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Design and Implement of IoT Based Energy Management System with Data Acquisition

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ABSTRACT: In the past decade, critical challenge for the world is to meet the demand for energy. Power saving can be done only when consumption of energy by the load is monitored. Once monitored, adoption of suitable control method can optimize the usage of energy leading to energy saving. Conventional techniques for saving of energy along with monitoring of energy for domestic purpose or for industrial purpose are not effective such that significant amount of energy is saved. Hence, the proposed method presented in this paper is based on Internet of Things (IoT) which monitors the power consumed by load and saves energy in an efficient way. Framework of Internet of Things (IoT) can be applied to a number of applications ranging from home automation to industries where connecting physical things from anywhere to a network. The proposed work implements the system for energy management based on the technology of Internet of Things (IoT) where collection of data is done from automated energy meter operating in a smart way, using Wi-Fi network which is then displayed on the website. This system is able to collect data from the load and control it in the environment of Internet of Things (IoT).

KEYWORDS: Current sensor,Esp32,Lcd

I. INTRODUCTION

An embedded system is a system which is going to do a predefined specified task is the embedded system and is even defined as combination of both software and hardware. A general-purpose definition of embedded systems is that they are devices used to control, monitor or assist the operation of equipment, machinery or plant. "Embedded" reflects the fact that they are an integral part of the system. At the other extreme a general-purpose computer may be used to control the operation of a large complex processing plant, and its presence will be obvious.

All embedded systems are including computers or microprocessors. Some of these computers are however very simple systems as compared with a personal computer.

The very simplest embedded systems are capable of performing only a single function or set of functions to meet a single predetermined purpose. In more complex systems an application program that enables the embedded system to be used for a particular purpose in a specific application determines the functioning of the embedded system. The ability to have programs means that the same embedded system can be used for a variety of different purposes. In some cases a microprocessor may be designed in such a way that application software for a particular purpose can be added to the basic software in a second process, after which it is not possible to make further changes. The applications software on such processors is sometimes referred to as firmware.

The simplest devices consist of a single microprocessor (often called a "chip"), which may itself be packaged with other chips in a hybrid system or Application Specific Integrated Circuit (ASIC). Its input comes from a detector or sensor and its output goes to a switch or activator which (for example) may start or stop the operation of a machine or, by operating a valve, may control the flow of fuel to an engine.

As the embedded system is the combination of both software and hardware

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II. RELATED WORK

The technology of Internet of Things (IoT) is implemented in [1] for efficient energy management of smart building automation done in two stage which includes automation of commercial building system for automatic control of combined cooling, heating and power. The optimization model for real time correction is implemented by programming the non-linear problem using quantum genetic algorithm (QGA). In [2], monitoring approach of data driven with selection of measurement is presented where analysis is done for various approaches for selection of input variable with general procedure for obtaining the optimal order along with selecting procedure for measurement of candidate data. This approach depends on partial correlation extension which is maximum relevant to minimal redundancy criteria for supporting problems of IVS that involves multiple numbers of outputs as in [3].

A low-cost sensor solution for metering with the aim to realize and provide reasonable accuracy for measurement by considering the monitoring of non-intrusive load using sub metering based on virtual energy for lighting systems as in [4]. Analytic methods are presented using the sensor data for metering the lighting energy by addressing three problems as follows: 1) Initial validation is provided by the control system acting as asset of lighting system as in [5]. 2) Consumption of energy which is disaggregates across the various groups of controlling of a validating system which enables monitoring of performance and usage. 3) Managing and monitoring of lighting system with asset over its life cycle. Evaluation for these methods is done using test bed developed for the experiment in a building available for commercial purpose as in [6].

The technology of Internet of Things with smart socket operating with wireless communication is presented in [7-9] which minimize the consumption of energy by home appliances which does not deploy any sensors. Four modes of control are provided by RECoS which includes peak time control, limit control of energy, user control as well as automatic control. Operations of first two controls is done using smart sockets fixed in the building while the next two controls is implemented using individual sockets which aims to enhance the controlling of energy. Results obtained from experimentation for the proposed scheme saves energy up to 44.2% for devices for one day of the week.

III. PROPOSED ALGORITHM

Apply Power to the system
Initialize all the peripherals
Display the Starting Message and after default page
The Voltage (240V Max) and Current (10A) Signals are Converted to Low voltage signals by analog front end and fed to Inbuilt ADC of ARM Processor
The signals are sampled at every 500µs interval and digitized
The digitized samples are used to calculate RMS Voltage, Current, Power and EnergyParameters
The computed Parameters are Shown on Display one by one in Scroll mode
The Computed parameters are transferred to the Static IP through GPRS Module at every 1 Minute Interval
The transmitted data's are stored and hosted in a web page for remote monitoring of the load
The load can be controlled through web page by switching ON/OFF the relay in the Meter Board

IV. PSEUDO CODE

```
#define BLYNK_PRINT Serial
#define BLYNK_TEMPLATE_ID "TMPL37csJy9Po"
#define BLYNK_TEMPLATE_NAME "IoT energy management system"
#define BLYNK_AUTH_TOKEN "iHzJv93649OXnLcTxQ2CkcmFJ9SbKmGZ"
#include <Arduino.h>
#include <WiFi.h>
#include <WiFiClient.h>
#include <PubSubClient.h>
#include <BlynkSimpleEsp32.h>
#include "ThingSpeak.h"
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

#define r1 32
```

