Development of an Internet based Embedded System for Smart House Controlling and Monitoring

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ABSTRACT

This paper provides an embedded Ethernet system for controlling and monitoring the electrical device at home from anywhere by a specific web application share on the internet. Our solution works on a standard Local Area Network (LAN) using a specially designed hardware interfaced with an Embedded Ethernet System using Microcontroller.

This system can access and detect the status of any electrical appliance through specially designed web site using any PC or phone with network access. Digital camera can be used for special monitoring purposes if expected event detected by the motion sensor.

Key words

Embedded systems, controlling, monitoring, smart house, internet

1. INTRODUCTION

An embedded system is a computer system designed for specific control functions within a larger system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical part. It contain processing cores that are typically either microcontrollers or digital signal processors (DSP).[4]

Embedded systems are everywhere, it is not surprise that millions of computing systems are built every year, destined for desktop computers like personal computers, laptops, workstations, mainframes and servers. What is may be surprising is that billions of computing systems are built every year for very different purpose.[5]They are found in a variety of common electronic devices, such as consumer electronics (cell phone, digital cameras, calculators, digital watches and MP3 players), home applications (microwave ovens, answering machines, thermostats, home security systems washing machines and lighting systems), office automation (fax machines, copiers, printers and scanners), business equipments (cash registers and card readers) and automatable (transmission control and fuel injection)[6]

Such systems achieved the time and efforts without human intervention and so, it proved a quite effective in terms, cost and efficiency in many applications such as industrial automation, communication and medical systems.

This work tried to make used of the Internet based embedded systems access capability to provide a simple and effective Smart hoses monitoring, controlling and household.

This system makes use of internet embedded systems in with the user from anywhere can access and control the electrical devices (on/off), and detect a specific event " motion" for Security system applications. Physical quantities measurement and control such as light, temperature and radiation can be handled in the same manner as introduction sensor internetwork applications.

Making use of internet as extension of microelectronic capabilities implementation as in this system, make easy to control and monitor the smart home specially for people with disabilities and the elderly and also for people who spend most of their time outside the home. This system proposed solution for the problem of the continuous recording of the surveillance cameras which record all time without stopping which replaced by "record if event method" in which the camera started if event is detected. Such systems make other use of internet rather than data browsing and transfer. Such embedded system can be used in the places which the human can't reach it, such as radiation place.

This project aims to facilitate the control and monitoring in the home through distance using the Ethernet service. Microcontroller, internet module, motion sensor, camera and relays are used. The microcontroller connected to the internet through the internet module for internet based access, it has a connection to the camera to be enabled if motion is detected by the motion sensor, number of relays connecting number of digital systems to the power source to turn it on/off if required by the browser. So, both controlling and monitoring done via Ethernet service, where the user can control and monitor his home by a web browser in PC or phone, from anywhere, whether in work or journey.

2. The Method

This system has to provide an internet based access for smart hoses through which users from everywhere can control and monitor a number of electric systems at home as in figure (1).

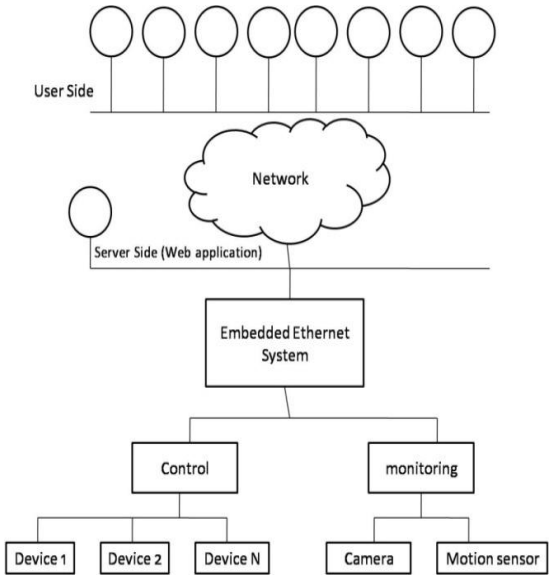

Fig 1: Systems General Overview

Through which the user from any of user side can read or written in Microcontroller for control and monitoring propose via Ethernet.

