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Web Automation Using AVR 128

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ABSTRACT: Today the Internet and the computer communication systems are playing an important role in the daily life. Using this combination of computer system and internet many applications are imaginable. In web automation, The data and the information stored on the microcontroller's flash memory will be displayed as web page on the web server.

Microcontrollers are crucial to build such automation systems. We're aiming to automate Home/office using RISC over (LAN) internet. The main purpose of project is, controlling the GPIO (General Purpose Input/Output) of RISC controller by web application by Network Layer (UDP, TCP) communication. Moreover creating an Alert System which sense the light, temperature. One can check the temperature, light intensity displayed on the LCD screen and can switch ON/OFF the furnancethrough the web application. Also many devices are controlled when connected in LAN of the company with the help of web server created on our RISC board using popular POST method of web services. This can also be helpful to automate a whole office (PCs, machines) using any PC in its network by Administrator. When Microcontroller is online (Using Ethernet module via RJ45), such logging is real time.

KEYWORDS: SPI (Serial Peripheral Interface), JTAG (Joint Test Action Group) , I^2C(Inter-Integrated circuit), SPCR (SPI control register), AVR, UART(Universal asynchronous receiver transmitter).

I. INTRODUCTION

Internet are playing an important role in Computer communication systems. Hence many applications are imaginable. Web applications, Home automation, appliances, security systems, utility meters, card readers, and building controls, which can be controlled using the front-end software or a standard internet browser client remotely from any corner around the world. System from small to large may provide an interface and can be control via the onboard switches or IR or RF based remote control. But issue arises when the User who wants to control a device, is at another part of world or could not reach the device. There are several other methods developed in order to control the devices remotely, while each technique requires some new implementations to be done. In web automation to connect the system to ethernet we are using the existing technique of Internet protocol i.e. Web based HTTP protocol with TCP/IP protocol suite in order to control the devices. The embedded web server is the process of embedding a web application in a system. Every server is connected to the network. A computer located at remote places controls all devices and can receive requests from other computers on the Internet. The web server is identified using its unique IP address and can be controlled remotely around the world. A computer located in home or office may send a request to turn off the furnace located at factory with the temperature displayed on LCD. The web server will run an HTTP application through the Serial Port interface with which the user can control and monitor the devices.

II. SYSTEM DESIGN

To implement the web automation on an 8 bit Microcontroller we will use an AVR microcontroller because of its high throughput. Also because of low number of pins ENC28J60 Ethernet controller is used that provides an easy interfacing with 8 bit Microcontroller. The following important components used:

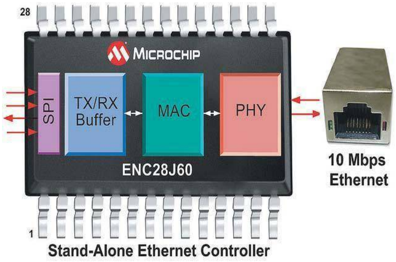
- Atmel ATmega128 Microcontroller
- Ethernet Controller ENC28J60

- Integrated Magnetics RJ -45 Jack.
- J-Tag
- Temperature sensor Temp-275
- LCD Display

Along with these the miscellaneous components, the SPI (Serial Peripheral Interfacing) is used to provide an interface between ATmega128 with ENC28J60.

Atmel ATmega128 Microcontroller-The high-performance and low-power consumption Atmel atmega128, 8-bit AVR RISC-based microcontroller used to combine 128KB of programmable flash memory, a 4KB EEPROM, 4KB SRAM, an 8-channel 10-bit A/D converter, and a JTAG interface (inbuilt) for on-chip debugging. The device operates between 4.5-5.5 volts and supports throughput of 16 MIPS at 16 MHz.
The device achieve the throughput of 1 MIPS per MHz, the balanced power consumption and processing speed, by executing the set of instructions in a single clock cycle. The main reason for using ATmega128 as an 8-bit Microcontroller in this application is because of its high throughput and SPI(Serial Peripheral Interface) interfacing. The SPI interfacing provides serial interface with the Ethernet device and hence reducing the number of address and data lines. The AVR uses Harvard architecture, in order to maximize performance and parallelism – with separate memories and buses for program and data. Single level pipelining is used for the Instructions in the program memory to be executed. While one of the instruction is being executed, the next instruction is pre-fetched from the program memory. Therefore, this concept enables the instructions to be executed in every clock cycle. The program memory is Reprogrammable Flash memory (Insystem). Moreover the Flash is 128 kBytes with 1 External Bus Interface, 64 Pin Count, Maximum Operating Freq. (MHz) as 16 MHz, CPU 8-bit AVR, 53 I/O Pins, 8 Ext Interrupts with 1 SPI,1 TWI (I2C) and 2 UART.

