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CONDITION MONITORING AND FLOW CONTROL OF CUTTING FLUID USING IOT FOR DRILLING OPERATION

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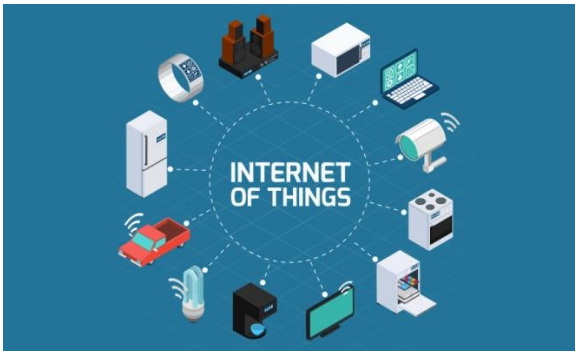
ABSTRACT

Internet of Things (IoT) is a sophisticated way to connect devices or objects to the Control and Enhancement system. The Internet of Things (IoT) is a rapidly growing problem with significant technological, social, and economic consequences. Internet connections are included with consumer products, solid goods, vehicles and trucks, industrial parts and utilities, sensors and other common items.
In this project, Monitoring and controlling the flow of cutting fluid in drilling operation using Ultrasonic sensor which is connected to Arduino UNO PCB is done. The IoT system described in this study is able to monitor input and output data from the Arduino UNO circuit board which is connected to a Relay module. A submersible mini water pump is connected to the Relay module which is powered with a battery and it circulates the flow of cutting fluid during drilling operation.
Keywords: IoT, Monitor, Ultrasonic sensor, Arduino UNO, Relay Module.

INTRODUCTION

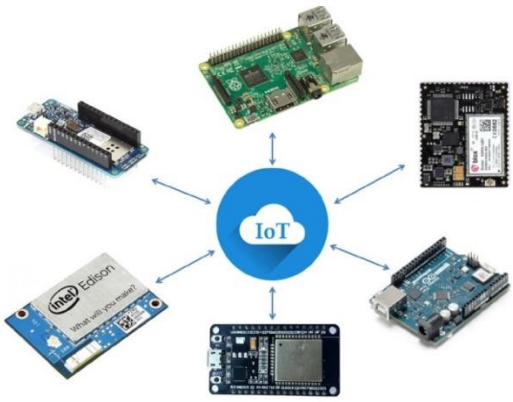
INTERNET OF THINGS (IoT)

The term "Internet of Things" refers to circumstances in which network connectivity and computer power are transferred to items, sensors, and commonplace objects that can be called computers, allowing these devices to generate exchanges and process data with little or no human participation.
The Internet of Things (IoT) is a hot topic in the specialist and general media, and it is an important topic in the technology, policy, and engineering industries. This technology encompasses a wide range of network products, systems, and sensors that take advantage of advances in computing power, electronics downsizing, and network connectivity to provide previously unattainable capabilities. Several conferences, publications, and news stories explore and debate the "IoT revolution's" possible impact, ranging from new market prospects and business models to worries about security, privacy, and technological cooperation.



1.Internet of Things(IoT)

2.IoT Hardware



3.Various PCB's used in IoT

Problem Definition

"Condition Monitoring and Flow Control of Cutting Fluid using IoT for drilling operation" is the problem statement of my project. In this I want to monitor and control the flow of cutting fluid using Internet of Things i.e., using sensors and Arduino board.

