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# DETERMINATION OF MECHANICAL PROPERTIES OF FLUIDS USING DRILLING TECHNIQUES BY HYBRIDIZATION OF EMBEDDED SYSTEM WITH ARTIFICIAL INTELLIGENCE

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**Abstract-** The dominant rise of automation & robotics in various walks of life is one of the few key technologies sustaining modern way of life. Also recent developments in computing & artificial intelligence have found the way for use of automation & robotics in fields where human intervention or control is difficult due to distance, time, or external hazards. One of such areas is space, or deep sea exploration or study of seismic activity or oil fields, where combination of robotics & AI can reduce human involvement or risk exposure to hazardous environment. Precise, accurate & repeatable measurement of mechanical properties of fluids is important in any exploration; the proposed system implements a drill based/ rotor based fluid properties measurement system, implemented by hybridization of embedded system & artificial intelligence. Use of function fitting neural network to predict various liquid parameters by observing rotor power consumption & associates sensors value. Use of low cost 8bit microcontroller to act as a data acquisition & control system for the experimental setup to acquire sensor values & control rotor & led parameters. The proposed system comprises of measurement of motor voltage & motor current in conjunction with temperature sensor & computation of mechanical equivalent of heat, density, using artificial neural network. Also a led array with photodiode is used to measure light intensity through liquid on two photodiodes which is used to compute transparency index using another pretend artificial neural network.

**Keywords:** embedded system, artificial intelligence, fluid properties measurement, sensor technology, drill based measurement.

## 1. INTRODUCTION

In physics and chemistry any substance that have mass and take up space by having volume are matters. Liquids, solids, and gases are matters. Classifications of matters are shown in Fig. 1.1.

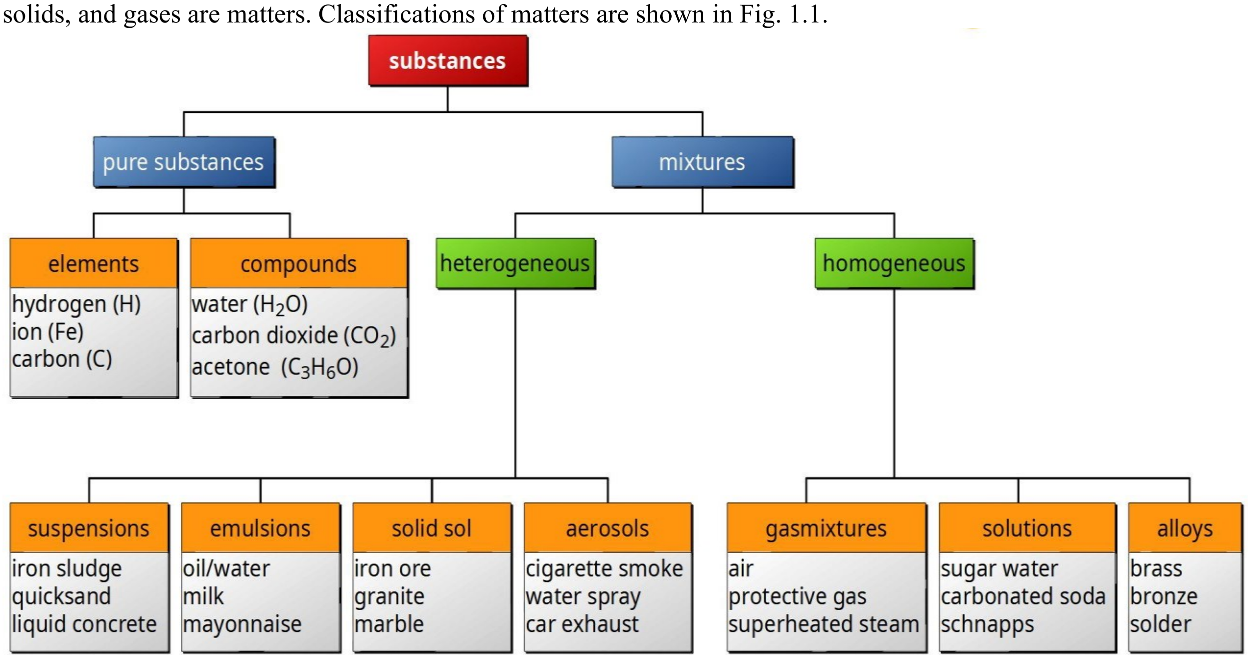


**Fig. 1.1 Classification of Matters**

All materials share the same physical and chemical properties. Physical characteristics like mass, colour, and volume can be measured by physicists without compromising the integrity of the test sample (the amount of space occupied by the sample). Flammability and corrosion resistance are two examples of chemical properties that shed light on a substance's innate propensity to react with other chemicals and produce new compounds. The chemical and physical properties of a pure material are consistent across all samples. To give just one example, pure copper always has the same physical properties: it is a reddish brown solid and, when dissolved in weak nitric acid, it always produces a blue solution and a brown vapour (chemical property).

