmitter is received using Frequency Demodulation. Finally, the output is passed on to a frequency to voltage converter as shown in Fig. 5.

5. Results

Proteus (Processor for Text Easy to use) is a fully operational, procedural programming language forged in the year 1998 by Simone Zanella. Proteus is more especially versatile in handling strings and has hundreds of dedicated functions; this makes it one among the richest languages involved in text manipulation. There are no data types, all variables can be used as integer numbers, floating point numbers or string representation of their values between calls, to decrease the execution time. Processor for the text is easy to use and is an entirely functional language, i.e., it has no operators; thus, there is no functional instability and hence expressions and parenthesis are not required during evaluation

5.1. Simulation result

Once the board is designed, it is run and played to check the output as shown in Fig. 6.

5.2. Hardware result

Home automation system has been experimentally evidenced to work, by connecting the resistive light loads and the operation of the loads were done successfully from a wireless device. The home automation was successfully tested with different large number of lamps; thus, it is proved more flexible and wider compatible. With the help of Transmitter Model, FSK technique and FM transmission is used for implementing the wireless communication in the transmission model. This will improve the mobility of signals so that it can track the signals within the specific range.

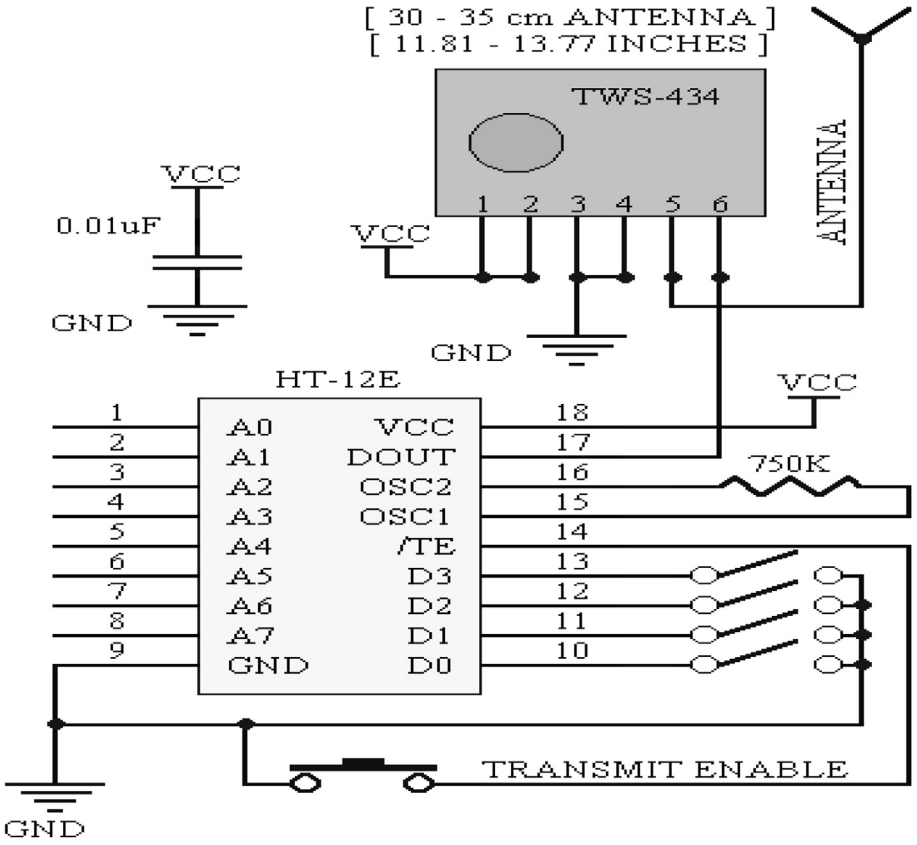

Fig. 4. Block diagram of Transmitter Module.