DESIGN AND METHODOLOGY

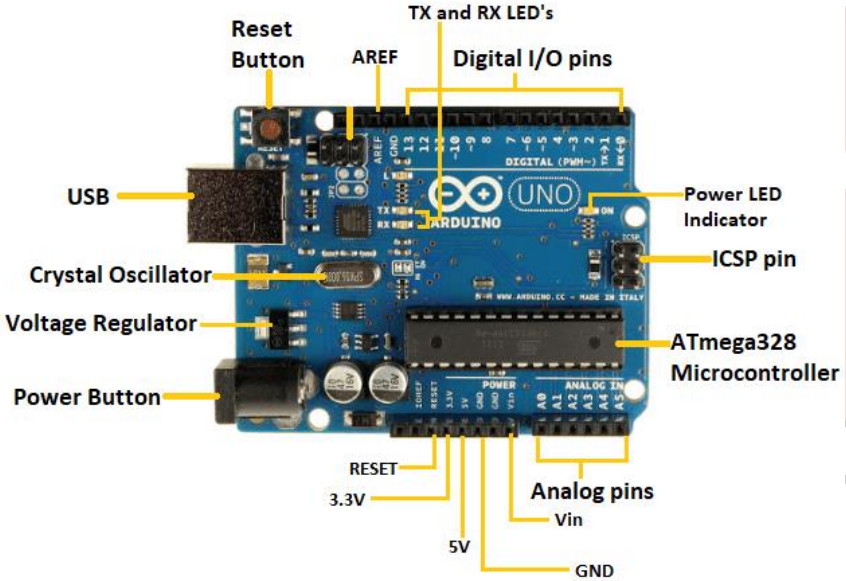
Radial Drilling Machine:

A radial drilling machine is designed for drilling in medium to large or heavy work areas. It has a heavy, circular column mounted on a large base. The column supports an extended arm, which can be raised or lowered or rotated in any position. The ball head that rests on the arm can be made to slip on the spreading arm. The drill head contains all the drill modes with different speeds and different feeds.

4.Radial Drilling Machine

ARDUINO UNO

Arduino has a microcontroller board based on ATmega328 (datasheet). It has 14 digital input / output pins (of which 6 can be used as PWM output), 6 analog input, 16 MHz ceramic resonator, USB connection, power jack, head of ICSP, and reset button. It contains everything needed to support a microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno is different from all previous boards in that it does not use the FTDI USB-to-serial driver chip.



5.ARDUINO UNO

Ultrasonic Sensor HC-SR04

The ultrasonic HC¬SR04 sensor uses sonar to determine the distance to an object such as a bat or a dolphin. Provides excellent contact distance detection with high accuracy and stable reading in an easy-to-use package. From 2cm to 400 cm or 1”to 13 meters. Its performance is unaffected by sunlight or dark spots such as Sharp rangefinders (although soft materials such as fabric can be difficult to detect). Comes complete with transmitter and receiver module.

6. Ultrasonic Sensor HC-SR04

Working of HC-SR04 Ultrasonic Sensor

The HC-SR04 Ultrasonic (US) sensor is a 4-module, with VCC, Trigger, Echo and Ground pin names respectively. This is a very popular sensor used in many applications where measurement distance or hearing aids are required. The module has two eyes like the previous projects that built the Ultrasonic transmitter and Receiver. The sensor works with that simple high school formula

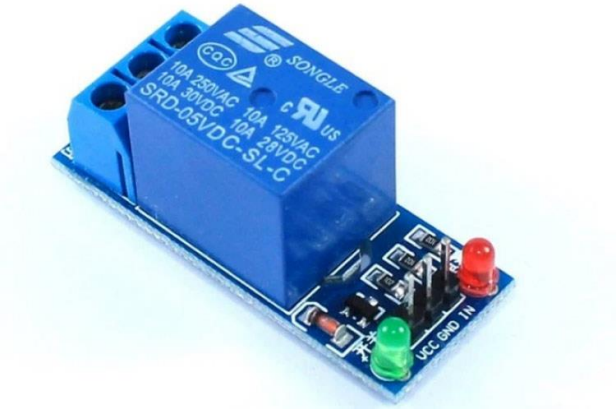
Distance = Speed × Time

The Ultrasonic transmitter transmits the ultrasonic wave, the wave moves through the air and when opposed to any object it appears to return to the sensor the reflected wave is maintained by the ultrasonic receiver module as shown in the image below

7. Working of Ultrasonic sensor HC-SR04

Relay Module

The relay module is an electrical switch used by an electromagnet. Holded in place in the spring, the arm leaves a gap in the magnetic circuit where the relay is strong. While in this position, one of the two contact sets is closed while the other set remains open. Transfer is an electromechanical device that uses electrical power to turn on or off the button contacts. The single-channel transmission module is more than just a clear transmission, it has features that make switching and connecting easier and are indicators of whether the module is enabled and whether the transmission is working or not.



