Industrial Automation System using MSP430 & Wi-Fi

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Abstract— This paper presents an industry management system. To protect the industry from the outsider's entry and provide the automation is very important now-a-days. This project mainly focusing on these issues, to do this project, we are using the MSP430G2553 microcontroller. To measure the several emergency parameters and the weather parameters, we are using the different sensors. The power consumed by the loads in the industry was measured by the energy meter and the total number of units is also displayed on the LCD. The GSM modem is used to send the alert messages to the user if any of the sensors value goes beyond the threshold level. All the sensor levels and the total number of units consumed were sent to the predefined web page by using the Wi-Fi module. The Wi-Fi module was interfaced to the controller through the UART port. The emergency switch provided was to get the status of all the sensors values in the form of SMS.
Key words: MSP430G2553, LCD, GSM, Wi-Fi, UART, SMS

I. Introduction

Our system consists of an industry controller system, community management system, and cloud server platform. The industry controller system comprises network connections, digital input and output (DIO) lines through which the industry controller system can integrate physical and conversion sensors and be extended to enable security settings, energy reporting, and scenario control. The community management system not only provides community and industry management services and third-party services that enable communication with the cloud service platform but also integrates a central monitor and control system, surveillance system.

Therefore, the community management system forms a location-based, integrated eco broker system. The core management on the cloud service platform focuses on the management and maintenance of communities and industry's and provides remote control and data analysis functions to fixed carriers and mobile carriers.

This study first proposed a hierarchical, industry-service architecture, which employed standard interface devices at the industry end to separate the logic and user interfaces, and achieving multiple in-industry displays.

Moreover, this study applied a community broker role to integrate industry services such as managing environment deployment operations, reducing the manual labor required of community management personnel, providing electronic information services, supporting diverse services, and extending the community's integration with the surrounding environment. Therefore, a complete and integrated industry system can be achieved. In addition, integrating cloud-based services with community services provided location-based services.

II. Objective

The main aim of this project is to protect the industry from the outsider's entry and provide the automation is very important now-a-days. This project mainly focusing on these issues, to do this project, we are using the MSP430G2553 microcontroller.

A. AIM

The main aim of this project is to develop a industry management with sensor interface device is essential for sensor data collection of wireless sensor networks (WSN) in mobile environments.

III. Block Diagram

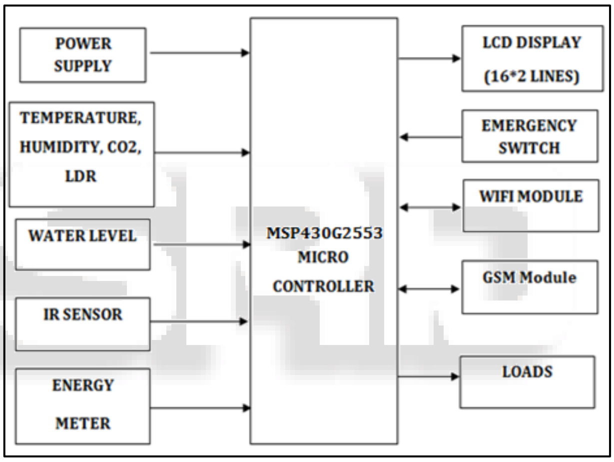

Fig 1: Block Diagram of Proposed System

The MSP430G2553 microcontroller is based on a 16-bit MSP430CPU that combine the microcontroller with embedded high-speed flash memory 16kb. Serial communications interfaces UARTs, SPI, I2C-bus and on-chip RAM make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 16-bit timers, 10-bit ADC, PWM channels and 16 fast GPIO lines with up to edge sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

A. Power Supply

The input to the circuit is applied from the regulated power supply. The A.C input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating D.C voltage. So in order to get a pure D.C voltage, the output voltage from the rectifier is fed to a filter to remove any A.C components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant D.C voltage.