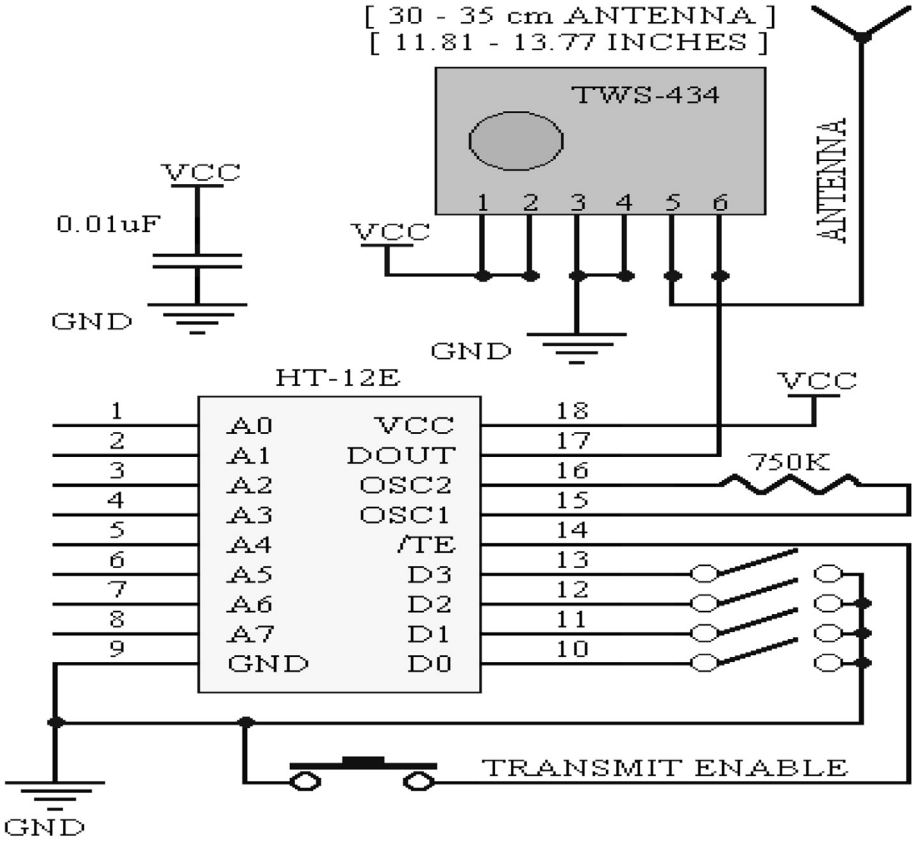

Fig. 5. Block diagram of Receiver Module.