Design of such systems divided into several parts: End user interface for the user to system access, Ethernet module system for microcontroller – internet communication, Controlling and monitoring systems

For the End user interface a programming language such as ASP, JavaScript, PHP and HTML is need. Via any programming language the secret and specific Web page for the user is design. This web page has to allow user to control and monitor the house. Suitable web browser such as Internet Explorer or Firefox is required for web page browsing on computer or mobile phone with Internet supports.

Ethernet module system is required to connect the microcontroller to Ethernet service to allow a user connection to the smart house control system. such as HXSP-2108E-M_serial_to_ethernet_module, Stellaris Serial-to-Ethernet Module , 400-ethernet module , or EM202 Ethernet-to-serial Module as Examples.

Controlling and monitoring system is consists of several hardware devices like microcontroller, surveillance camera, motion sensor and relays. the system's main communicate as in Figure (2).

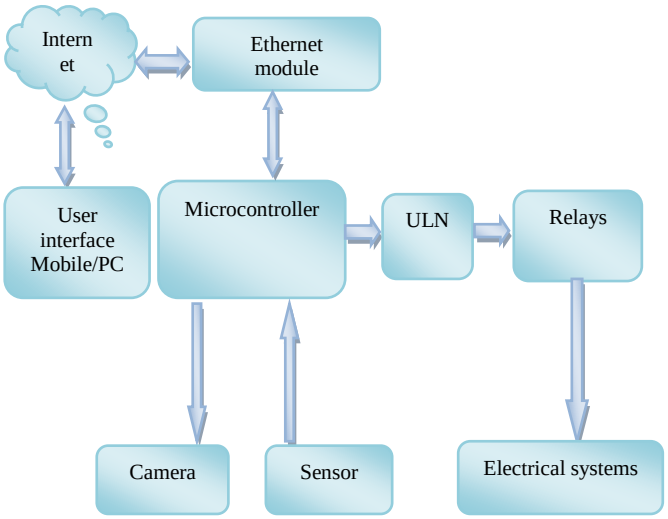

Fig 2: System Components Communication

The microcontroller is connected to Ethernet module, sensor, camera and relays through one of its input / output ports for each device. The ULN used her to make interfaces between microcontroller and relays.

Integrated micro program required can be developed using Low level programming language such as assembly language or mikroC language. The program has to be converted into hexadecimal format and loaded to the microcontroller internal memory.

Generally, this program has two main functions: monitoring and control. In the monitoring part, the microcontroller has to read the motion sensor signal and tern no the camera if event through suitable relay as explained in Figure (3).

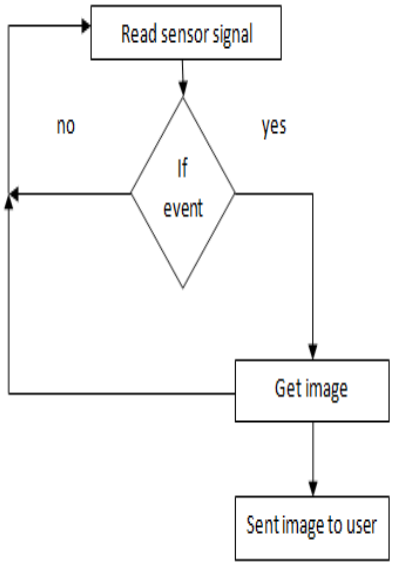

Fig 3: Flow chart of Monitoring System

The Surveillance camera connect with microcontroller , and it captures the image or record the video depending on the motion sensor ; if event occur, the camera capture image and save it in microcontroller memory "or send this image to user via Ethernet module or other media if suitable functions added".

The other part of the program has to read internet module status and wait for message; if a message resaved by the internet module through its related IP, the microcontroller has to capture and analyze it then identify what to do.

This message should be send by an internet web from anywhere, it contains one or more of binary digits with specified control function.

3. Tools

With refer to figure (2) Microcontroller such as ATmega16, PIR motion Sensors, Ethernet module, Surveillance camera , ULN2003 device , Relays , Computer or mobile phone and programming language are required for system design.

Microcontrollers are classified on the basis of internal bus width, architecture, memory and instruction set.