8. 5V Relay Module

ARDUINO CODE

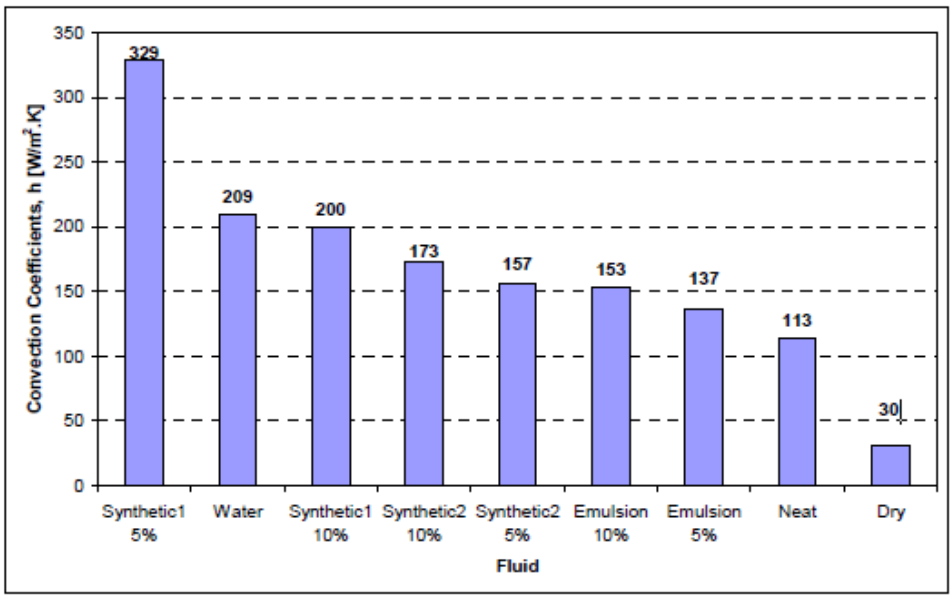
```
sketch_jun17a | Arduino 1.8.13
File Edit Sketch Tools Help
sketch_jun17a
void dist() {
  // Clears the trigPin condition
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin HIGH (ACTIVE) for 10 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2; // Speed of sound wave divided by 2 (go and back)
  // Displays the distance on the Serial Monitor
  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");
}
void loop(){
  dist();
  while (distance>toolLen){
  dist();
    }
   digitalWrite(trigRelay, HIGH);

   if (distance >= threshold){
   digitalWrite(trigRelay, LOW);
   }
Done Saving.
```

```
sketch_jun17a | Arduino 1.8.13
File Edit Sketch Tools Help
sketch_jun17a
// ---------------------------------------------------------------- //
// Arduino Ultrasonic Sensor HC-SR04
// Re-writed by ROHITH
// Using Arduino IDE 1.8.13
// Using HC-SR04 Module
// Tested on 17 JUNE 2021
// ---------------------------------------------------------------- //

#define echoPin 2 // attach pin D2 Arduino to pin Echo of HC-SR04
#define trigPin 3 //attach pin D3 Arduino to pin Trig of HC-SR04
#define trigRelay 4
#define toolLen 5
#define threshold 15

// defines variables
long duration; // variable for the duration of sound wave travel
int distance; // variable for the distance measurement

void setup() {
  pinMode(trigPin, OUTPUT); // Sets the trigPin as an OUTPUT
  pinMode(echoPin, INPUT); // Sets the echoPin as an INPUT
  pinMode(trigRelay, OUTPUT);
  Serial.begin(9600); // // Serial Communication is starting with 9600 of baudrate speed
  }
Done Saving.
```

