Coolant Management and Environment Monitoring System in Fms Machine using Microcontroller

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***Abstract*— This paper presents the coolant management in flexible manufacturing system (FMS). A FMS is a manufacturing system in which there is some amount of flexibility that allows the system to react in case of changes, whether predicted or unpredicted. A great number of industrial processes such as grinding, milling and turning create heat and particles. Machine coolants are used to keep the work surface cool and to carry away metal chips and particles. This cools the work and washes particles out of the way. The liquid runs over the work area and then down the machine where it collects in a sump at the bottom of the machine. The liquid is pumped out of the sump and constantly recirculated. In this paper the level of the coolant in sump is checked along with this, cleanliness of the coolant, air quality and temperature and humidity will be sensed and displayed with the help of various sensors and LCD displays.**

Keywords*— Coolant, MQ135, DHT22, Cleanliness of the coolant, Float switch.

I. INTRODUCTION

1.1 *Overview*

One of the vital components of a vehicle is its cooling system; the purposes of which are to keep the engine from overheating and to keep it at constant temperature for better efficiency. It requires several things including adequate supply of coolant and thermostat to regulate the engine temperature. Most cooling systems include a coolant reservoir which holds extra volume of coolant as support for the radiator. Checking the coolant level on a regular basis is important to maintain good condition of the cooling system.

A coolant is a substance, typically liquid or gas that is used to reduce or regulate the temperature of a system. An ideal coolant has high thermal capacity, low viscosity, is low-cost, non-toxic, chemically inert, and neither causes nor promotes corrosion of the cooling system. The liquid is typically 90 to 95% water and 5 to 10% machine coolant.

Coolant keeps getting dirty as it flows through the machine surface. If the coolant level becomes too low, too dirty or too contaminated, it cannot properly cool the machine. In order to check the cleanliness of the coolant, we are using IR sensor.

In order to check the coolant level in the tanks, we are using float switch sensor, is a type of level sensor and a device used to detect the level of liquid within a tank so that we can avoid the overflow of the coolant in the tanks and to avoid the coolant level in the tank being low.

There may be people who are sensitive to the various gases such as ammonia, alcohol, benzene, smoke and CO_2 hence we need to check these gases in air. This will be done by using air quality sensor (MQ135).

In order to check the humidity and temperature surrounding the machine, we are using DHT22 sensor.

Objectives

1 To monitor the levels of the coolant in the tanks.
1 To check the humidity and temperature surrounding the machine.
2 To check the air quality surrounding the machine.
3 To check the cleanliness of the coolant.

II LITERATURE SURVEY

1. Liu Peng, Fu Danni, Jiang Shengqian and Wang Mingjie presented a paper on “A Movable Indoor Air Quality Monitoring System”. This paper provides an intelligent movable indoor environment monitoring system based on Arduino's control using various sensors to detect air quality, which has been designed to simulate users' indoor route and detect air quality real-time to help acquire indoor air condition exactly [3].

2. Sherin Abraham and Xinrong Li presented paper on “Cost-effective wireless sensor network system for indoor air quality monitoring applications”. In this paper, they presented a low-cost indoor air quality monitoring wireless sensor network system

developed using Arduino, XBee modules, and micro gas sensors. The system that they have developed is capable of collecting six air quality parameters from different locations simultaneously [4].

3. Gianpiero Einaudi and Walter Mortara presented a paper on “Engine cooling electronic control system”. An electronic control system has been developed to control the heat exchange in the engine, so as to maintain the engine structure temperature at full-power levels, whatever the operating conditions. This paper discusses the system design criteria and provides a description of the tests made on engine and vehicle [5].

4. J.Wsgner, Venkat Srinivasan, Darren M. Dawson and Egidio E. Marotta presented a paper on “Smart thermostat and coolant pump control for engine thermal management systems”, this automotive inspired thermal system contains a heater, smart thermostat value, radiator and variable speed electronic pump [6].

