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ABSTRACT

The demands of electricity are increasing from day to day as many housing and building construction are built to fulfil the demands. Abreast with the development, the electricity is an essential for daily basis, thus the wastage is also a problem that needs to overcome. The electrical wastage problem is focused on the residency college as students are always not aware to turn off the appliances when leaving the room, for instance, the fan and lamp. The first stage to overcome the wastage problem, an approach called "Non-Intrusive Electrical Energy Monitoring (NIEM)" is proposed to this project. NIEM encompass a method of detecting the electrical energy consumption in a building by using a single set of sensor on the main distribution board for each building. This method is in contrast to Intrusive Electrical Energy Monitoring (IEM) where the end-use devices are sensed. To realize the method used, an energy meter is used to measure the electrical consumption by the appliances. The data obtained will be analyzed using a method called Multilayer Perceptron (MLP) technique of Artificial Neural Network (ANN). The technique will firstly implement the event detection to identify the type of loads and the power consumption of the load which is intensified as fan and lamp. The switching ON and OFF events of the loads are made in order and random to test the capability of MLP to classify the type of loads. Then the data were divided to 70% for training, 15% for testing and 15% for validation. The output of the MLP is either '1' for fan or '0' for lamp. The system can be re-train to obtain a good performance, lower Mean Square Error (difference between output and target), and lower percent error (misclassified data). For later stages in future, a Neural Network system can be design to automatically turn off the appliances whenever not in used, so that the electrical wastage and monthly bill can be reduced to strive for a green and energy saving manner.

ABSTRAK

Permintaan ke atas bekalan elektrik meningkat dari hari ke hari apabila banyak perumahan dan bangunan dibina untuk memenuhi permintaan dan kehendak pengguna. Seiring dengan pembangunan itu, bekalan elektrik menjadi penting untuk kegunaan seharian, jadi pembaziran elektrik menjadi satu masalah yang perlu diatasi. Masalah pembaziran elektrik ditumpukan pada kolej kediaman dimana pelajar sering terlupa dan cuai untuk menutup bekalan elektrik apabila meninggalkan bilik, seperti contoh kipas dan lampu. Langkah pertama untuk mengatasi masalah pembaziran ini, satu pendekatan dipanggil *"Non-Intrusive Electrical Energy Monitoring (NIEM)"* dicadangkan dalam projek ini. NIEM mencakupi kaedah untuk mengesan kadar penggunaan tenaga elektrik di dalam sesebuah bangunan dengan hanya menggunakan satu set pengesan yang diletakkan di pembahagian utama elektrik *(distribution board)* untuk setiap bangunan. Kaedah ini adalah berbeza dengan *Intrusive Electrical Energy Monitoring (IEM)* dimana pengesan diletak di setiap peralatan. Untuk merealisasikan kaedah yang digunapakai, satu meter tenaga telah digunakan untuk mengukur kadar penggunaan elektrik oleh peralatan. Data yang diperolehi akan dianalisis menggunakan kaedah *"Multilayer Perceptron (MLP)"* di dalam *"Artificial Neural Network (ANN)"*. Teknik ini akan melaksanakan pengesanan acara (*event detection*) untuk mengenal pasti jenis beban dan penggunaan kuasa oleh beban yang difokuskan kepada kipas dan lampu. Acara ON dan OFF suis oleh beban dilakukan secara teratur dan rawak untuk menguji kebolehan MLP untuk mngklasifikasi jenis beban. Kemudian data akan dibahagikan kepada 70% untuk latihan, 15% untuk pengujian dan 15% lagi untuk pengesahan. Keluaran MLP sama ada '1' untuk kipas dan '0' untuk lampu. Sistem boleh dilatih berulang kali untuk mendapatkan prestasi yang bagus, rendah Ralat Min Kuasa Dua (MSE) dan rendah peratusan ralat.

