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Industrial Safety Monitoring and Security Alert System

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***Abstract* - Industry 4.0 is the integration of information system along with automation to provide complete control over all industrial operation. Although fully automated industry is the target of industry 4.0, there still a need for human supervision and expert guidance. Many of these industries have various safety standards that must be maintained for the safety of the workers and industry experts. Introduction of covid-19 in the year 2019 have also emphasized the need to use masks in workplace all the time. Other necessities such as helmets are also crucial. As most industries are hazardous at certain stages, we also need to monitor and regulate the environment inside the industrial workplace. Bearing these necessities, we propose an intelligent industrial safety and health monitoring system which is capable of detecting workers with or without helmet/mask in real time and also monitor the environmental conditions inside the industry and issue real time warning for an abnormalconditions.**

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

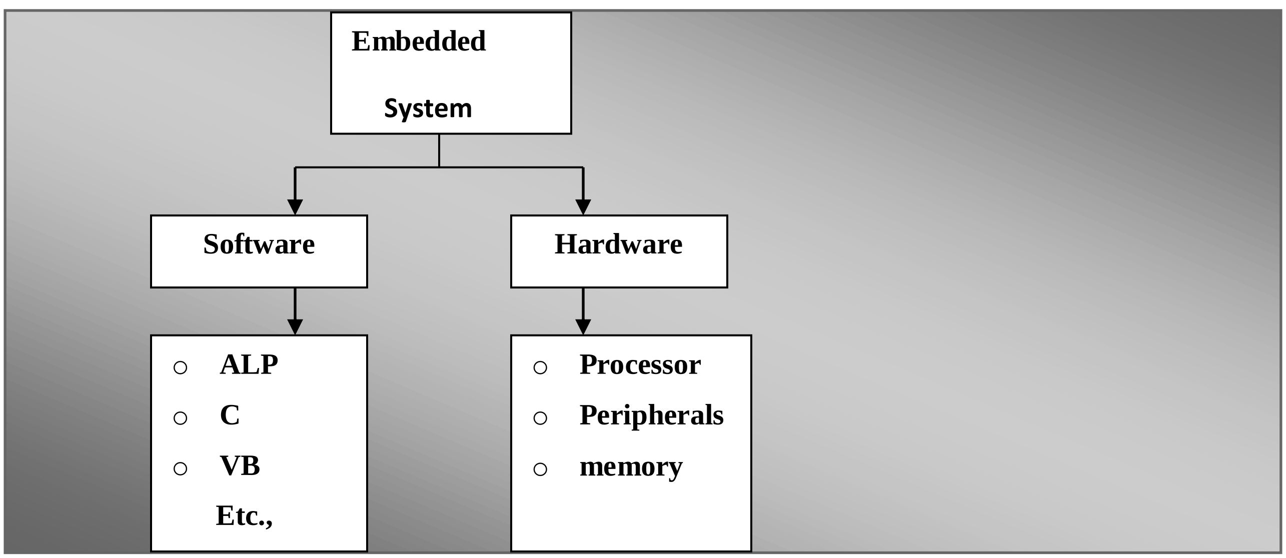


Figure: Block diagram of Embedded System

1.2 Harvard Architecture

Computers have separate memory areas for program instructions and data. There are two or more internal data buses, which allow simultaneous access to both instructions and data. The CPU fetches program instructions on the program memory bus.

The **Harvard architecture** is a computer architecture with physically separate storage and signal pathways for instructions and data. The term originated from the Harvard Mark I relay-based computer, which stored instructions on punched tape (24 bits wide) and data in electro-mechanical counters. These early machines had limited data storage, entirely contained within the central processing unit, and provided no access to the instruction storage as data. Programs needed to be loaded by an operator, the processor could not boot itself.