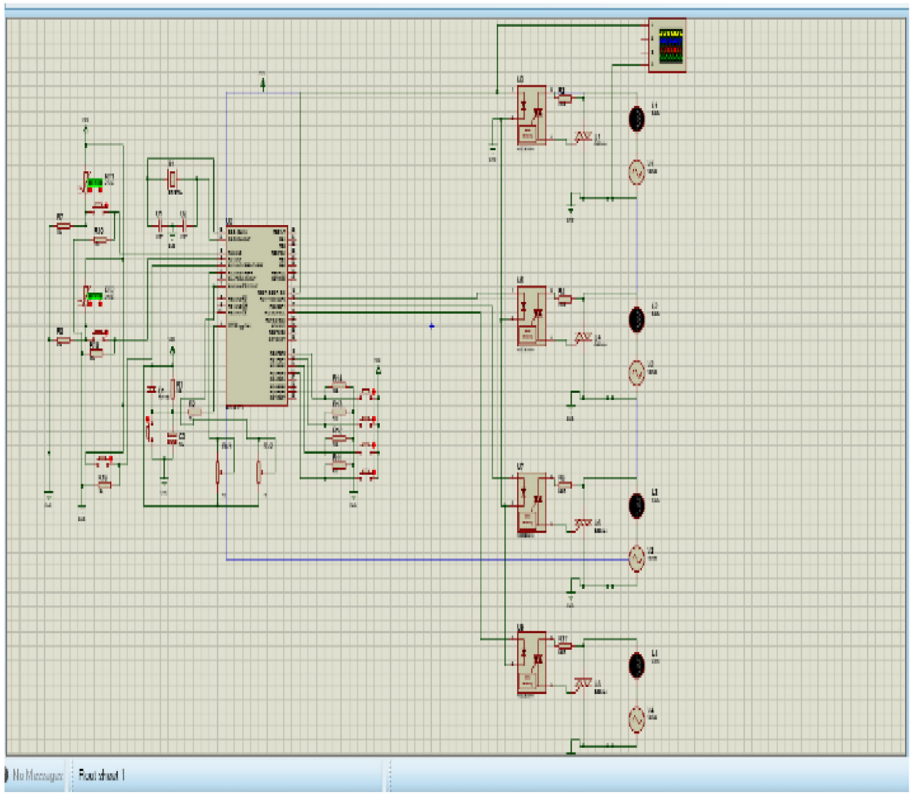

Fig. 6. Simulation result using Proteus.

FSK technique comes under the category of digital communications. In angle modulation, the information signal may be used to modulate the carrier frequency, giving rise to frequency modulation. With every input given to the system the signal is being transmitted and it is sent to the receiver which is shown in Fig. 7.

The receiver will receive the data from the transmitter through the antenna and passes it to a microcontroller which is then converted to a digital data and that data will be transmitted (Fig. 8).

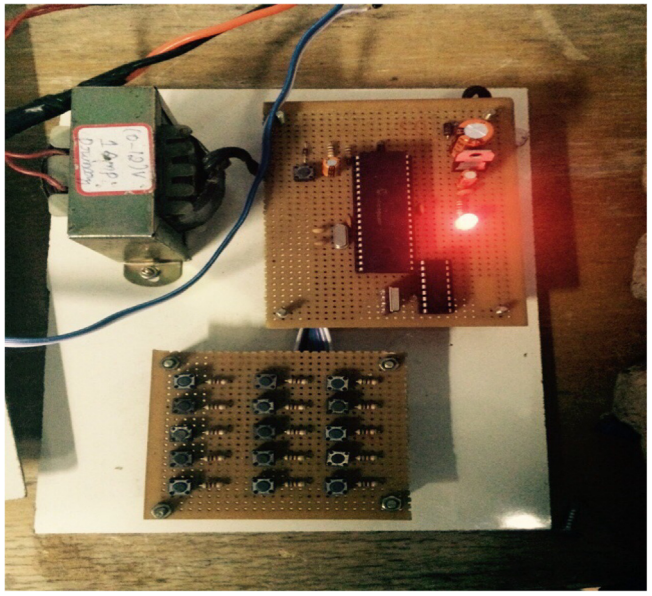

Fig. 7. Output at the Transmitter side.

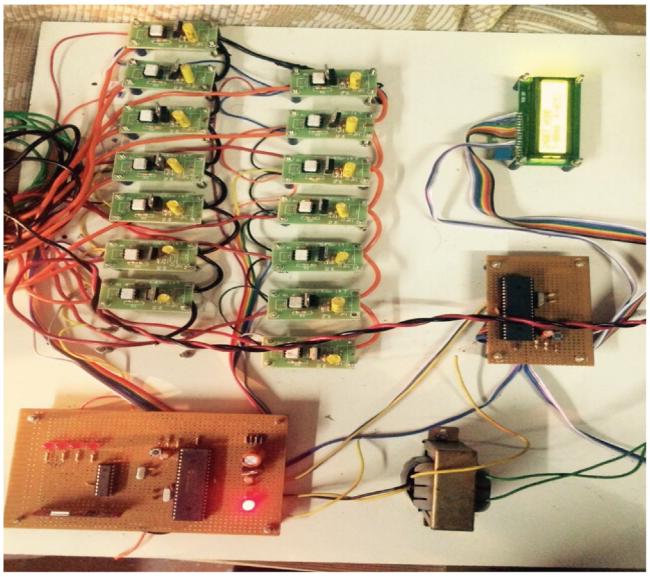

Fig. 8. Output at the receiver side

By using the optical devices, the current fluctuations are eliminated. Opto devices have more advantages. This driver circuit output will drive the load. This TRIAC device here we used to have more lifetime span and has no problem of inrush current. They can be triggered by supplying voltage. In some dc application, a TRIAC may work without a diode, as safe breakdown is possible in either direction. Further the LCD display will show the present condition of the kit and it indicates the lamp which is in ON state which is displayed in the diagram as shown in Fig. 9.