Extensive and intensive physical properties are possible. Mass, weight, and volume are all global characteristics that are proportional to the total amount of matter. Intense properties such as color, melting point, boiling point, electrical conductivity, and physical condition at a certain temperature are not proportional to the mass of the material.

### 1.1 Embedded System Introduction & Application

An embedded system is a type of electronic system in which software is directly integrated into the hardware. Depending on the use case, it might be either programmable or non-programmable. The functioning, organization, and execution of an embedded system to accomplish one or more goals is defined as an embedded system. All the components of an embedded system have been put together, and they all function in accordance with the specifications. Several common household items, such as microwaves, washing machines, printers, automobiles, cameras, etc., all contain embedded systems. Various processors, including microprocessors, microcontrollers, and digital signal processors, are employed in such setups. In this post, we will discuss what an embedded system is and the different kinds of embedded systems that exist.

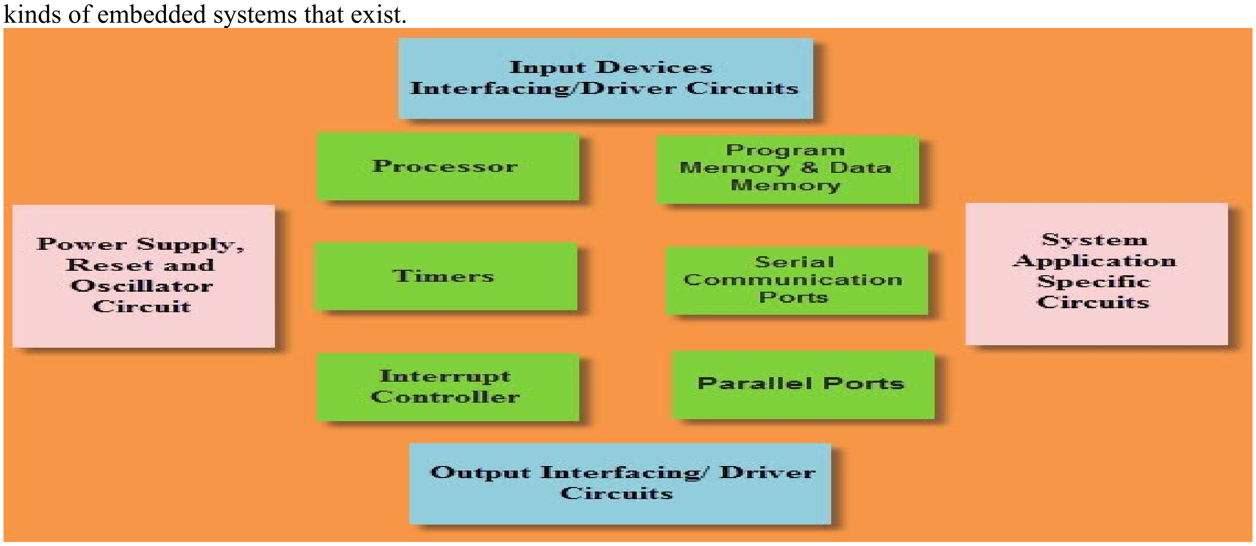


**Fig. 1.2 Layout of Embedded System**

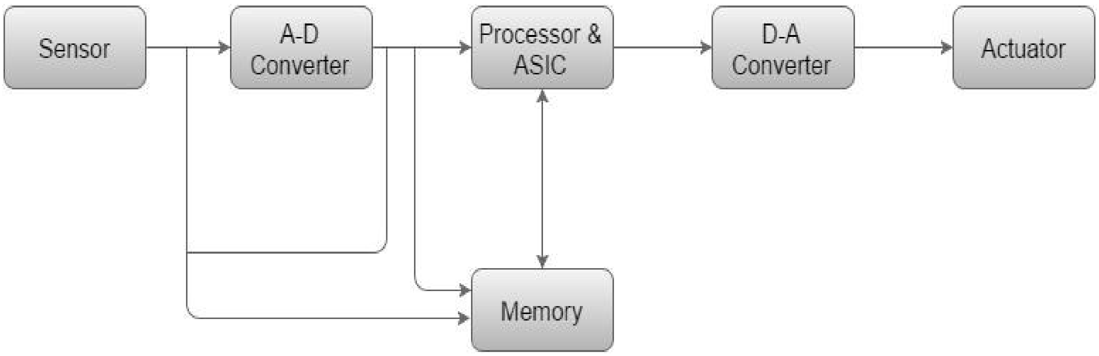


**Fig. 1.3 Basic Structure of Embedded System**

## 2. PROPOSED WORK METHODOLOGY & HARDWARE

This chapter explains the development and implementation of two electronic circuits in our proposed work. One is an electronic circuit in which we convert 220volt into 9 volt & 3 volts. The 9-volt power supply is used to operate the electronic circuit and 3 volts is used to drive the motor. Voltage and current measurement circuit connected with motor supply to measure motor voltage and current. A simple block diagram of the electronic circuit is shown in Figure 2.1.