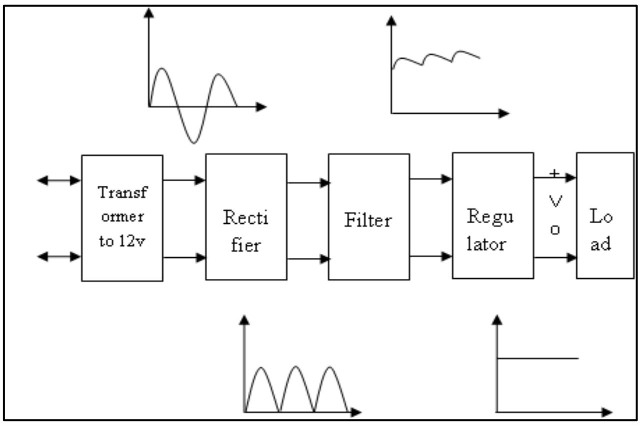

Fig. 2: Block Diagram of Power Supply

B. *MAX232*

Max232 IC is a specialized circuit which makes standard voltages as required by RS232 standards. This IC provides best noise rejection and very reliable against discharges and short circuits. MAX232 IC chips are commonly referred to as line drivers.

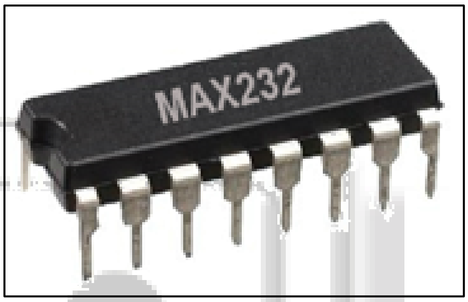

Fig. 3: MAX232 IC

To ensure data transfer between PC and microcontroller, the baud rate and voltage levels of Microcontroller and PC should be the same. The voltage levels of microcontroller are logic1 and logic 0 i.e., logic 1 is +5V and logic 0 is 0V. But for PC, RS232 voltage levels are considered and they are: logic 1 is taken as -3V to -25V and logic 0 as +3V to +25V. So, in order to equal these voltage levels, MAX232 IC is used. Thus this IC converts RS232 voltage levels to microcontroller voltage levels and vice versa.

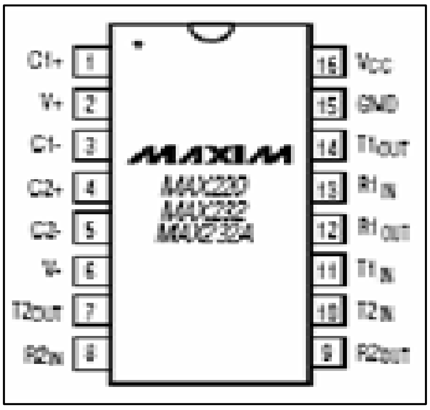

Fig. 4: MAX232 Pin Diagram

C. *Energy Meter*

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business, or an electrically powered device. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic readings of electric meters establish billing cycles and energy used during a cycle.

1) *Direct Current (DC)*

Many experimental types of meter were developed. Edison at first worked on a DC electromechanical meter with a direct reading register, but instead developed an electrochemical metering system, which used an electrolytic cell to totalize current consumption. At periodic intervals the plates were removed, weighed, and the customer billed. The electrochemical meter was labor-intensive to read and not well received by customers? In 1885 Ferranti offered a mercury motor meter with a register similar to gas meters; this had the advantage that the consumer could easily read the meter and verify consumption. The first accurate, recording electricity consumption meter was a DC meter by Dr. Hermann Aron, who patented it in 1883. Hugo Hirst of the British General Electric Company introduced it commercially into Great Britain from 1888. Meters had been used prior to this, but they measured the rate of energy consumption at that particular moment, i.e. the electric power. Aron's meter recorded the total energy used over time, and showed it on a series of clock dials.

