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AVR Micro-Controller Based Embedded Weather Monitoring System

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Abstract: Weather information plays significant role in agriculture as well as in green house projects. So monitoring of weather parameter is very essential. The present system is designed to monitor weather parameters like temperature and humidity with digital display. *The stored data can be transmitted to personal computer (PC).* ***Micro-controller AVR-Atmega 32 is the heart of the weather monitoring system. Temperature sensor used is LM-35 and humidity sensor used is SY-HS-220.Software programming has been done by using embedded-C programming. The system's experimental results show that the present weather monitoring system is more accurate to measure temperature and humidity.***
Keywords: Weather monitoring system, Atmega 32, Signal conditioning, Temperature sensor LM 35, Humidity sensor SY-HS-220.

I. INTRODUCTION

Aim of the present system is to measure weather parameter temperature and humidity. Monitoring of weather parameter helps to manage greenhouse climate conditions and some industrial process environment. So it is essential to monitor weather parameters. Accurate and reliable weather information helps manage the work schedules, reduce the costs and achieve maximize outcome. In earlier period for monitor weather parameters mechanical or electromechanical instruments are used. These instruments suffer from the drawbacks like accuracy, need of human intervention, associated parallax errors and durability. Due to electronic instrument system becomes flexible, compact and cheaper. Despite of this, systems flexibility of remote monitoring and data logging was not good [1]. T.Murugan et.al.have developed embedded based industrial temperature monitoring system using GSM and PIC micro-controller. System can send and receive weather messages facilitated by GSM technology. For measuring temperature IC sensor LM 35 was used [2]. Kamarul Ariffin Noordin et. al. designed a low cost micro-controller based weather monitoring system. The system uses sensor to measure temperature, atmospheric pressure and humidity [3]. Kang. J. and Park S have developed monitoring systems; using sensors for indoor climate and environment based on the parameters such as temperature and humidity. Further they developed a reliable and economically feasible remote sensing system for temperature and relative humidity measurement with the combination of sensors with data acquisition system [4]. Karishma Patil et. al. have developed a weather monitoring system using micro-controller, which monitors temperature and humidity using sensors but this system suffers from low secured and low data rate[5]. P.Susmithaet.al. have been designed and implemented weather monitoring and control system to monitor gas and humidity .The system uses ARM micro-controller LPC1768 [6]. S.Rajeshkumaret.al. have been designed Industrial temperature monitoring and control system through Ethernet LAN using LAB View. The system uses ARM microcontroller and sensing temperature LM 35 was used. For simulation data was obtained from micro-controller through Ethernet [7]. Madukar S. Chavan et.al. designed a system that monitors temperature of heater using AVR micro-controller with real time data-logger [8].

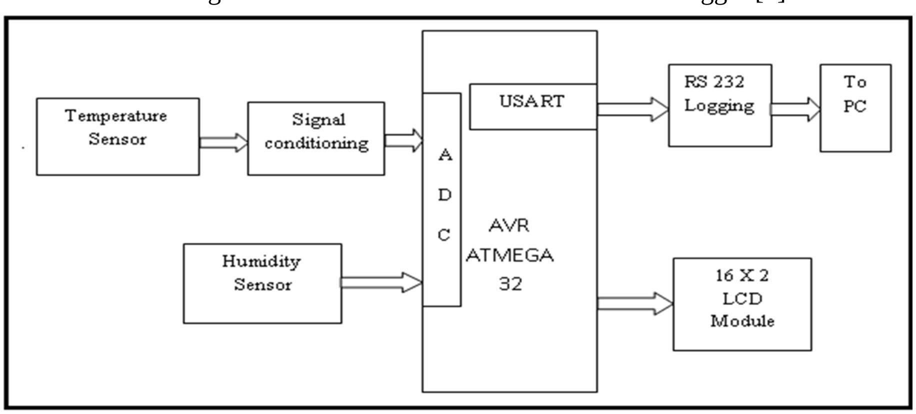

Fig. 1: Block diagram of weather monitoring system

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The sensors sense the weather parameters temperature and relative humidity and convert it into the electrical quantities such as voltage, current, resistance. The output of sensors after signal conditioning is feed to the microcontroller. The output of sensors is an analog quantity which we have to convert in to digital form to make compatible with the microcontroller. Atmega 32 has on-chip ADC. The microcontroller is a heart of the system which makes a true embedded system. The data processed by a controller is stored in EEPROM of the microcontroller and displayed on display unit. The stored data is transmitted to PC using RS 232 logging. The functional block diagram of the system is shown in fig.1