ENC28J60 Ethernet Controller- An Ethernet Controller is a device that is used to implement Ethernet Protocols.ENC28J60 as an Ethernet Controller is used in our application because it supports SPI(Serial Peripheral Interface) interfacing. The SPI interfacing reduces the number of data and address lines used and provides serial interface with the device. With an industry standard Serial Peripheral Interface (SPI), the ENC28J60 is a stand-alone Ethernet controller. It is designed to serve as an Ethernet network interface for different controllers equipped with SPI. The ENC28J60 meets all the specifications of the IEEE 802.3. To limit the incoming packets it incorporates a number of packet filtering schemes. Moreoverit provides an internal DMA module for fast data throughput and hardware checksum calculation, which can be further used in different network protocols. The communication with the host controller is implemented through an interrupt pin and the SPI interface, with clock rates of up to 20 MHz. The Two dedicated pins are used for network activity indication and LED link.An ATmega128 Microcontroller uses SPI (Serial Peripheral Interface) to efficiently communicate with the Ethernet controller ENC28J60.Thiseliminate large number of lines used with the usage of SPI provides serial communication for data and addressing purpose. The SPI allows high-speed synchronous data transfer between the AVR microcontroller and peripheral devices or between several AVR devices. The connection between two SPI devices always happens between a master and a slave device. When compared to some peripheral devices such as sensors which can only run in slave mode, the SPI interface of the AVR microcontroller can be configured for both master and slave mode. The running mode of the AVR microcontroller is specified by setting the master bit (MSTR) in SPI control register (SPCR). SS pin taken is taken under special considerations. The master is the active part in this system and on the basis of serial data transmission it has to provide the clock signal. The slave cannot get active on its own as it is not capable of generating the clock signal. The slave just sends and receives data if the master generates the necessary clock signal. The master however generates the clock signal only while sending data. That means that the master has to send data to the slave to read data from the slave.



ENC28J60 block diagram

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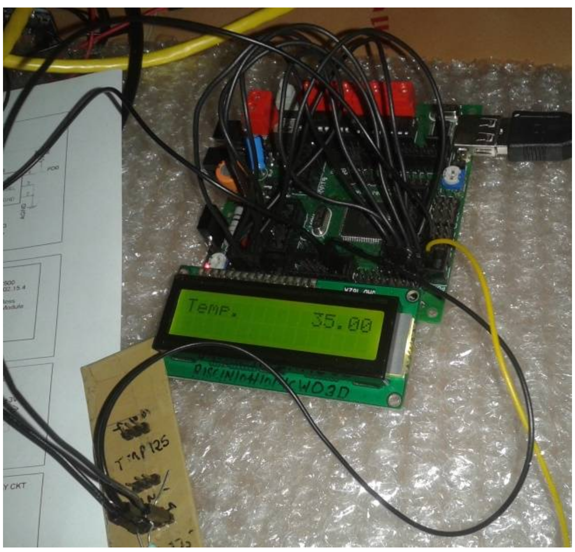
JTAG(Joint Test Action Group)

JTAG is standards for on-chip instrumentation and act as a complementary tool to digital simulation. It postulates the use of a debug port implementing a low-overhead access, serial communications interface without requiring direct external access to the system data and address buses. To implement a stateful protocol, interface connects to an on-chip test access port (TAP) that to access a set of test registers that presents chip logic levels and device capabilities of various parts. Initially JTAG read-only identification data , usedifferent registers to operate the debug facilities and to execute processor instructions while in a special "Debug Mode" . Later, Debug Communications Channel (DCC) ,used for bidirectional data transfer to the core. DCC is used both in debug mode and at runtime when talking to debugger-aware software and Embedded Trace Module (ETM) for data trace mechanism and to control the operation of a passive instruction. Passive debugging is being supported by Tracing (examining execution history) and profiling for performance tuning.
The debug module access hardware breakpoints, watchpoints. It does not need to be in Debug Mode this can be written while the processor is running.

