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Development of An Enhanced Home Automation System For Energy Saving Using GSM, Internet of Things and Bluetooth Technologies

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***Abstract*—Residential electricity usage accounts for a large portion of Nigeria's electricity consumption due to the rising population and the increasing rate of urbanization. However, much attention has not been given to electricity conservation in the country. In response to this, several recent research studies are tailored towards ensuring a rapid reduction in home energy consumption through various alternatives, including energy-efficient technologies given the current state of inadequate electricity supply worldwide. In this research work, an enhanced home automation system (HAS) for energy saving using GSM, IoT and Bluetooth technologies is developed. The system comprises a temperature sensor, motion sensor, GSM, Bluetooth and Wi-Fi Modules. Others are light dependent resistor (LDR), Solar System, Overvoltage Sensor, an AC Mains and a microcontroller. HAS design and simulation were done using proteus software. The Results shows that in a situation where renewable energy is incorporated into the home automation system to power the appliances alongside the mains supply, 32.79% of energy is conserved.**

Keywords—Residential electricity, Home automation, Renewable energy, Microcontroller, Proteus software, Arduino IDE and Wireless communication

I. INTRODUCTION

The Nigerian power grid is faced with numerous problems [1], the major ones being the growing energy demand, which is currently estimated at 19,100MW [2] and which by far is higher than the current transmission capacity of about 5,103MW [3]. This is as a result of the increasing population size. The country's population at the moment is over 170 million, and with a population growth rate ranging between 2.5 and 2.7% per annum, the population in the next 20 years is expected to grow to 310 million by 2035 [4]. This huge disparity between the available electrical energy and the demanded energy has created an energy mismatch between the quantity of energy supplied, and the energy demanded. If the grid is to meet all the peak demands, it will be strained, thereby exposing it to the danger of collapse. Therefore given the insufficient energy supply, serious measures are needed to limit peak periods of energy demand and curtail any kind of energy losses that may arise from the consumption of electricity. Another is the inefficient use of the available power as a result of power losses along the transmission lines and energy wastage amidst shortage at the residence of the consumers, and this is going to be the focus of this research. Residential buildings globally take up a substantial amount of the total electrical energy produced, and about 30-40% of the total global electricity consumption as at 2018 emanated from the residential sector [5]. In developing countries such as Nigeria, residential electricity consumption is up to 60% [6]. A substantial portion of residential electricity consumption is used for lighting, television, radio, refrigeration, ironing, and air-conditioning, just to mention a few. Even though these devices provide the householders with the necessary comforts and convenience, the energy wasted when the user neglects to turn them off or are left in standby mode is a source of global concern. In recent times, the use of high-efficiency lighting systems alone in residential sectors has helped save a significant amount of electrical energy. Thus, achieving savings of 30 to 50% in lighting costs [7], but its main disadvantage is a short life cycle. Customer load consumption can be controlled by direct and indirect means.

Direct load control involves using an automation device to control loads directly. This control device can either be a simple circuit that applies a pre-programmed schedule for a single load or a more complex device that communicates with a house automation system and smart meter and controls various loads. Although the direct load control approach requires technological development and additional costs for infrastructure, the cost of controlling loads with a device is less than the cost of constructing a new power plant or the set up and use of an energy storage system [8].

In this paper, an enhanced home automation system with an energy management algorithm and a hybrid wireless communication system have been developed for consumer residence in Nigeria. The choice of a hybrid wireless communication is for redundancy (to reduce the chances of total system failure), thus enhancing the reliability of the overall system. The HAS will help monitor and manage the energy consumption of home appliances to reduce energy waste and improve the overall home energy efficiency. Instead of shedding off or shifting some loads during the periods of peak demands as done in the previous research to

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