II. HARDWARE IMPLEMENTATION OF THE SYSTEM

For temperature sensing, precision centigrade temperature sensor LM35 is used, which has an analog output voltage proportional to centigrade temperature. The output voltage of sensor is linearly proportional to centigrade temperature. Its operating range lies over -55 ºC to 100ºC with accuracy of 0.5ºC.Its scale factor is 10mV/ºC and provides the output in the range of 0V to 5V. The distinct features of LM35 make it a good choice for temperature measurement. The arrangement of signal conditioning required for LM35A involves high input impedance op. amp. as shown in the fig.2

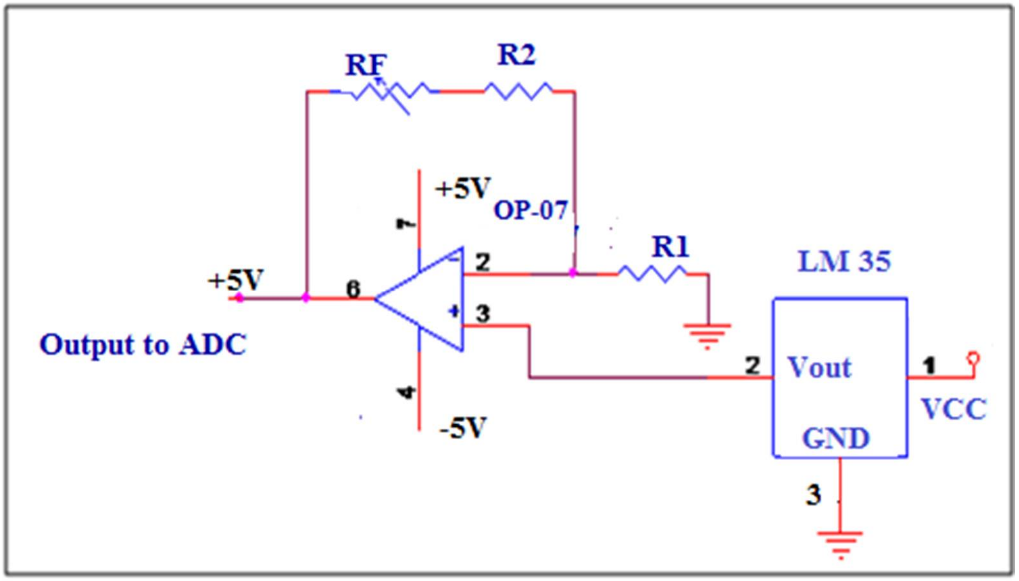

Fig 2: Signal Conditioning of LM 35

In this experimentation, amplifier gain is the ratio of span of output voltage of amplifier to the span of sensor output. Resistor value selection:-

For non-inverting amplifier the gain is set by equation (1).

$$A_V = 1 + \left(\frac{RF'}{R1} \right) \quad (1)$$

$$R_F' = (A_V - 1) * R_1 \quad (2)$$

$$R_F' = R_F + R_2 \quad (3)$$

Selecting R1=10 kΩ suggest the value of RF' to be around 40 KΩ. Gain is adjusted via variable resistor. For signal conditioning of LM-35 an ultra-low offset operational amplifier OP-07 is used. Relative humidity is monitored with humidity sensor module SY-HS-220. This module converts relative humidity to output voltage. Its output voltage is in mV. Output voltage corresponds to 30-90%RH. Its accuracy is ±5 RH. The output voltage is directly compatible with microcontroller, hence there is no need of signal conditioning at all. It thus reduces the system complexity by reducing component count. The heart of the system is Atmega32 microcontroller which works as CPU. It is an 8 bit microcontroller. This microcontroller controls all operations. AVR have RISC with load store architecture. Atmega32 provides eight channels and 10 bit ADC. It has 32 Kbytes of in-system programmable flash memory. Atmega 32 has 32 Kbytes of in system programmable EEPROM flash memory. Data is stored in the memory of controller and then it is transferred to the PC by using RS 232 logging. LCD is used to display the result. The module has on-board display. The display unit is composed of 16x2 dot-matrix alphanumeric LCD. The LCD is configured in 4-bit mode. The schematic of this system is as shown in fig 3.