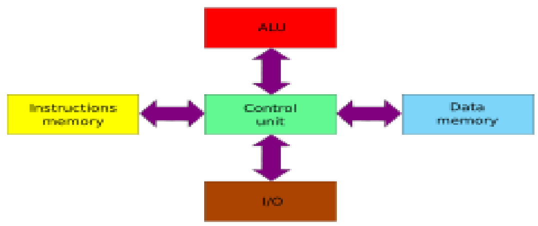


Figure: Harvard Architecture

1.3 Von-Neumann Architecture

A computer has a single, common memory space in which both program instructions and data are stored. There is a single internal data bus that fetches both instructions and data. They cannot be performed at the same time

A **stored-program**digital computer is one that keeps its programmed instructions, as well as its data, in read-write, random-access memory (RAM). Stored-program computers were advancement over the program-controlled computers of the 1940s, such as the Colossus and the ENIAC, which were programmed by setting switches and inserting patch leads to route data and to control signals between various functional units. In the vast majority of modern computers, the same memory is used for both data and program instructions. The mechanisms for transferring the data and instructions between the CPU and memory are, however, considerably more complex than the original von Neumann architecture.

The terms "von Neumann architecture" and "stored-program computer" are generally used interchangeably, and that usage is followed in this article.

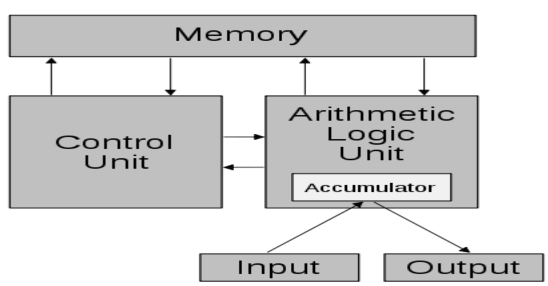
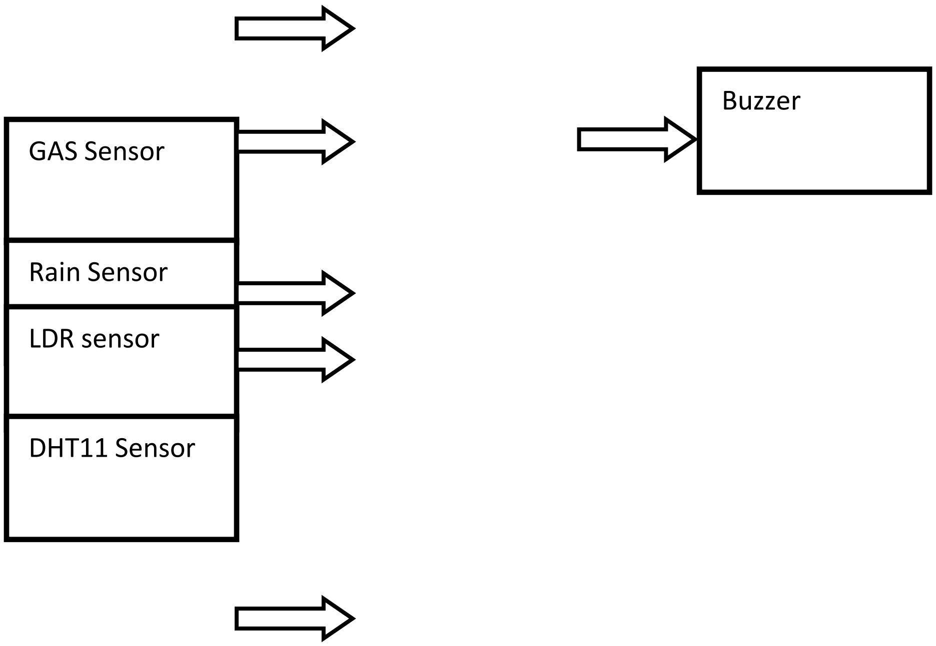