9.ARDUINO CODE

Cutting Fluid

Liquid cutting is a type of cooler and lubricant designed specifically for metal processes, such as machining and sealing. There are various types of cutting fluids, including oils, water-based emulsions, pastes, gels, aerosols (fog), and air or other gases. Liquid cutting is done with petroleum distillates, animal fats, vegetable oils, water and air, or other raw ingredients. Depending on the context and what type of liquid cutting is considered, it can be called liquid cutting, oil cutting, composite, cooling, or lubrication

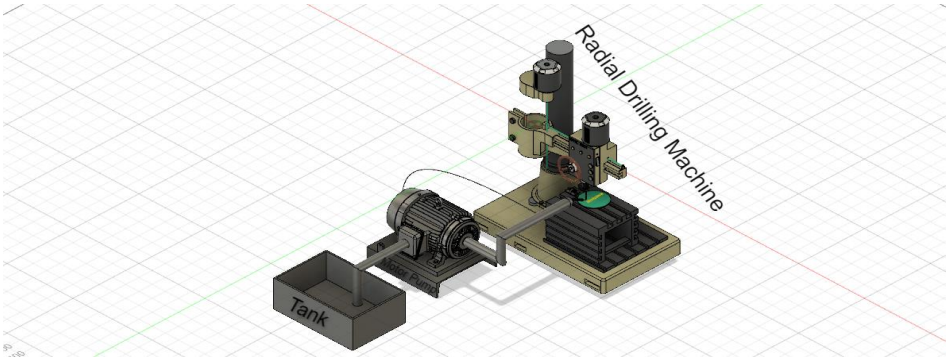


10.Convection coefficients (h) of the cutting fluids

RESULTS AND DISCUSSION

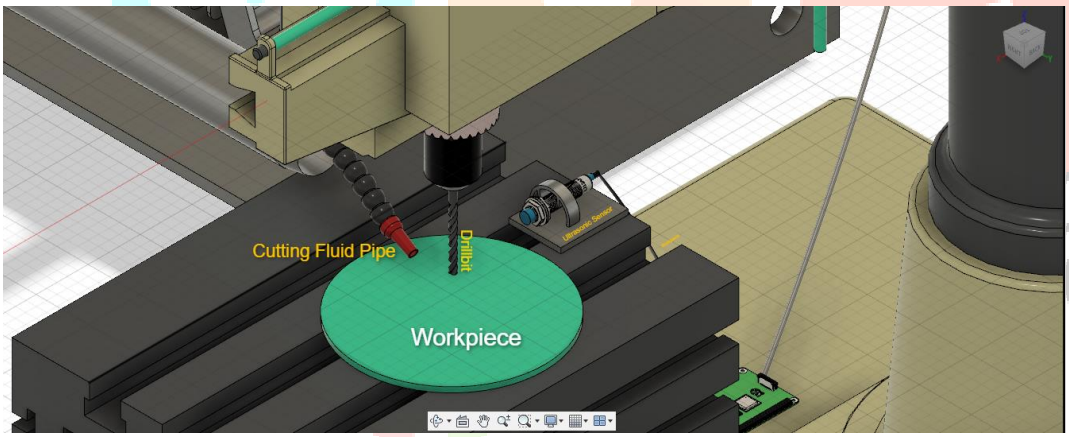
Results

The ultrasonic sensor HC-SR04 and 5v Single channel Relay Module is connected to Arduino UNO board. A submersible mini water pump is connected to the relay module and this water pump is powered with the 9V Hi-watt battery.



11.Schematic layout of the Arduino setup

When the power is supplied to the Arduino UNO which is programmed with the code which is mentioned above. The coding is done is such a way that the sensor detects the drill bit of the drilling machine within 5cm range. However it can detect objects up to 4 meters. When the ultrasonic sensor detects the drilling operation, it transmits the signals to the receiver from receiver then water motor will be ON and cutting fluid will start flowing on the workpiece.