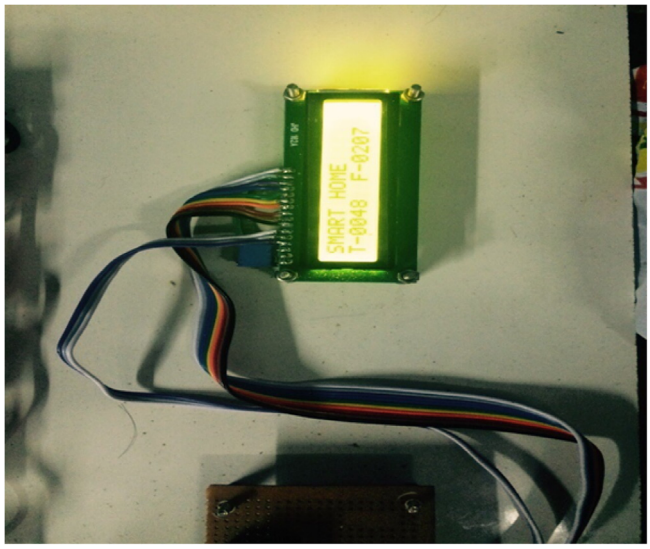

Fig. 9. LCD Display output.

6. Conclusion

We had a wonderful opportunity to gather adequate ideas and information of our engineering field implementations during our project period. We frame worked our paper in "Solid State Switching using Wireless Network in home automation". This Paper aims to control the home automation which is achieved by using DALI and the communication in the system is performed by using wireless network. We had an idea the about existing industrial relays and by which we choose to implement solid state switching device, thereby we suggest an enhancement in control. Control of elements via wireless network makes this technology to widespread use in electrical engineering applications. The model can be implemented and used for an apartment sector, with more switching devices of higher switching rate. This model can also be adapted for industrial and office automation where task is to control several appliances.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] A. Song, G. Song, W. Zhang, Y. Zhou, A multi-interface gateway architecture for home automation networks, IEEE Trans. Consum. Electron. 54 (3) (2008) 1110–1113.
[2] C. Gomez, J. Paradells, Wireless home automation networks: a survey of architectures and technologies, IEEE Commun. Magazine (2010) 92–101.
[3] Dae-Man Han, Jae-Hyun Lim, Smart home energy management system using IEEE 802.15.4 and ZigBee, IEEE Trans. Consum. Electron. 56 (3) (2010) 1403–1410.
[4] D. Dietrich, D. Bruckner, G. Zucker, P. Palensky, Communication and computation in buildings: a short introduction and overview, IEEE Trans. Consum. Electron. 57 (11) (2010) 3577–3584.
[5] F. Yao, K. Gill, S.-H. Yang, L.u. Xin, A ZigBee-based home automation system, IEEE Trans. Consum. Electron. 55 (2) (2009) 422–430.
[6] M. Patel, S. Mukherjee, Lighting control protocols and standards, in: R. Karlicek, C.-.-C. Sun (Eds.), Handbook of Advanced Lighting Technology, Springer International Publishing AG, Cham, Switzerland, 2017, pp. 559–582.
[7] Y.-S. Cheng, J.-H. Chen, Y.-H. Liu, S.-C. Wang, Development of wireless RGB LED dimming control technology using smart phone. In Proceedings of the 2014 International Conference on Intelligent Green Building and Smart Grid (IGBSG 2014), Taipei, Taiwan, 23–25 April 2014.
[8] C.K. Lee, S. Li, S.Y. Hui, A design methodology for smart LED lighting systems powered by weakly regulated renewable power grids, IEEE Trans. Smart Grid 2 (2011) 548–554.
[9] Alexandru Lavric, Valentin Popa, Ilie FINIS, Daniel SIMION Stefan cel Mare University of Suceava (2012) 'The design and implementation of an energy efficient street lighting monitoring and control system'.
[10] S. Baskar, V. Vijayan, I.J. Isaac Premkumar, D. Arunkumar, Dowhi Thamaran., "Design and material characteristics of hybrid electric vehicle", Materials Today: Proceedings, Received 26 April 2020, Accepted 11 May 2020, Available online 18 June 2020.
[11] S. Baskar, L. Karikalan, V. Vijayan, D. Arunkumar, K. Sukenraj, Performance, emission characteristics of compressed ignition engine with alternative fuel, Materials Today: Proceedings (2020), https://doi.org/10.1016/j.matpr.2020.06.191.
[12] A. Gil-de-Castro, A. Moreno-Munoz, F. Domingo-Perez, F. J. Bellido-Outeirino, J. M. Flores-Arias (2011) Lighting Control System based on DALI and Wireless Sensor Networks.
[13] Darold Wobschall, M.A. Yuan (2006) A Sensor network for buildings based on the DALI bus, Sensor application symposium.
[14] Baskar Sanjeevi, Karikalan Loganathan, Synthesis of MWCNT Nanofluid by using Two Step Method, Thermal Science, International Scientific Journal, Published Online: November 2019, DOI: https://doi.org/10.2298/TSCI190414430S.