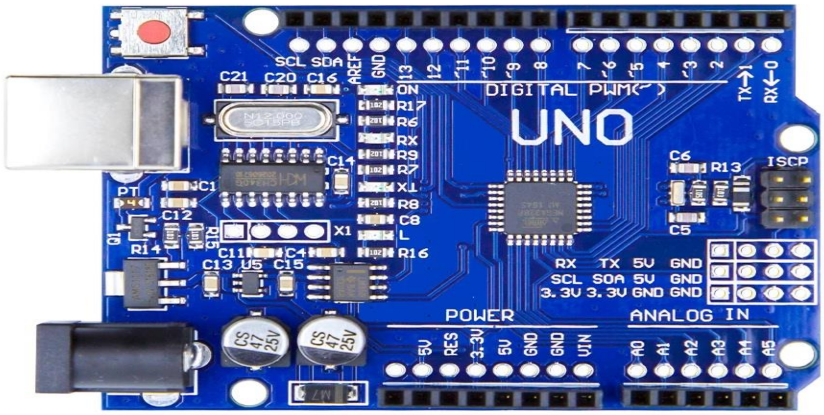
Figure: Schematic of the Von-Neumann Architecture.

PROPOSED SCHEME



Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

1.4 Arduino uno microcontroller:



Overview

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

1.5 How to use Arduino Board

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

1. **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
2. **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
3. **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
4. **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
5. **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

II. HARDWARE COMPONENTS

2.1 LCD (Liquid Cristal Display):

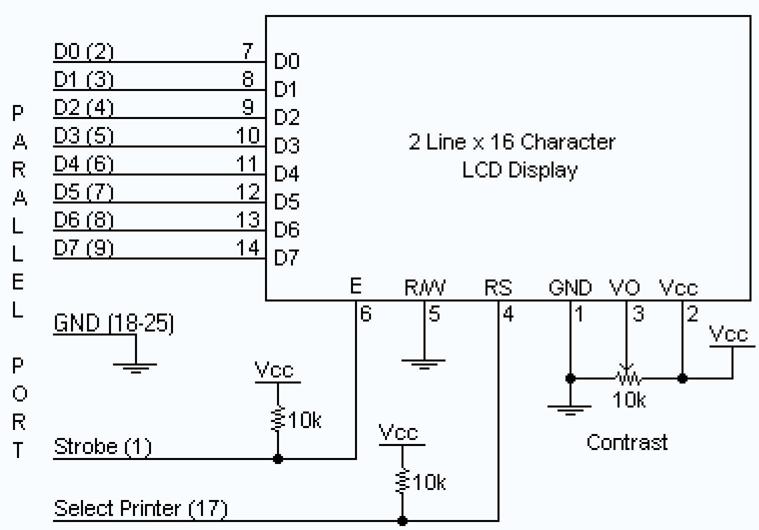
A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters, the axes of polarity of which are perpendicular to each other. Without the liquid crystals between them, light passing through one would be blocked by the other. The liquid crystal twists the polarization of light entering one filter to allow it to pass through the other.

A program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an controller is an LCD display. Some of the most common LCDs connected to the contollers are 16X1, 16x2 and 20x2 displays. This means 16 characters per line by 1 line 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

2.2 Description Of 16x2:

This is the first interfacing example for the Parallel Port. We will start with something simple. This example doesn't use the Bi-directional feature found on newer ports, thus it should work with most, if noall Parallel Ports. It however doesn't show the use of the Status Port as an input. So what are we interfacing? A 16 Character x 2 Line LCD Module to the Parallel Port. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required to run them is on board.

2.3 Schematic Diagram:



2.4 PIN DESCRIPTION:

Most LCDs with 1 controller has 14 Pins and LCDs with 2 controller has 16 Pins (two pins are extra in both for back-light LED connections).