2) *Alternating Current (AC)*

The first specimen of the AC kilowatt-hour meter produced on the basis of Hungarian Ottó Bláthy's patent and named after him was presented by the Ganz Works at the Frankfurt Fair in the autumn of 1889, and the first induction kilowatt-hour meter was already marketed by the factory at the end of the same year. These were the first alternating-current watt meters, known by the name of Bláthy-meters. The AC kilowatt hour meters used at present operate on the same principle as Blathy's original invention. Also around 1889, Elihu Thomson of the American General Electric company developed a recording watt meter (watt-hour meter) based on an ironless commutator motor. This meter overcame the disadvantages of the electrochemical type and could operate on either alternating or direct current.

D. *Unit of Measurement*

The most common unit of measurement on the electricity meter is the kilowatt hour, which is equal to the amount of energy used by a load of one kilowatt over a period of one hour, or 3,600,000 joules. Some electricity companies use the SI mega joule instead. Demand is normally measured in watts, but averaged over a period, most often a quarter or half hour.

Fig. 5: Energy Meter

E. MSP430G2553

The Texas Instruments MSP430 family of ultra-low-power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architecture, combined with five low-power modes, is optimized to achieve extended battery life in portable measurement applications. The device features powerful 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The digitally controlled oscillator (DCO) allows wake-up from low-power modes to active mode in less than 1µs. On the left are the CPU and its supporting hardware, including the clock generator. The emulation, JTAG interface and Spy-Bi-Wire are used to communicate with a desktop computer when downloading a program and for debugging.

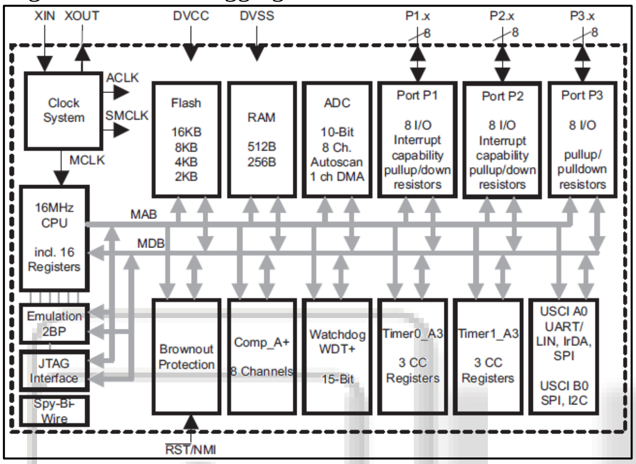

Fig. 6: Functional Block Diagram of MSP430G2553

The main blocks are linked by the memory address bus (MAB) and memory data bus (MDB). These devices have flash memory 16KB, and 512 bytes of RAM. MSP430s peripheral include input/output ports, Timer_A, and a watchdog timer. The universal serial communication interface (USCI) and analog-to-digital converter are particular features of this device. The brownout protection comes into action if the supply voltage drops to a dangerous level.

F. SENSORS

1) Temperature Sensor

LM35 converts temperature value into electrical signals. LM35 series sensors are precision integrated-circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature. The LM35 requires no external calibration since it is internally calibrated. . The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

Fig. 7: Temperature Sensor

2) Gas Sensor or Smoke Sensor

Electrochemical gas sensors are gas detectors that measure the concentration of a target gas by oxidizing or reducing the target gas at an electrode and measuring the resulting current.

The sensors contain two or three electrodes, occasionally four, in contact with an electrolyte. The electrodes are typically fabricated by fixing a high surface area precious metal on to the porous hydrophobic membrane. The working electrode contacts both the electrolyte and the ambient air to be monitored usually via a porous membrane. The electrolyte most commonly used is a mineral acid, but organic electrolytes are also used for some sensors.