[15] A. Sinha, S. Sharma, P. Goswami, V.K. Verma, M. Manas. Design of an energy efficient Iot enabled smart system based on DALI network over MQTT protocol. In Proceedings of the 3rd International Conference on Computational Intelligence & Communication Technology (CICT 2017), Ghaziabad, India, 9–10 February 2017; pp. 1–5.
[16] G.K. Adam, P.A. Kontaxis, C.A. Bouroussis, D.E. Ventzas, F.V. Topalis, Embedded computer communication and control of DALI LED drivers, in: Proceedings of the Balkan Light Conference, Athens, Greece, 16–19 September 2015, 2015, pp. 125–130.
[17] S. Baskar, L. Karikalan, Thermo-physical properties of Al2O3 and preparation technique, Advances in Industrial Automation and Smart Manufacturing, Lecture Notes in Mechanical Engineering, Publisher : Springer Singapore, doi. org/10.1007/978-981-15-4739-3_61, 21 October 2020.
[18] F.J. Bellido-Outeiriño, F.J. Quiles-Latorre, C.D. Moreno-Moreno, J.M. Flores-Arias, I. Moreno-García, M. Ortiz-López, Streetlight control system based on wireless communication over DALI protocol, Sensors 16 (2016), https://doi.org/10.3390/s1605059.
[19] G.K. Sathishkumar, G. Rajkumar, K. Srinivasan, M.J. Umapathy, Structural analysis and mechanical properties of lignite fly-ash-added jute–epoxy polymer matrix composite, J. Reinf. Plast. Compos. 37 (2018) 90–104, https://doi.org/10.1177/0731684417735183.
[20] G. Rajkumar, V. Dhivya, S. Mahalaxmi, K. Rajkumar, G.K. Sathishkumar, R. Karpagam, Influence of fluoride for enhancing bioactivity onto phosphate based glasses, J. Non. Cryst. Solids. 493 (2018) 108–118, https://doi.org/10.1016/j.jnoncrysol.2018.04.046.
[21] B. Gopinath, G.K. Sathishkumar, P. Karthik, M. Martin Charles, K.G. Ashok, M. Mohamed Ibrahim, M. Akheel, A systematic study of the impact of additives on structural and mechanical properties of Magneto Rheological Fluids, Mater. Today: Proc., 2020, https://doi.org/10.1016/j.matpr.2020.07.246.
[22] G.K. Sathishkumar, Mohamed Ibrahim, M. Mohamed Akheel, G. Rajkumar, B. Gopinath, R. Karpagam, P. Karthik, M. Martincharles, G. Gautham, G. Gowri Shankar. Synthesis and Mechanical properties of natural fiber reinforced Epoxy/Polyester/Polypropylene composites: A review. J. Natural Fibers 2020. https://doi.org/10.1080/15440478.2020.1848723.
[23] G.K. Sathishkumar, G. Gautham, G. Gowri Shankar, G. Rajkumar, R. Karpagam, V. Dhivya, B. Gopinath, G. Zacharia, P. Karthik, M. Martin-Charles, Influence of lignite fly ash on the structural and mechanical properties of banana-added polymer matrix composite, Polymer Bulletin (2021), https://doi.org/10.1007/s00289-020-03524-6.
[24] V.S. Shaisundaram, M. Chandrasekaran, S. Mohan Raj, R. Muraliraja, Investigation on the effect of thermal barrier coating at different dosing levels of cerium oxide nanoparticle fuel on diesel in a CI engine, Int. J. Ambient Energy 41 (1) (2020) 98–104.
[25] V.S. Shaisundaram, M. Chandrasekaran, S. Mohan Raj, R. Muraliraja, T. Vinodkumar, Control of carbon dioxide emission in automobile vehicles using CO2 scrubber, Int. J. Ambient Energy 40 (7) (2019) 699–703.
[26] V.S. Shaisundaram, M. Chandrasekaran, M. Shanmugam, S. Padmanabhan, R. Muraliraja, L. Karikalan, Investigation of Momordica charantia seed biodiesel with cerium oxide nanoparticle on CI engine, Int. J. Ambient Energy (2019) 1–5.
[27] M. Shanmugam, S. Sathiyamurthy, G. Rajkumar, S. Saravanakumar, S.T. Prabakaran, V.S. Shaisundaram, Effect of thermal Barrier coating in CI engines fueled with Citrus Medica (Citron) peel oil biodiesel dosed with cerium oxide nanoparticle, Mater. Today: Proc. (2020).