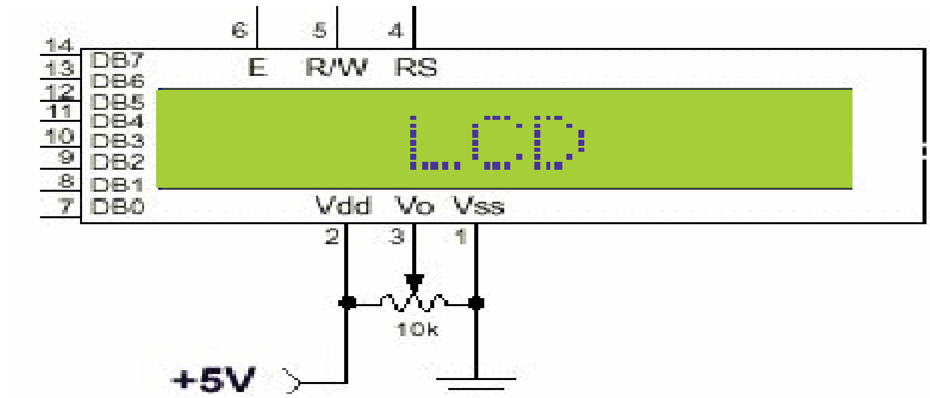


Fig 19: pin diagram of 1x16 lines LCD

2.5 GAS SENSOR:

A sensor is a technological device that detects / senses a signal, physical condition and chemical compounds. It is also defined as any device that converts a signal from one form to another.

Sensors are mostly electrical or electronic.Gas sensor is a subclass of chemical sensors.

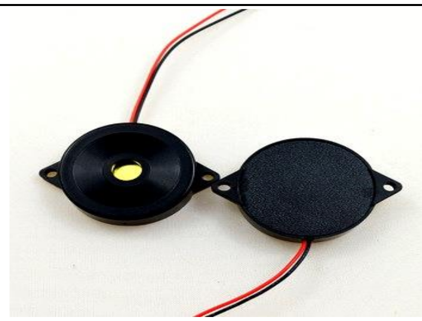
Gas sensor measures the concentration of gas in its vicinity. Gas sensor interacts with a gas to measure its concentration. Each gas has a unique breakdown voltage i.e. the electric field at which it is ionized. Sensor identifies gases by measuring these voltages. The concentration of the gas can be determined by measuring the current discharge in the device.

1. Gas sensors main aim is to sense hazardous gases that evolve its surroundings
2. Gas sensor detects the concentrations of combustible gas in the air and ouputs its reading as an analog voltage. The sensor can measure concentrations of flammable gas of 300 to 10,000 ppm.The sensor can operate at temperatures from -20 to 50°C and consumes less than 150 mA at 5 V.

III. BUZZER

A **buzzer** or **beeper** is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows.

It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong . Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to make the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to a cheap 8-ohm speaker. Nowadays, it is more popular to use a ceramic-based piezoelectric sounder like a Son alert which makes a high-pitched tone. Usually these were hooked up to "driver" circuits which varied the pitch of the sound or pulsed the sound on and off.



3.1 LDR Module:

When T1 conducts, base pf T2 will be grounded and it remains off to inhibit the Alarm generator. IC UM 3561 is used in the circuit to give a Fire force siren. This ROM IC has an internal oscillator and can generate different tones based on its pin connections. Here pin 6 is shorted with the Vcc pin 5 to get a fire force siren. When the temperature near the diode increases above 50 degree, it conducts and ground the base of T1. This makes T1 off and T2 on. Alarm generator then gets current from the emitter of T2 which is regulated by ZD to 3.1 volt and buffered by C1.Resistor R4 (220K) determines the frequency of oscillation and the value 220K is a must for correct tone. To set the fire sensor circuit, keep a lighted candle near the diode and wait for 1 minute. Slowly adjust VR till the alarm sounds. Remove the heat .After one minute, alarm will turns off. VR can be used for further adjustments for particular temperature evels.

LDR Sensor Circuit Diagram

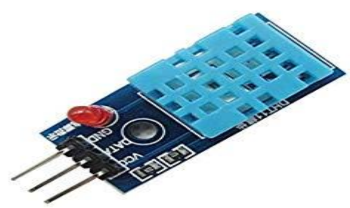
1. The Fire sensor, as the name suggests, is used as a simple and compact device for protection against fire. The module makes use of IR sensor and comparator to detect fire up to a range.

2. The device, weighing about 5 grams, can be easily mounted on the device body . It gives a high output on detecting fire. This output can then be used to take the requisite action.

3.2 HUMIDITY SENSOR:

A sensor (also called detectors) is a device that measures a measurable attribute and converts it into a signal which can be read by an observer or by an instrument. For example, a mercury-in-glass thermometer converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. A thermocouple converts temperature to an output voltage which can be read by a voltmeter. A humiditysensor, also called a hygrometer, measures and regularly reports the relative humidity in the air. They may be used in homes for people with illnesses affected by humidity; as part of home 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 humiditysensor 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.