12.Schematic layout of sensor and cutting fluid pipe

ECONOMICS

Let us consider a drilling machine and 0.5 HP Centrifugal Water Pump which is used for flow of cutting fluid.

Consumed Energy is expressed in kilowatt hour (kWh) or what we commonly call a unit.

Power = Power x Time

(By getting Power in “kilowatt hour or unit”, generate Power in kilo Watts and time in hours).

So Here,

Power = 1/2 HP or 373 Watts or 0.373 Watts

Time = 1 Hours

So Energy (per kWh or Unit) - 0.373 kW x 1 hour = 0.373 kWh or **0.373 Units**

For one hour 0.5 HP water pump uses **0.373** units of current,

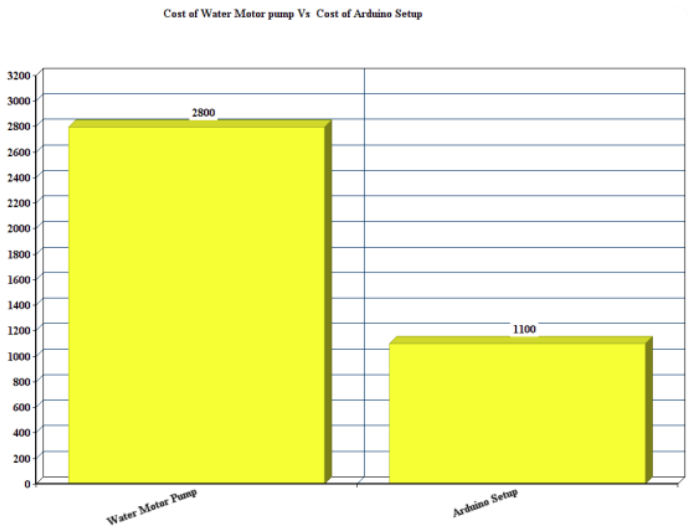
Then for 10 hours-10 hours x 0.373 units = **3.73** units.

If the water motor runs for 30 days at an average of 10 hours per day,

Then amount of current consumed by 0.5 HP water pump

Will be-3.73 units x 30 days = **111.9 units**

The cost of a 0.5 HP centrifugal pump is around Rs.2800/- whereas the cost of this Arduino setup is around Rs.1100/-



13.Graph representing the costs of water motor pump and Arduino setup

DISCUSSION

We have designed a working model using Arduino UNO, Ultrasonic sensor, Relay module and submersible water pump. The Ultrasonic sensor HC-SR04 detects the drill bit and cutting fluid has flown on the workpiece. The sensor is programmed to detect the drill bit at a range of 5 centimeters. When the drill bit is moved away from the range of sensor the motor stops pumping the cutting fluid.

1.Comparision of economics of Centrifugal water motor pump and Arduino Board Setup

	Centrifugal Water Motor Pump	**Arduino Board Setup**
Initial cost	Rs.2800/-	Rs.1400/-
Power Consumption for 10 hours	112 units	30 units
Power consumption charges for 30 days	Rs.437.88/-	Rs.70.3/-
For 20 machines, Power consumption charges for 30 days	Rs.8757.6/-	Rs.1406/-

CONCLUSIONS

1. The Sensor based IOT system i.e. Ultrasonic Sensor HC-SR04, Arduino UNO board, Relay Module are perfectly working and has given desirable results.

2. Cost of IOT system is **40% less** when compared with 0.5 HP water motor pumps.

3. Power consumption charges of IOT system is only **16%** when compared with centrifugal pump.

4. With this IOT system there is **50% decrease** in human intervention.

5. The IOT system decreased the fatigue of the worker and he can attend multiple machines at a time.

6.The cost savings of the IOT system when compared with Motor Pump when run for 10 hours daily for 30 days is **Rs.7350/-** .

7. This IOT system can be implemented to any machining operation which requires cutting fluid and realize the benefit.

8. This IOT system can be fabricated easily and the components are commercially available at a price of **Rs.1100/-**.

9. This IOT system will be very useful to Small Scale to Medium Scale Industries.

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