5. Oner Arici, John H. Johnson and Ajey J. Kulkarni presented paper on “The Vehicle Engine Cooling System Simulation Part 1- Model Development”. In this the vehicle engine cooling system simulation (VECSS) computer code has been developed at the Michigan Technological University to simulate the thermal response of the cooling system of an on-highway heavy duty diesel powered truck under steady and transient operation [7].

6. Arun Kumar, S. Senthilraja, and Arvind presented paper on “Design and development of microcontroller based automatic engine cooling system”. In this paper the experimental test bench has been designed to investigate the efficiency of the internal combustion engine [8].

7. In paper “Air and noise pollution monitoring in the city of Zagreb by using mobile crowdsensing” a mobile crowdsensing (MCS) solution for air quality and noise pollution monitoring. More specifically, we show a practical experience of a real-world system deployment, from sensor calibration to data acquisition and analysis [9].
8. Muhammad Saqib Jamil, Muhammad Atif Jamil, Anam Mazhar and Abdullah Ahmed presented paper on “Smart Environment Monitoring System by employing Wireless Sensor Networks on Vehicles For Pollution Free Smart Cities”. In this proposed architecture having innovative mesh network will be more efficient way of gathering data from the nodes of wireless sensor networks. It will have lots if benefits with respect to the future concept of smart cities that will have the new technologies related to Internet of Things [10].
9. Rajat Gupta presented paper on “A simulation model for an engine cooling system and its application for fault detection in vehicles”. In this paper describes the development of a simulink model for an engine cooling system and its application for fault detection in vehicles. Thermodynamics and physical laws are used to derive mathematical equations to represent an engine cooling system that is implemented in simulink [11].

III METHODOLOGY

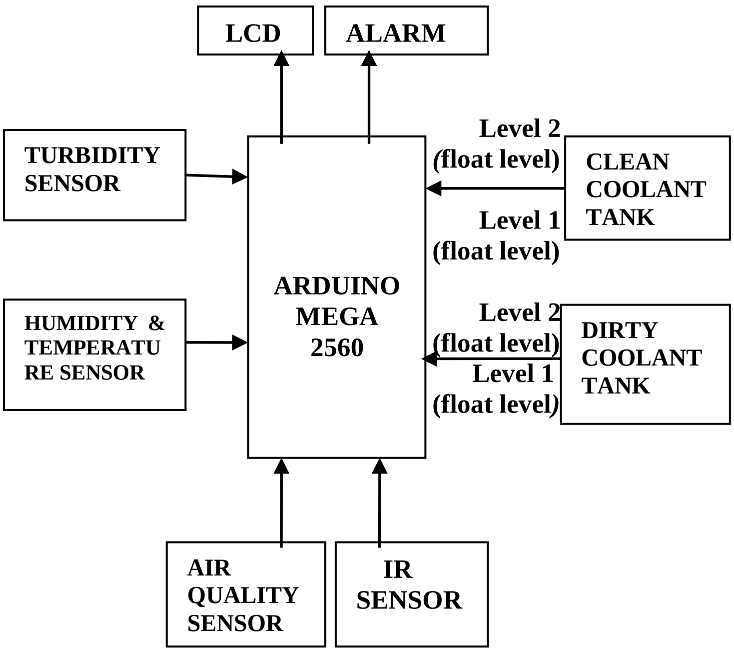

Figure 1: Block diagram

1. IR sensor is used to check the cleanliness of the coolant in order to avoid the usage of dirty coolant. IR sensor has 4 pins, 1st pin is connected to VCC, 2nd pin is connected Ground, 3rd is analog output(not used), 4th pin is digital output.
2. Float switch is used to monitor the coolant level in the tank. When the tank is empty, it gives digital low output else digital high output. If tank is empty it gives a alarm by glowing LED.
3. Air quality sensor(MQ135) is used to check the air quality surrounding the machine. It is sensible to Ammonia, co2,benzin gases etc. It gives digital output. If the output is less than 100ppm, air quality is good. And if it is greater than 200ppm, it is dangerous to sensible people.
4. Humidity and temperature sensor(DHT22) is used to measure humidity and temperature around the machine. Humidity is measured using humidity sensing element and temperature is measured using

thermometer. It has 4 pins, VCC, GND, data pin and a not connected pin which has no usage.