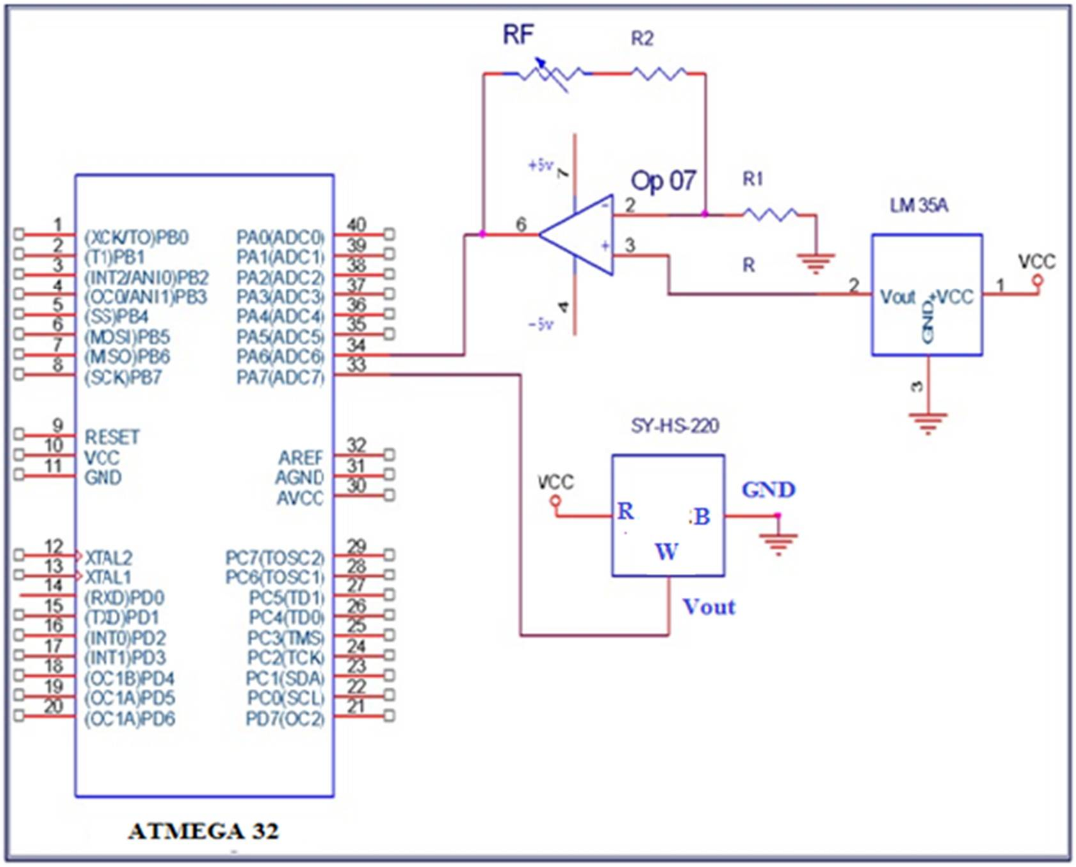

Fig. 3: Interfacing of sensors with Atmega32

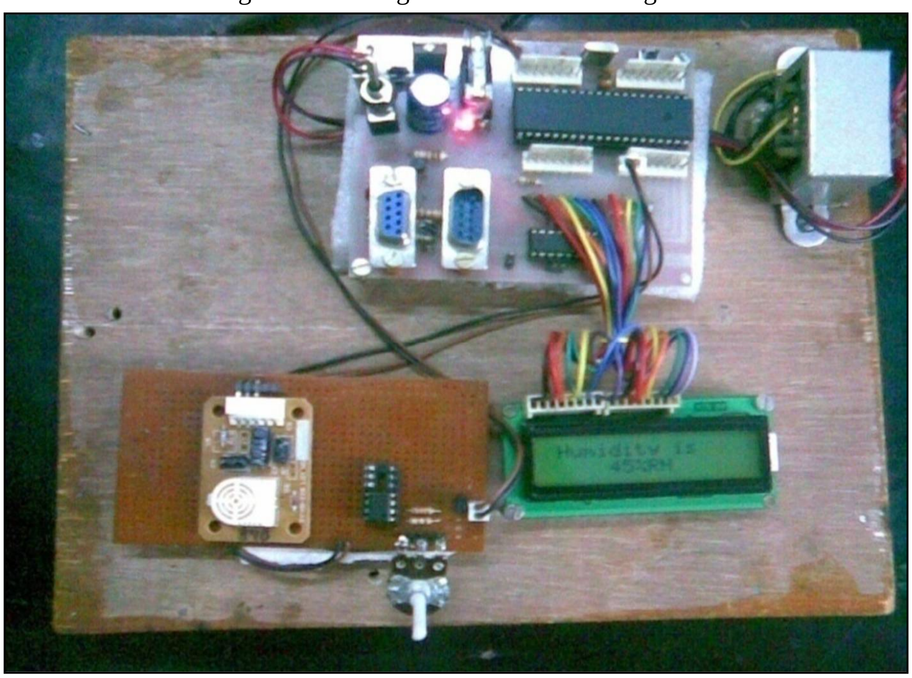

Fig4: Photo snaps of developed weather monitoring system

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III. SOFTWARE IMPLEMENTATION OF THE SYSTEM

After designing the circuit, the software implementation was done through embedded-C.Fig.5 shows the flow chart of functioning flow of system.