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LIST OF ABBREVIATIONS

AC	-	Alternating Current
ANN	-	Artificial Neural Network
BP	-	Backpropagation
EBP	-	Error Backpropagation
FFNN	-	Feedforward Neural Network
FSM	-	Finite State Machine
IC	-	Integrated Circuit
LVQ	-	Learning Vector Quantization
MSE	-	Mean Square Error
NBN	-	Neuron-by-neuron
NIEM	-	Non-Intrusive Electrical Energy Monitoring
RMS	-	Root Mean Square
RNN	-	Recurrent Neural Network
SVM	-	Support Vector Machine
WT	-	Wavelet Transform

LIST OF SYMBOLS

I	-	Current
P	-	Power
R	-	Regression
s	-	Second
T	-	Time
V	-	Voltage
W	-	Watt

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CHAPTER 1

INTRODUCTION

1.1 Background

Electrical energy wastage occurred everywhere, from small organization such as houses and big organization such as residential colleges. The lack of awareness from the users resulted the increase spending to pay for the electricity bills. Even though the wastage and power cost in a household is small rather than the residential college, but the problem becomes bigger when it comes on how to reduce the electricity bills for the residential colleges. Students are not aware of this problem since they have paid for the college fees [1].

Residential college is different from a rental house because of the lower fees that included the electricity, water, internet Wi-Fi and other utilities. But for the rental house, the student must paid for every single watt of electricity and every gallon of water that they used. So the wastage problem can be optimize by using a method called Non-Intrusive Electrical Energy Monitoring (NIEM) [2].

1.2 Non-Intrusive Electrical Energy Monitoring (NIEM)

Non-Intrusive Electrical Energy Monitoring (NIEM) is the process of detecting the changes in the voltage, current and collecting data about the load inside a building and without implementing a sub-meter infrastructure with a single set of sensor [3][4]. This configuration is in contrast to an intrusive method scheme which requires sensors on all of the devices of interest. These sensors then communicate back to a central aggregation hub, which can be a part of the residential smart meter.

Instead of having multiple sensors spread out on the appliance of interest, NIEM used only a single sensor located at the building service entrance [5]. The trade-off is that NIEM requires much more signal processing and analysis than a distributed metering scheme would need, especially if the system is autonomously learning about the loads inside the home without human intervention.

There are mainly three categories of nonintrusive disaggregation algorithm and methods which are the Wavelet Transform (WT), Support Vector Machine (SVM) and Artificial Neural Network (ANN). Chan [6] explained the Wavelet Transform that the fuzzy numbers are used for the harmonic signature recognition. They have made use of new development in wavelet so that each type of current waveform polluted with power harmonics can be well presented by a normalized energy vector consisting of five elements [7].

Support Vector Machine (SVM) generally practiced using a randomly selected training set classified in advance [8]. SVM is a classifier that gives a set of training example with each marked as belongings to one of two categories. The third method is Neural Network that will be applied in this project as an analysis method. The use of neural network classifies to evaluate back propagation (BP) and learning vector quantization (LVQ) for feature selection of load identification in NIEM.

The back propagation of neural network will be selected due to the general nature of the BP training method means that a BP net (a multilayer, feedforward net trained by BP) can be used to solve problems in many areas with a simpler method and stages.

Training a network by BP involves three stages which are the feedforward of the input training patterns, the BP of the associated error and the adjustment of the weights [9][10].

1.3 Problem Statement

The problem statement is how to measure, monitor and collecting data of power consumption by the loads to reduce the wastage of electrical energy consumption in residential college. Then how to develop the best algorithm of Multilayer Perceptron (MLP) technique using MATLAB software to identify and classify the type of loads which are intensified as fan and lamp.

1.4 Objectives

This project aims to achieve an objectives which are:

1. To apply event detection method to identify the type of load.
2. To develop an intelligent system for power measurement using Artificial Neural Network (ANN).
3. To implement the intelligent system to classify the type of household appliances.

1.5 Scopes

The scopes and limitations of this work are focused on the data collection and analysis method. A single phase system is used by the energy meter to monitor and measure the electricity usage of appliances. The monitored electrical energy usage is then being analyzed by using MLP technique in ANN. The type of loads are intensified as fan and lamp. Apparatus such as harmonic load bank, personal computer and MATLAB software also used to achieve the objective of the work.

1.6 Thesis Organization

This thesis is arranged into five chapters with the introduction as the preface to elaborate the project background, objectives, and scope of the project. Chapter 2 describes the state of art from previous researchers that related to this project, for instance, power measurement using energy meter and development of neural network system. The methodology and the flows of project are described in Chapter 3. The details to measure the power of the loads and the classification of the type of loads using MLP technique are shown in this chapter. Chapter 4 involves the results from the data of power measurement from Fluke energy meter and output from the MLP of ANN using the MATLAB software. Chapter 5, on the other hand, conclude the whole project with a precise conclusion from the result obtained in the previous chapter. This chapter also recommend an ideas for future use to improve this project by other researchers.

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