Humidity sensor

3.4 MOTOR:

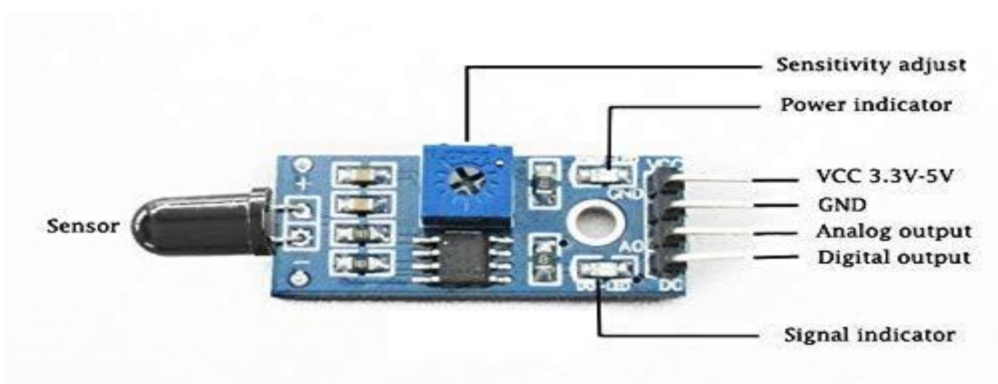
A power sensor tag with interference reduction for electricity monitoring of two-wire household appliances consists of transmitter and receiver section separately. Mainly this project is used for reducing human effect and for increasing water usage in the field of agriculture automatically.

First these kits are connected to the main supply (230V A.C).then it is step down to 5V d.c supply. 230V A.C supply is given as input to the step down transformer then it is step down that voltage to some 18V A.C supply. Then it is given to the Bridge wave Rectifier. This converts A.C to Pulsating D.C. then this is given to the filter circuit. Here capacitive filter is used. So it converts that pulsating D.C to pure D.C. next this is connected to 7805 regulator. It produces our required 5V D.C supply.

Electricity can be monitored by using the parameters like voltage and current these 2 Parameters can be sensed by using the voltage and current sensors. But the controlling of the devices in the house is not possible in the existing system. To overcome these disadvantages we are going for proposed method

3.5 FIRE SENSOR:

The fire sensor circuit is too sensitive and can detect a rise in temperature of 10 degree or more in its vicinity. Ordinary signal diodes like IN 34 and OA 71 exhibits this property and the internal resistance of these devices will decrease when temperature rises. In the reverse biased mode, this effect will be more significant. Typically the diode can generate around 600 milli volts at 5 degree centigrade. For each degree rise in temperature; the diode generates 2 Mv output voltage. That is at 5 degree it is 10 Mv and when the temperature rises to 50 degree, the diode will give 100 milli volts. This voltage is used to trigger the remaining circuit. Transistor T1 is a temperature controlled switch and its base voltage depends on the voltage from the diode and from VR and R1. Normally T1 conducts (due to the voltage set by VR) and LED glows. This indicates normal temperature.



Fire Sensor Module

IV. CONCLUSION

In order to enable total control over all industrial operations, Industry 4.0 integrates automation and information systems. Industry 4.0 aims for fully automated industries, yet there will still be a need for professional assistance and human supervision. For the protection of the employees and industry professionals, many of these industries have a variety of safety regulations that must be upheld. The requirement to always wear masks at work has been highlighted with the introduction of COVID-19 in 2019. Helmets and other essentials are also essential. We must also keep an eye on and control the atmosphere inside the industrial workplace because most industries are dangerous at some points. With these requirements in mind, we propose an intelligent industrial safety and health monitoring system that can detect workers wearing helmets or masks or not in real time. It can also monitor the environmental conditions within the industry and issue real-time warnings for any abnormal conditions. In our work, we have achieved high accuracy and precision in intelligent safety monitoring and environmental monitoring in industries.

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