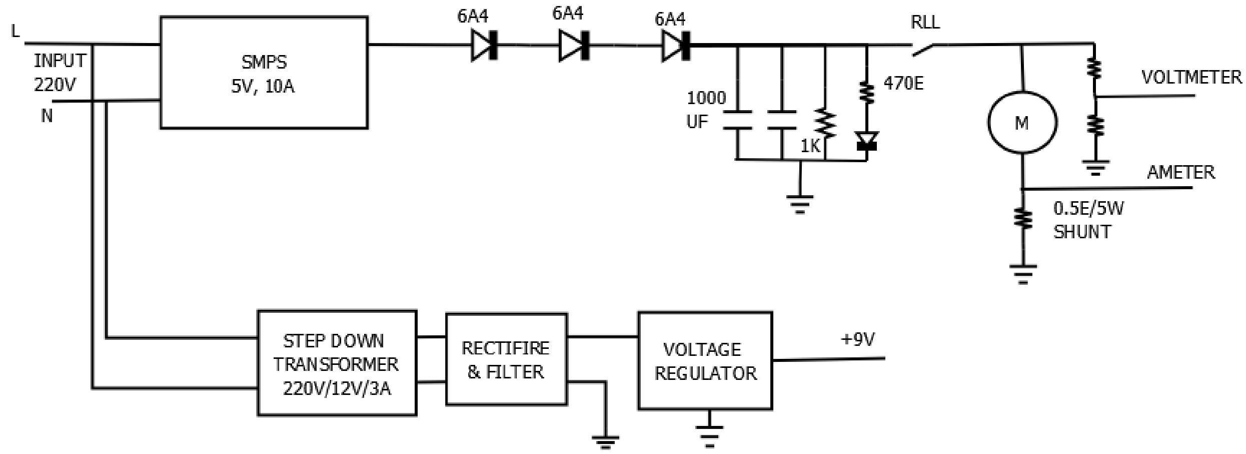


**Fig. 2.1 Electronic Circuit**

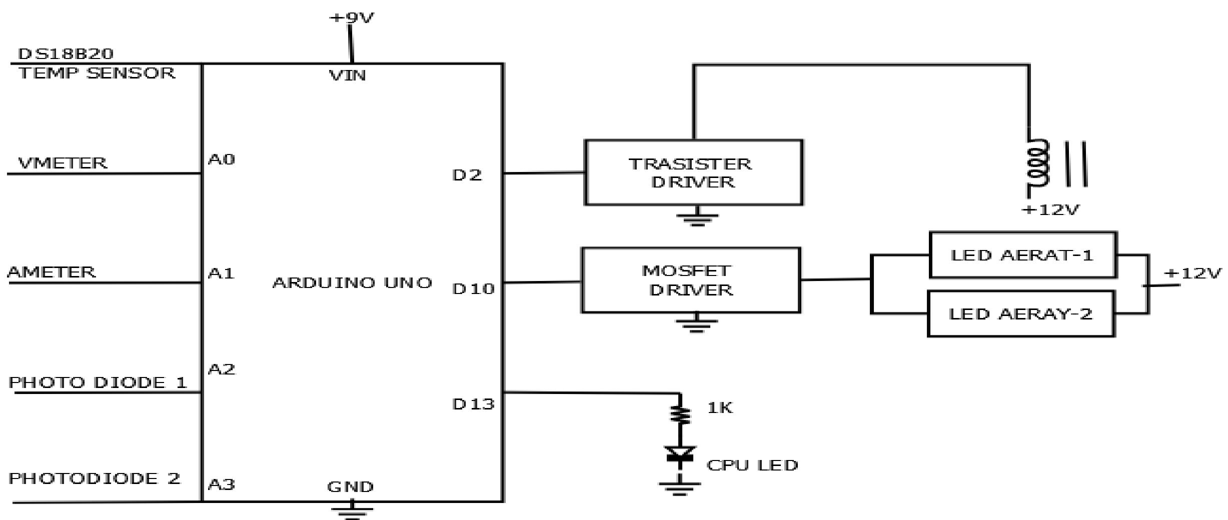


**Fig. 2.2 Arduino UNO Circuit**

Fig. 2.2 shows the Arduino circuit which connects with led array and photo diode and other sensors to collect data from sensors and feed to MATLAB. Led array with photo diode used to check transparency of liquids. Temperature sensor also used to calculate temperature.

### 2.1 Mechanical Setup

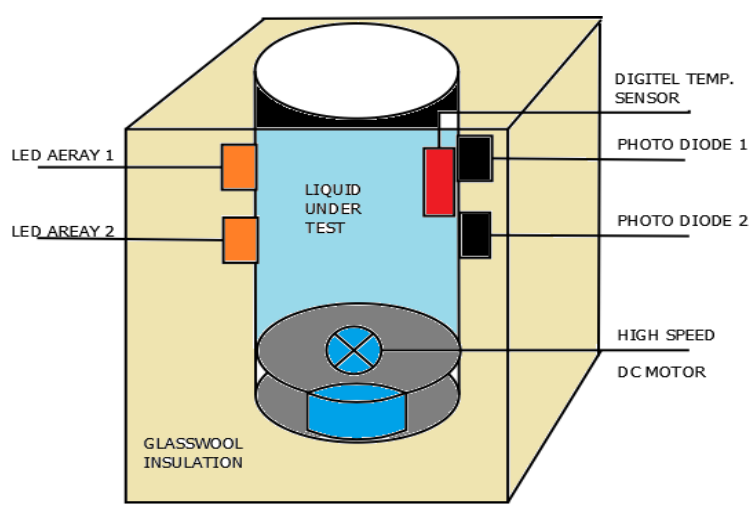


**Fig. 2.3 Mechanical Structure**

### 2.2 Flow Chart of ANN Training

The flow chart shows ANN training for generating approximate results similar to data set input in ANN training.