The basic internal designs of microcontrollers are pretty similar. Figure (4) shows the block diagram of a typical microcontroller. All components are connected via an internal bus and are all integrated on one chip. The modules are connected to the outside world via I/O pins.[7]

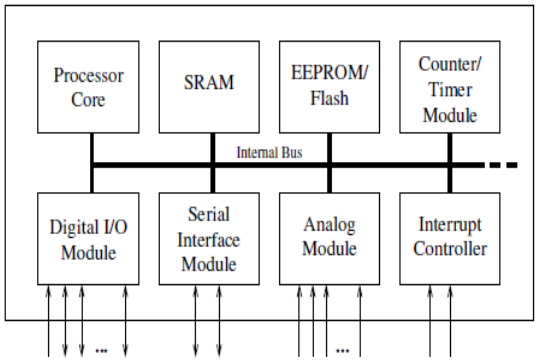

Fig 4: Basic layout of a microcontroller

The ATmega16 Microcontroller used in this system to process data that receive from network.

It is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designed to optimize power consumption versus processing speed [2]

ATmega16 have 24 in/out pins, that means this system can control and monitor number of device.

ATmega16 send signals throw ULN2003 which make interface between microcontroller and relays.

The ULN2003 are high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters.[3]

On the other side ATmega16 Although read the sensor signal ,if it is enabled, it can send high signal to turn on the camera, else the camera is disabled.

Digital camera captures image and save it in memory.

Here, Microcontroller used as central processing unit CPU which has to receive data from network and process it ,and then pass it to relays ,and send back message to user by using Ethernet module, also the microcontroller must contain many ports or pins to connect it with sensors , camera, Ethernet module and relays, the microcontroller program has to be augmented to perform web page message construction and transmission to the user .

The low-level language such as Micro c or basic language used to create the program for the microcontroller and the web application programming language such as ASP, JavaScript, PHP and html can be used to create the web page for user interface.

Ethernet module used to connect the Microcontroller with network such as local network or internet network so, the user can control and follow-up the smart house through web browser. The HXSP-2108E-M_serial_to_ethernet_module which designed to transmit and receive data between network and microcontroller is used. It is an engineered circuit for bridging serial communication to the Ethernet network, it's Specifically designed for interfacing with microprocessor as web enabled electronic device via serial interface, Low power consumption (5v , 15mA), Wide operating temperature range of (-10 to +70 degree C) [1]

The motion sensors used to sense events and the Surveillance camera capture image based on motion sensor.

The ULN device used to make interface to relays, lamps, and other electrical device, and the relays use as remote control switches.

Web page in web server used as user interface to control and follow-up the smart house through internet based connection with the microcontroller for data transmit / receive.

4. Design and Result

The design stage consist of both hardware components connecting using test board and software creation, compiling convert to hexadecimal and upload to the microcontroller memory

In hardware design, one of the microcontroller input / output ports used to connect the internet module using the communication lines RxD and TxD, other input / output port used to connect the motion sensor as an input port, other input / output port used to be connected to the relays as an output port and other input / output port used to be connected to the camera through relay as an output port.

Therefore, The HXSP-2108E-M can captures the packets from the LAN and sends it to the Microcontroller where the packets are processed. As soon as the Microcontroller receives any request to turn on / off one or more of the systems regarding the status of Electrical device, it gets the required effect through the relays and send back update message to the user web. Embedded System is shown in Figure(5).

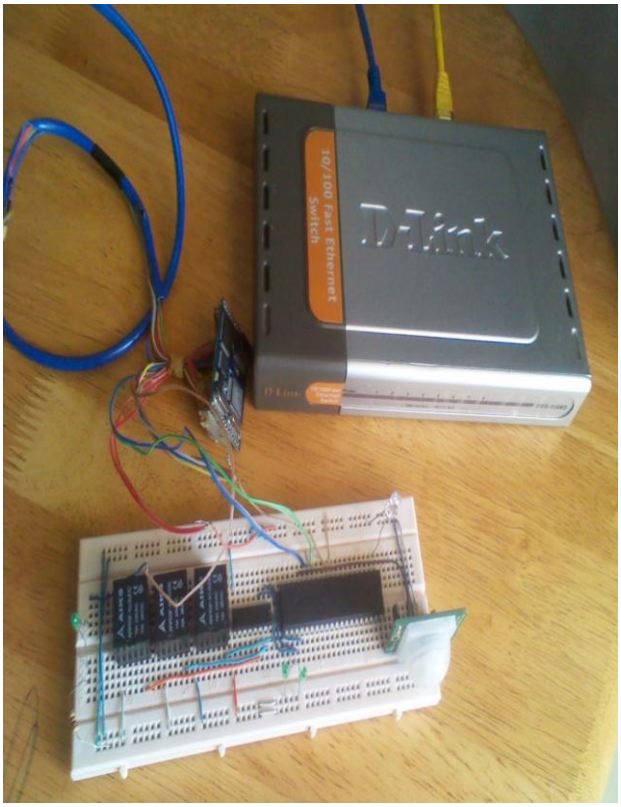

Fig 5: Embedded system design

On the other hand the Software design consists of three basic parts: Microcontroller software, Ethernet module software for Communication and User end software.

