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Cost-Effective Design of IoT-Based Smart Household Distribution System

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Abstract: The Internet of Things (IoT) plays an indispensable role in present-day household electricity management. Nevertheless, practical development of cost-effective intelligent condition monitoring, protection, and control techniques for household distribution systems is still a challenging task. This paper is taking one step forward into a practical implementation of such techniques by developing an IoT Smart Household Distribution Board (ISHDB) to monitor and control various household smart appliances. The main function of the developed ISHDB is collecting and storing voltage, current, and power data and presenting them in a user-friendly way. The performance of the developed system is investigated under various residential electrical loads of different energy consumption profiles. In this regard, an Arduino-based working prototype is employed to gather the collected data into the ThingSpeak cloud through a Wi-Fi medium. Blynk mobile application is also implemented to facilitate real-time monitoring by individual consumers. Microprocessor technology is adopted to automate the process, and reduce hardware size and cost. Experimental results show that the developed system can be used effectively for real-time home energy management. It can also be used to detect any abnormal performance of the electrical appliances in real-time through monitoring their individual current and voltage waveforms. A comparison of the developed system and other existing techniques reveals the superiority of the proposed method in terms of the implementation cost and execution time.

Keywords: internet of things; smart household distribution board; smart appliances; condition monitoring; energy management

Citation: Ahmed, M.M.; Qays, M.O.; Abu-Siada, A.; Muyeen, S.M.; Hossain, M.L. Cost-Effective Design of IoT-Based Smart Household Distribution System. *Designs* **2021**, *5*, 55. https://doi.org/10.3390/designs5030055

Academic Editors: Saher Javaid and Yuto Lim

Received: 27 June 2021
Accepted: 20 August 2021
Published: 24 August 2021

1. Introduction

Worldwide energy demand has been significantly augmented over the last few years due to the increased population and rapid industrial advancement. As such, renewable energy sources have been widely employed at both industry and residential levels [1,2]. As a result, the traditional consumer market has been changed into prosumer-oriented market [3,4]. Thus, developing smart home systems to monitor and manage electrical energy has become essential [5]. Although a number of scholarly articles on the development of smart home systems have been published in the literature, developing a cost-effective prototype for the distribution board has not been given much attention. For instance, renewable energy-based smart home energy management system (HEMS) is presented in [6] to optimize the power generation and consumption. In [7], an internet of things (IoT)-related smart meter is explored to support voltage control strategies within the low voltage distribution system of 30 smart homes. Although the simulation analysis shows good performance, the proposed methodology can be only used to improve the user-friendly conditions.