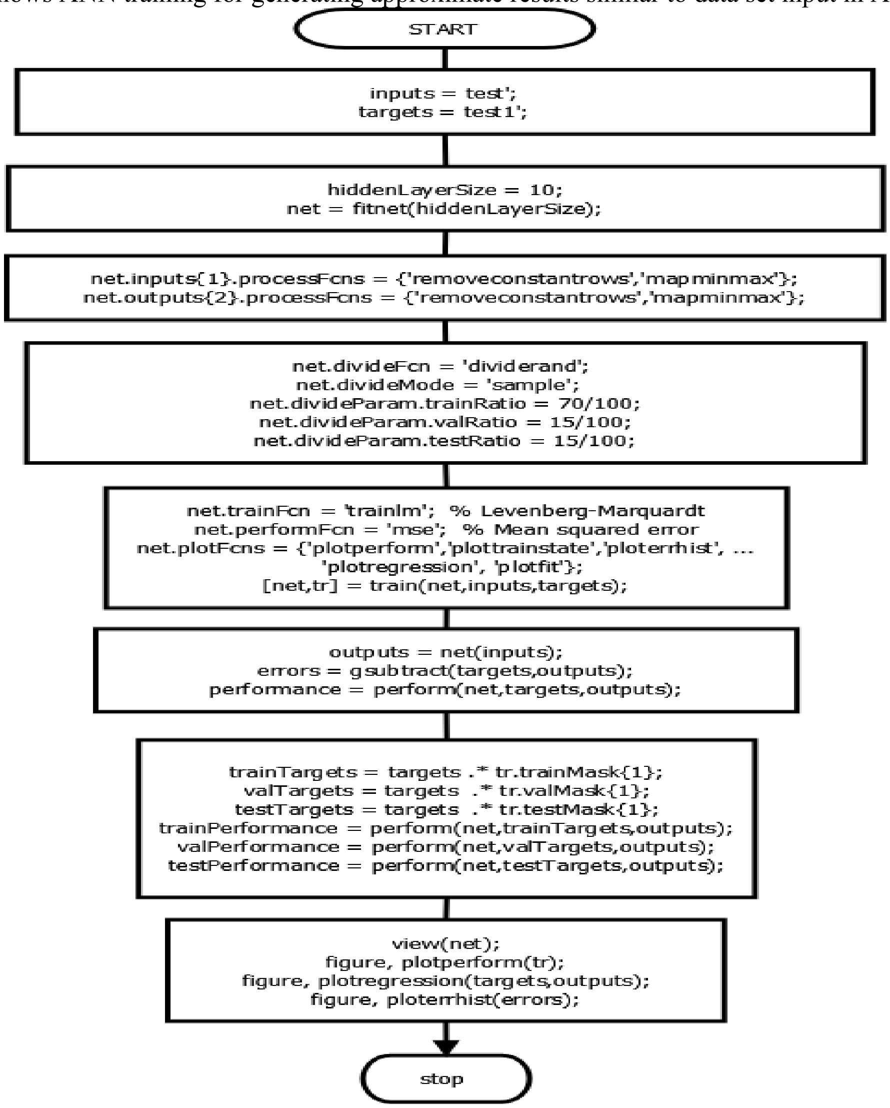


**Fig. 2.4 ANN Training Flow Chart**

## 3. RESULTS ANALYSIS

Four types of liquids for testing, water, petrol, oil & fruit mixed juice for analysis. Testing is done with different liquids and find out different results. In the next step, the results in graphical and table form for different liquids.

**Table-3.1 Under Tested Liquids Properties**

| S.No. | Liquid Name | Color | Fluidity | Texture |
|---|---|---|---|---|
| 1 | Water | Colorless | Easy flow | Transparent |
| 2 | Machine Oil<br>(Castrol machine oil) | Dark Brown | Less flow | Low Transparent |
| 3 | Petrol | Yellow | Easiest flow | Semi-Transparent |
| 4 | Fruit Juice<br>(Real mix Fruit Juice) | Yellow-Orange | Less flow | Low Transparent |