HARDWARE SPECIFICATION:

The hardware requirements of the project are as follows.

- Arduino mega board : 2560
- Air quality sensor : MQ135
- Humidity & temperature sensor: DHT22
- IR sensor
- Turbidity sensor
- Float switches
- LCD display

SOFTWARE SPECIFICATION :

The software requirements of the project are as follows.

- Operating system : Windows XP/7.
- Coding Language : EMBEDDED C
- Tool :ARDUINO

A. Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). The Arduino MEGA 2560 is designed for projects that require more I/O lines, more sketch memory and more RAM with 54 digital I/O pins, 16 analog inputs. This gives your projects plenty of room and opportunities maintaining the simplicity and effectiveness of the Arduino platform.
The Arduino Mega 2560 is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards and running both online and offline.
The USB connection with the PC is necessary to program the board and not just to power it up. The Mega2560 automatically draw power from either the USB or an external power supply. Connect the board to your computer using the USB cable.

Microcontroller	ATmega2560
Operating voltage	5V
Input voltage(recommended)	7-12V
Input voltages(limits)	6-20V
Digital I/O Pins	54(OF WHICH 14 PROVIDE PWM output)
Analog input Pins	16
DC Current per I/O Pins	40mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256KB of which 8KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock speed	16MHz

Table 1: Arduino mega Specifications

Input and Output

Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:
● Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX)
and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit
(TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
● External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5),
19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
● PWM: 0 to 13. Provide 8-bit PWM output with the analogWrite() function.
● SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Uno, Duemilanove and Diecimila.
● LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
● I2C: 20 (SDA) and 21 (SCL). Supports I2C (TWI) communication using the wire library(documentation on the Wiring website). Note that these pins are not in the same location as the I2C pins on the Duemilanove or Diecimila.

B. DHT22

The DHT22 is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed).

- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 0-100% humidity readings with 2-5% accuracy
- Good for -40 to 80°C temperature readings ±0.5°C accuracy

Compared to the DHT11, this sensor is more precise, more accurate and works in a bigger range of temperature/humidity, but its larger and more expensive.

C. MQ135

The MQ series of gas sensors utilizes a small heater inside with an electro chemical sensor these sensors are sensitive to a range of gasses are used at room temperature. MQ135 alcohol sensor is a SnO_2 with a lower conductivity of clean air. Sensitive material of MQ135 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, the sensors conductivity is more higher along with the gas concentration rising. By using simple electroniC circuits it converts the charge of conductivity to correspond output signal of gas concentration.

MQ135 gas sensor has high sensitity to Ammonia, Sulfide and Benzen steam, also sensitive to smoke and other harmful gases. It is with low cost and suitable for different application.

Used for family, Surrounding environment noxious gas detection device, Apply to ammonia, aromatics, sulfur, benzene vapor, and other harmful gases/smoke, gas detection, tested concentration range: 10 to 1000ppm

D. IR Sensor

Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000µm.The wavelength region which ranges from 0.75 to 3µm is known as the near infrared regions. The region between 3 and 6µm is known as the mid-infrared and infrared radiation which has a wavelength greater higher than 6µm is known as far infrared. Infrared technology finds applications in many everyday products. Televisions use an infrared detector to interpret the signals sent from a remote control. The key benefits of infrared sensors include their low power requirements, their simple circuitry and their portable features.

E. Float switch

A float switch is a type of level sensor, a device used to detect the level of liquid within a tank. The switch may be used to control a pump, as an indicator, an alarm, or to control other devices.