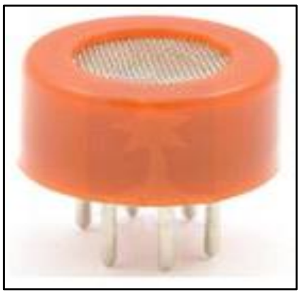

Fig. 8: Smoke Sensor

The detector consists of three sub-blocks namely smoke sensor, transducer and ADC. The smoke sensor is the main component of the detector block which is embedded onto the exhaust of the vehicle. The sensor senses the amount of emission from the vehicle and feeds the data to the microcontroller through the transducer and the analog to digital converter at regular intervals of time. The transducer is used to convert the output of the sensor into an electrical signal. The analog electrical signal is then converted into a digital signal using an ADC, so that, it can be compared with the predefined values, in the microcontroller.

Used in gas leakage detecting equipment for detecting of LPG, iso-butane, propane, LNG combustible gases. The sensor does not get trigger with the noise of alcohol, cooking fumes and cigarette smoke.

3) Humidity Sensor

A humidity sensor also called a hygrometer, measures and regularly reports the relative humidity in the air. They may be used in industrys for people with illnesses affected by humidity; as part of industry heating, ventilating, and air conditioning (HVAC) systems; and in humidors or wine cellars. Humidity sensors can also be used in cars, office and industrial HVAC systems, and in meteorology stations to report and predict weather.

A humidity sensor senses relative humidity. This means that it measures both air temperature and moisture. Relative humidity, expressed as a percent, is the ratio of actual moisture in the air to the highest amount of moisture air at that temperature can hold. The warmer the air is, the more moisture it can hold, so relative humidity changes with fluctuations in temperature.

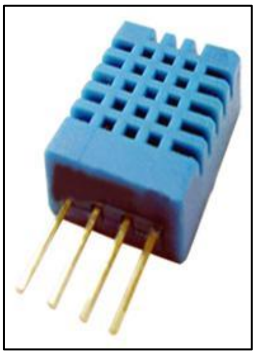

Fig. 9: Humidity sensor

4) Light Dependent Resistor

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1,000,000 ohms, but when they are illuminated with light, the resistance drops dramatically. Thus in this project, LDR plays an important role in switching on the lights based on the intensity of light i.e., if the intensity of light is more (during daytime) the lights will be in off condition. And if the intensity of light is less (during nights), the lights will be switched on.

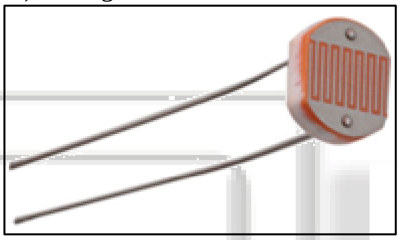

Fig. 10: LDR sensor

5) Photoelectric Sensors (IR Sensor)

A photoelectric sensor, or photoeye, is a device used to detect the distance, absence, or presence of an object by using a light transmitter, often infrared, and a photoelectric receiver. They are used extensively in industrial manufacturing. There are three different functional types: opposed (a.k.a. through beam), retro reflective, and proximity-sensing.

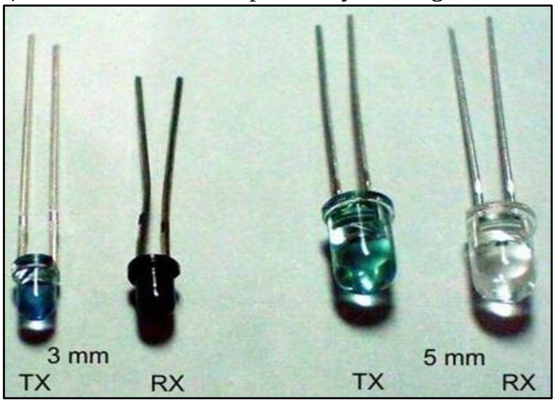

Fig. 11: IR Sensor

6) Water Level Sensor

Level sensors detect the level of substances that flow, including liquids, slurries, granular materials, and powders. Fluids and fluidized solids flow to become essentially level in their containers (or other physical boundaries) because of gravity whereas most bulk solids pile at an angle of repose to a peak. The substance to be measured can be inside a container or can be in its natural form (e.g., a river or a lake). The level measurement can be either continuous or point values. Continuous level sensors measure level within a specified range and determine the exact amount of substance in a certain place, while point-level sensors only indicate whether the substance is above or below the sensing point. Generally the latter detect levels that are excessively high or low.