The different colors show different parameters.
Graph 3.1
Voltage –Red
Current – Blue
Motor state – Green
Motor Time – Yellow
Fluid Temperature – Red
Graph 3.2
LED State – Red
LED Time – Blue
Photo sensor 1 (PD 1) – Blue
Photo Sensor 2 (PD2) – Red

**Case-1 Led Light and Sensors Observation Without any Liquid**

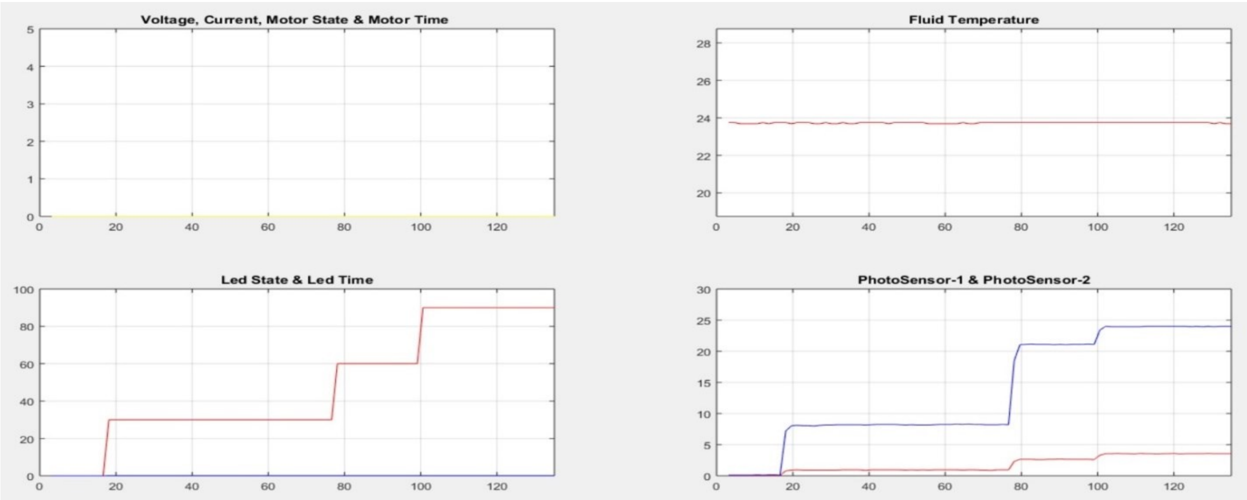


**Fig. 3.1 Parameters Observation without any Liquid when Motor OFF**

In above figure show results in graphical terms. When running the project without any liquid then no change in voltage, current, fluid temperature due to the motor is not running. When I manually change in led state then automatically change in photo sensors 1 & 2 shown in the figure.