One type of float switch uses a mercury switch inside a hinged float. Another common type is a float that raises a rod to actuate a microswitch. One pattern uses a reed switchmounted in a tube; a float, containing a magnet, surrounds the tube and is guided by it. When the float raises the magnet to the reed switch, it closes. Several reeds can be mounted in the tube for different level indications by one assembly.

very common application is in sump pumps and condensate pumps where the switch detects the rising level of liquid in the sump or tank and energizes an electrical pump which then pumps liquid out until the level of the liquid has been substantially reduced, at which point the pump is switched off again. Float switches are often adjustable and can include substantial hysteresis. That is, the switch's "turn on" point may be much higher than the "shut off" point. This minimizes the on-off cycling of the associated pump.

F. LCD

A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. Here, in this we're going to use a monochromatic 20x4 alphanumeric LCD. 20x4 means that 20 characters can be displayed in each of the 4 rows of the 20x4 LCD, thus a total of 80 characters can be displayed at any instance of time.

G. Turbidity Sensor

Turbidity is the measurement of water clarity. Suspended sediments, such as particles of clay, soil and silt, frequently enter the water from disturbed sites and affect water quality. Suspended sediments can contain pollutants such as phosphorus, pesticides, or heavy metals. Suspended particles cut down on the depth of light penetration through water, hence they increase the turbidity -- or "murkiness" or "cloudiness" of the water.

Applications

- It can be implemented in public places where there is a need of environmental monitoring.
- It can be used to monitor the levels of any liquid in tanks

ADVANTAGES

- Used to check the cleaniness of the coolant using IR sensor
- Used to check air quality around the machine
- Used to find the levels of coolant in the tank
- Used to determine the temperature and humidity value

RESULTS AND DISCUSSIONS

This chapter gives the overall results and conclusion of the proposed system.

In the LCD display, the humidity and temperature, air quality, cleanliness of the coolant and the information about the levels of clean and dirty coolants are displayed depending on the data collected by the various sensors.

In the LCD display, measured humidity value is displayed and is indicated by “H-57.40%”, which means measured humidity value is 57.50 which is measured in percentage.

Similarly, the measured temperature value, which is measured in Celsius, gets displayed in the display board.

Air quality is measured and displayed along with its unit. And also it displays whether it is good or bad for sensible people.

In the result,
T1 indicates float switch 1 which is placed at the bottom of the dirty coolant's tank.
T2 indicates float switch 2 which is placed at the top of the dirty coolant's tank.
T3 indicates float switch 3 which is placed at the top of the dirty coolant's tank.
If the coolant crosses the float switch it gets indicated by "F" else by "E".

Figure 2: System

Figure 3: Results displayed in LCD

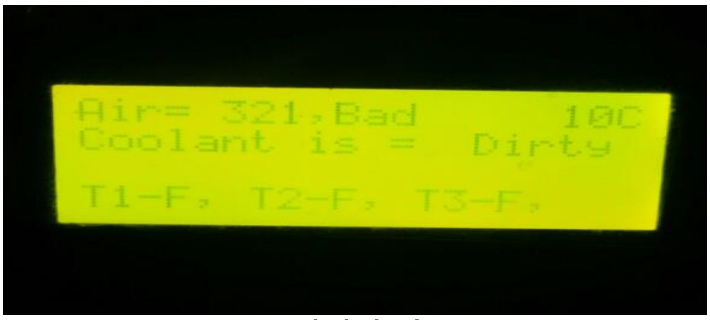

Figure 4: Results displayed in LCD

CONCLUSION

Coolant management and environmental system in FMS machine has been designed and demonstrated. In future we can add more sensors related to environmental monitoring.
Hence we can conclude that the system is ready to monitor the coolant levels in the various tanks and to do environmental monitoring.

FUTURE SCOPE

In future, we can add the GSM or GPRS services to give messages regarding alarms instead of LEDs and also we can send the whole status of the system to the cell phones via GSM service.

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