Fig. 12: Soil Moisture Sensor

7) Liquid Crystal Display

LCD stands for Liquid Crystal Display. LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons:

1) The declining prices of LCDs.
2) 2. The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.
3) Incorporation of a refreshing controller into the LCD, thereby relieving the CPU of the task of refreshing the LCD. In contrast, the LED must be refreshed by the CPU to keep displaying the data.
4) Ease of programming for characters and graphics.

LCD screen shown in figure 13 consists of two lines with 16 characters each. Each character consists of 5x7dot matrix.

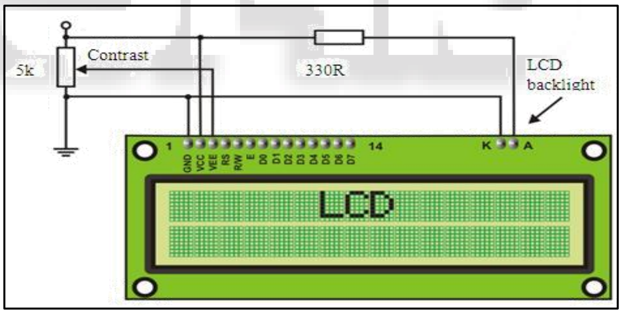

Fig. 13: LCD Connection

IV. SYSTEM DESCRIPTION

This project is to monitor the industry management system. The main of this project is to develop an industry management with sensor interface device is essential for sensor data collection of wireless sensor networks (WSN) in mobile environments. In this project, we are using different types of sensor to measure the various weather parameters in the filed/ industry and also for the protection. To do this project, we are using the MSP430 Microcontroller, which has in- built ADC channels. In this project, we are using the different sensors like, temperature sensor to measure the surrounding temperature, humidity sensor, CO2 sensor, light sensor, IR sensor, and the water level sensor. All these sensors will give us the analog values but the controller will take only the digital data. So, we have to connect all these sensor values to the ADC channel pins of the microcontroller.

Then the ADC will convert all these values to the corresponding digital values. In this project, we are using the energy meter to measure the power consumed by the electrical loads in the field/ industry. The water level sensor is used to measure the moisture level for the plants and switch on the water pump whenever needs. The IR sensor is used to sense the human interruption to sense the stranger entered into the house. All these sensor values will display on the LCD screen continuously. For every sensor we set the threshold level and if the sensor value goes beyond that level the alert message will send to the user. If the user wants to know the status of all the sensors, then he should press the emergency switch provided. In this project, we are also using the Wi-Fi module also to send all these sensor values will send to the predefined web page continuously.

V. Advantages & applications

A. *Advantages*

- Simplicity of the system.
- Accuracy of the system
- Real time monitoring
- Emergency alerts when parameters exceeds their threshold values
- Energy meter monitoring
- From anywhere we can monitor the system

B. *Applications*

Data collection is the essential application of WSN and more importantly it is the foundation of other advanced applications in IOT environment.

- Industry applications
- Industrial applications

VI. Conclusion

Hence an integrated cloud-based industry management system with community hierarchy can be implemented for accessing sensor data from anywhere. This study first proposed a hierarchical, industry- service architecture, which employed standard interface devices at the industry end to separate the logic and user interfaces, and achieving multiple in-industry displays.

VII. Future scope

In future, instead of the MSP430 microcontroller, we will use the Raspberry Pi 3 board. The Raspberry Pi 3 has in-built Wi-Fi module. So, there is no need of external Wi-Fi module.

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