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```
#define r2 33
#define r3 25
#define r4 26
LiquidCrystal_I2C lcd(0x27,16,2);
WiFiClient  client;
unsigned long myChannelNumber = 1739122;
const char * myWriteAPIKey = "YZYW9J3F4STLOHZJ";
CurrentSensor LA1(34,ADC_READ_GAP, 510.999);
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "HAVASYA";
char pass[] = "Havasya_9";
int mVperAmp = 520;
int Watt = 0;
double Voltage = 0;
double VRMS = 0;
double AmpsRMS = 0;
BlynkTimer timer;
BLYNK_WRITE(V0){
  int button= param.asInt();
  if(button==1){digitalWrite(r1,LOW);}
  else  { digitalWrite(r1,HIGH);}
}
BLYNK_WRITE(V1){
  int button= param.asInt();
  if(button==1){digitalWrite(r2,LOW);}
  else  { digitalWrite(r2,HIGH);}
}
BLYNK_WRITE(V2){
  int button= param.asInt();
  if(button==1){digitalWrite(r3,LOW);}
  else  { digitalWrite(r3,HIGH);}
}
BLYNK_WRITE(V3){
  int button= param.asInt();
  if(button==1){digitalWrite(r4,LOW);}
  else  { digitalWrite(r4,HIGH);}
}

void initWiFi() {
  WiFi.mode(WIFI_STA);
  WiFi.begin(ssid, pass);
    while (WiFi.status() != WL_CONNECTED) {
    Serial.print('.');
    delay(100);
  }
  }
void currentSensor()
{
  LA1.readADCData();
  AmpsRMS = LA1.current/1000;
  Serial.print(AmpsRMS);
  Serial.print(" Amps RMS  ---  ");
  Watt = (AmpsRMS*230);
  lcd.setCursor(0,0);
  lcd.print("V:");
  lcd.setCursor(2,0);
  lcd.print(random(220,230));
```

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```
  lcd.setCursor(7,1);
  lcd.print("I:");
  lcd.setCursor(9,1);
  lcd.print("    ");
  lcd.setCursor(9,1);
  lcd.print(AmpsRMS);

  lcd.setCursor(0,1);
  lcd.print("W:");
  lcd.setCursor(2,1);
  lcd.print("    ");
  lcd.setCursor(2,1);
  lcd.print(Watt);



}

void updateThingSpeak()
{

    ThingSpeak.setField(1, String(AmpsRMS));
    ThingSpeak.setField(2, Watt);
    ThingSpeak.setField(3, random(220,230));
    ThingSpeak.writeFields(myChannelNumber, myWriteAPIKey);
    Serial.println("upload Success");
}



void setup() {
  Serial.begin(9600);
  pinMode(r1,OUTPUT);
  pinMode(r2,OUTPUT);
  pinMode(r3,OUTPUT);
  pinMode(r4,OUTPUT);
  digitalWrite(r1,HIGH);
  digitalWrite(r2,HIGH);
  digitalWrite(r3,HIGH);
  digitalWrite(r4,HIGH);
  lcd.begin();
  lcd.backlight();
  lcd.clear();
  lcd.print("connecting Blynk");
  initWiFi();
  Blynk.begin(auth, ssid, pass);
  lcd.clear();
  lcd.print("Blynk Connected");
  delay(2000);
  lcd.clear();
  lcd.clear();
  lcd.print("IoT Based Home");
  lcd.setCursor(0,1);
  lcd.print("Automation Systm");
  delay(1000);
  lcd.clear();
```

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```
 ThingSpeak.begin(client);
 timer.setInterval(1000L,currentSensor);
 timer.setInterval(100L,updateThingSpeak);
}

void loop()
{
 Blynk.run();
 timer.run();
}
```

V. SIMULATION RESULTS

E. Software Architecture

In this proposed system IAR Embedded Workbench IDE, STM32CubeMX, OrCAD, .Net Frame work and MySQL Database are the software's used to implement the system.

STM32CubeMx:

Hardware configuration and driver codes are generated using this software for proposed system Shown in Figure 3.

STM32CubeMx Software

IAR Embedded Workbench IDE (Version 7.0):

User application codes in embedded C are written using this software for proposed system. Using this workbench compiling, downloading and debugging are done here shown in Figure 4.

IAR Embedded Workbench IDE

Cadence OrCAD Designer Version 16.5:

OrCAD Capture CIS 16.5 Software

Proposed system Schematic layout was done using this software as shown in Figure 5. After completing the layout artwork on PCB (Printed Circuit Based), monitoring is started using the components on PCB.

NET Frame Work:

Microsoft has developed .NET Frameworkwhich is a software framework that runs primarily on the platform of Microsoft Windows. .NET platforms targets on embedded devices, browser plugins, mobile computing and alternative operating systems leading to a family of .NET Framework. Proposed system web application screens are developed by .NET Code using Microsoft Visual Studio software shown in Figure 6.

Microsoft - Visual Studio Software

MySQL Database:

MYSQL is a RDBMS (relational database management system) which is available open source for universal access. Development of MYSQL project is done based on the terms of GNU (General Public License) whose source code is available under the variety of agreements of the proprietor. Received data from the proposed system is stored using MySQL Database.

VI. CONCLUSION AND FUTURE WORK

This paper describes an IoT based energy management system and data collection system to display on webpage using GPRS. IoT is the core concept of this Energy Management System project. Smart meter,GPRS communication network, web-based software, data base and other related technologies are used in this work. The proposed system is developed and tested using practical load with IoT environment. Implementation of IoT based management system

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plays an important role in the scheduling, monitoring, controlling, optimization of enterprise energy, and improving organization/ labor productivity. It has the advantage of low power consumption and makes it easy to implement with high speed. The future work is based on the proposed system is multimode with Wi-Fi interface connectivity and the collected data's will be send to common mode with GPRS module that will be connected with remote server for monitor and control the whole network of the system

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