Temperature sensor TEMP275:

The TMP275 is a ±0.5°C accurate digital temperature sensor integrated with a 12-bit analog-to-digital converter (ADC) and can operate as low as 2.7-V supply voltage.It is pin and register compatible with the Instruments LM75, TMP75, TMP75B, and TMP175. It requires no external components to sense the temperature. The TMP275 is proficient of reading temperatures with a maximum resolution of 0.0625°C (12 bits) and low as 0.5°C (9 bits), this allows the user to make the most of efficiency by programming for higher resolution with faster conversion time. The device is defined over a temperature range of –40°C to 125°C.
The TMP275 device features two-wire interface compatibility and SMBus and allows atmost eight devices on the same bus with overtemperature alert function- the SMBus. Due to the factory-calibrated temperature accuracy and the noise-immune digital interface the TMP275 becomes the preferred solution for temperature compensation of other sensors and electronic components, without the need for any additional system-level calibration.

III. RESULTS AND OUTPUT



The project had the hardware requirements as AVR microcontroller Atmega128, LCD,LED, power supply, TEMP 275, APDS(light intensity sensor),Ethernet ENC28j60,ADC,LM 35,Ethernet controller and the software requirements are

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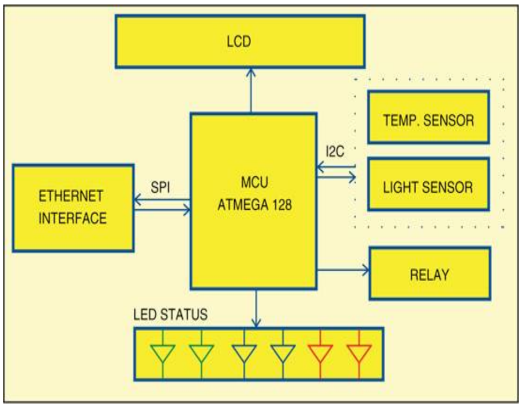
Code Vision AVR IDE tool Embedded C programming, STK 200/300 programmer.

System design

The two system tasks are established in OS µC / OS-П,to transmit the data from SPI to Ethernet. One to receive front-end data through SPI interface and the other is to transmit data to Ethernet.

The communication is done through two protocols as SPI and I2C. First, the Temperature sensor , sense the temperature and display on LCD and the HTML web Page. This is done through I2C communication further the APDS sensor sense the light intensity and display it on LCD and web page. This is also done suing the I2C communication Portocol.

This data is transferred to the web page using the Ethernet ENC28j60. The communication developed through ethernet ENC28j60,AVR and the HTMLweb page is using the SPI communication ove the TCP/IP protocol suite.



SPI Receiving Task: In order to transmit the data to Ethernet, the data that arrived at SPI port is stored into SPI sending buffer and is packed according to TCP/IP protocol and hence added with IP and UDP message header. The condition t be followed is that the the SPI interface is enabledand the PC with SPI interface is set to slave mode. At the end, the data converted is sent to the host through the respective UDP port.

Ethernet Receiving Task In order to receive the data from Ethernet, the local IP address and subnet mask is set along with the appropriate UDP port is open to monitor if there are data in UDP port. As UDP packet, the data which reached the UDP port, is analysed according to TCP/IP protocol and then stored in SPI receiving buffer. At the end, the analysed data is sent to the SPI serial device through SPI interface driver.

The web page designed using HTML language is requested by the client to server. Through the internet processes the client request and server response with web page.

Hence the Client can check the status of industry machineries/furnances and from remote location it can control the machines via its own browser. The status of the temperature and light intensity can be displayed on the web page by typing the IP address of the server board. We can view the status of furnance or location where the sensor is placed and change the status by clicking on it and update the system. Therefore, the results show that the client can access the whole industry from any remote place via its own local browser. In project the single AVR microcontroller board acts as data acquisition and control system and passes through web server, so the system is compact with less complexity.

IV. CONCLUSIONS

In order to transmit the data from the AVR to the web browser via Ethernet using the SPI interface through TCP/IP protocol suite. With the I2C communication the data from the Temperature sensor and the APDS light intensity sensor is collected at AVR and is displayed on LCD display. This data is further transferred to the Web Page using the Ethernet. It can also display various Patterns on LED as per requirement. This design can be widely used in remote data acquisition and control system industry. Such Embedded Ethernet module have the capacity to perform as a true Ethernet device. The different sensors can be applied to the module as per the requirement and make various applications. Achieving the network monitoring purpose, it can monitor embedded system operation state through Internet. The AVR microcontroller system adopts the high performance Ethernet controller. The system communication

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and debugging are fast, reliable and real-time; In addition, it can be also applied in on-line monitoring, remote fault diagnosis system.

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