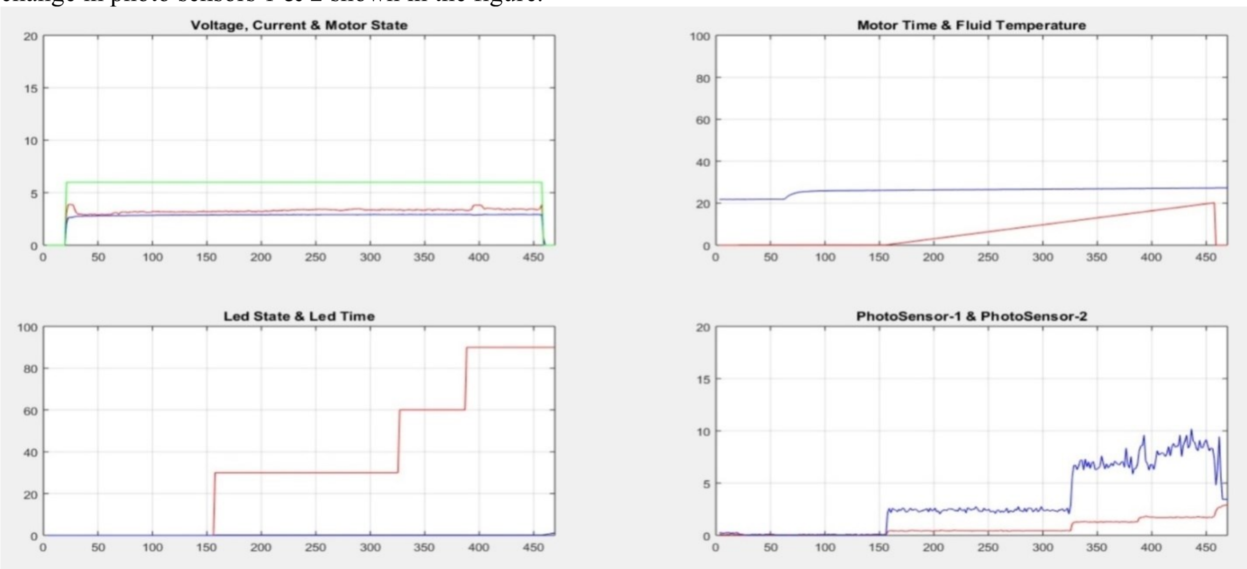


**Fig. 3.2 Parameters Observation without any Liquid when Motor ON**

In above figure show results in graphical terms. When running the project without any liquid then graph shows small changes in voltage, current, fluid temperature due to motor is running without load.

**Table-3.2 Comparison with Base Paper**

| S. No. | Parameter | Base paper | Proposed work |
|---|---|---|---|
| 1 | Artificial intelligence | NA | Levenberg–Marquardt function fitting neural network |
| 2 | Data acquisition system | NA | Arduino based custom 10-Bit ADC 4CH & digital temp DAQ |
| 3 | Parameter computed | Density | Thermal conductivity, density, transparency |
| 4 | Fluids tested | Oil, petrol, acetone | Water, machine oil, petrol, fruit juice |

## CONCLUSION

Experiments on a custom fest setup comprising a jar with a rotor, packed in a wooden enclosure with glass wool insulation were performed using various fluids such as water, machine oil, mixed fruit juice & petrol. The observed values & artificial intelligence-based computational results validate the proposed system.

## FUTURE SCOPE

The proposed system drill/rotor-based fluid properties measurement system using embedded system /sensor technology in conjunction with artificial intelligence has been successfully developed & demonstrated. However, with the modernization & advancement of computer & sensor technology, it is imperative to enhance or upgrade the developed system, to meet the needs & challenges of the future. One of the most sought updates would be to cooperate with self-learning capability in the ANN. Another enhancement is to incorporate more parameters testing such as viscosity, calorific values, PH, TDS ETC.

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