[28] R. Sridhar, S. Baskar, V.S. Shaisundaram, K. Karunakaran, M. Ruban, S.J.I. Raja, Design and development of material behavior of line follower automated vehicle, Mater. Today: Proc. (2020).
[29] S. Satish, S.J. Alexis, A. Bhuvendran, M. Shanmugam, S. Baskar, V.S. Shaisundaram, Design and analysis of mild steel mini truck body for increasing the payload capacity, Mater. Today: Proc. (2020).
[30] V.S. Shaisundaram, M. Chandrasekaran, R. Muraliraja, M. Shanmugam, S. Baskar, A. Bhuvendran, Investigation of Tamarind Seed Oil biodiesel with aluminium oxide nanoparticle in CI engine, Mater. Today: Proc. (2020).
[31] V.S. Shaisundaram, S. Karthick, L. Karikalan, Implementation of vacuum braking system in four wheeler, Mater. Today: Proc. (2020).
[32] A. Prabhakaran, K.S. Krishnan, R. Dhinakaran, S. Baskar, V.S. Shaisundaram, Analysis of the efficiency of an automotive alternator by replacing mild steel into aluminum as a material for rotor, Mater. Today: Proc. (2020).
[33] N.K. Chandramohan, M. Shanmugam, S. Sathiyamurthy, S.T. Prabakaran, S. Saravanakumar, V.S. Shaisundaram, Comparison of chassis frame design of Go-Kart vehicle powered by internal combustion engine and electric motor, Mater. Today: Proc. (2020).
[34] R. Dhinakaran, R. Muraliraja, R. Elansezhian, S. Baskar, S. Satish, V.S. Shaisundaram, Utilization of solar resource using phase change material assisted solar water heater and the influence of nano filler, Mater. Today: Proc. (2020).