The Microcontroller software for ATmega16 Microcontroller has been designed using bascom language .this program has the capability to receive message from the Ethernet module through RxD pin and process it, and send message to electrical device, also send message by TxD to Ethernet module. Interrupt procedure is developed to turn on the camera if the motion sensor connected to INT1 detects event.

The Ethernet module has configuration software to assign the IP address before connecting.

Therefore, the Ethernet to serial module has to be connected to a PC via a switch or router, Download (ezConfig-v6.0-pop-en), open the configuration utility, search to find the Ethernet to serial module and set all sitting for IP address and select UDP or TCP protocols that's used.[1] figure (6) is a configuration window. The IP 192.168.0.11 is used as example.

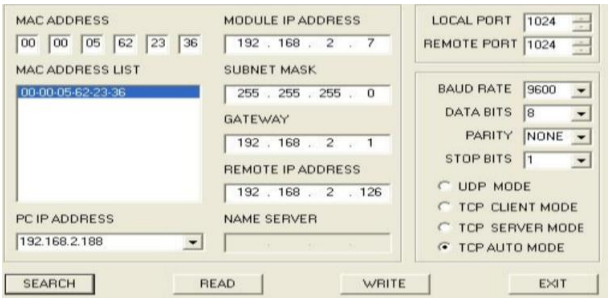

Fig 6 : Verify the settings with the configuration utility

The Communication and user interface software as in figure (7) is designed using ASP.NET whit multi function: detect and view the smart house devices status, enable the user "if logging in" to select and change the devices status and communicate with the internet module via internet. This internet module system connected to three electrical devices as example in addition to one surveillance camera. The system has database to make users logs system which required for creating a list of activities.

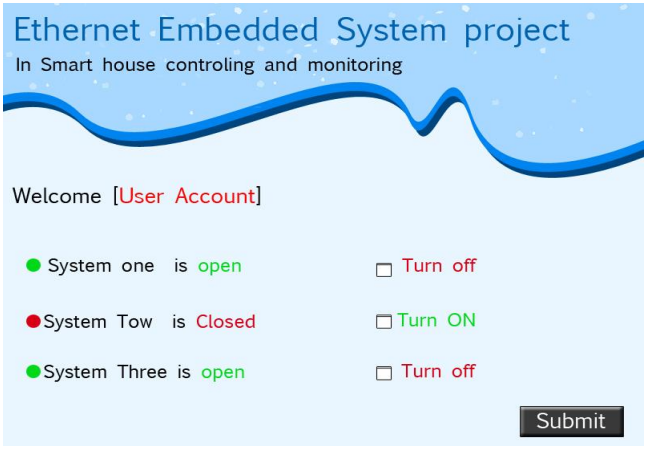

Fig 7: User Interface

Therefore, Users can check or change the status of these electrical device from anywhere inside the network by going to this website. User name and password used for security and authority.

While, various recent research works in the field of wireless sensor networks include SensorWeb, Wireless Sensor and Actor Networks, ocean sensor network, ZigBee technologies for low power communication, memory management mechanisms in sensor devices, various routing technologies, and the solving the problem of the data distortion due to the Ad-Hoc networking.[8]

5. Conclusion and Recommendation

The system designed to make interactive between the hardware device and user from anywhere via Internet, It can control and monitor a about 20 devices in one amount. Such systems can be used effectively in household as well as in the industry, greenhouse, and radiation places.

In case of household it can be used to bring common household appliances such as alarm systems, water sprinklers, washing machines and refrigerators as online applications.

In case of industry this system can be used to control and monitor multiple machines like generators, pumps, valves and assembly line machines through a single PC by a single person and from anywhere.

Thus, they can be controlled and monitored from anywhere in the world

New features can be added to the monitoring System like surveillance camera for image processing and sending.

6. REFERENCE

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