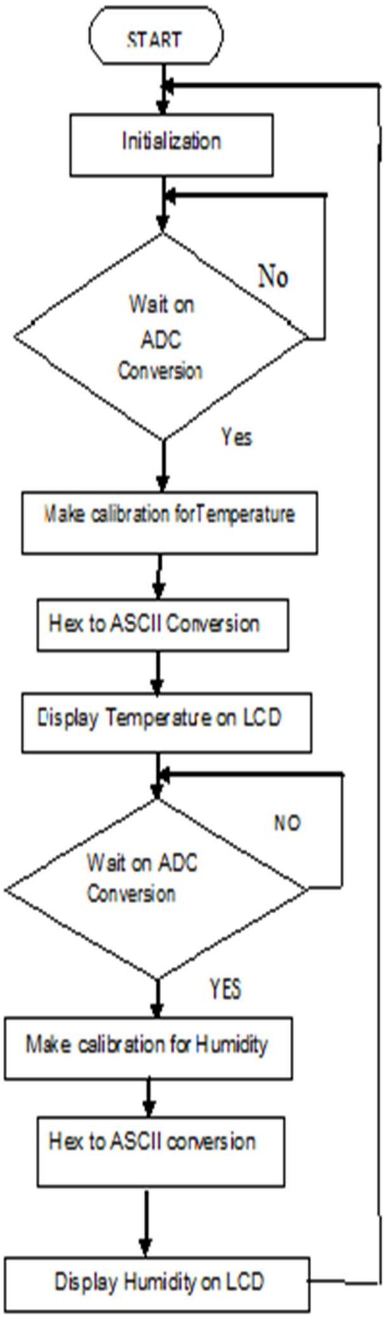

Fig. 5 Flow chart of weather monitoring system software

IV. EXPERIMENTAL RESULTS

The monitoring system can measure temperature from0ºC to 100ºC with an accuracy of ± 0.5ºC and relative humidity from 30%RH to 90%RH with resolution of 1% RH. Accuracy of weather monitoring system depends on sensor accuracy. The observed data is compared with the actually measured data using conventional mercury thermometer and hygrometer. The results obtained are summarized in Table-1, Table- 2.Experimentation with the designed system was done to measure the temperature and humidity and shown in table 1 and 2.

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Table 1. Observation table of temperature

Sr. No.	Time Interval (min)	Temperature by Proposed device (°C)	Temperature by thermometer (°C)	Difference (°C)
1	10	32.5	32	0.5
2	20	32.9	32.5	0.4
3	30	32.1	32.6	0.5
4	40	32.1	32	0.1
5	50	32.9	32.2	0.7
6	60	31.7	31.3	0.4
7	70	32.1	32	0.1
8	80	32.5	33	0.5
9	90	32.6	33.1	0.5
10	100	32.9	32.3	0.6

Table 2. Observation table of relative humidity

Sr. No.	Time Interval (min)	Relative Humidity (%)	R.H. by Hygrometer (%)	Difference (%)
1	10	42	40	2
2	20	43	42	1
3	30	40	40	0
4	40	37	38	1
5	50	34	36	2
6	60	36	33	3
7	70	34	35	1

From Table-1, it can be observed that the temperature sensor shows a good level of stability as well as accuracy. The average error of 0.43°C is observed pertaining to ±0.5°C errorof LM35A itself. The humidity sensor has also shown very good accuracy as depicted in Table-2.An error of 2.42 % is observed mainly due to the hysteresis effects of the sensor.

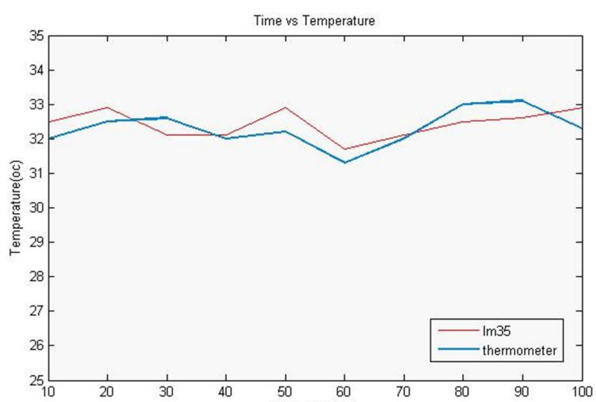

Fig 6: Graph of Temperature of LM 35& Thermometer with respect to time

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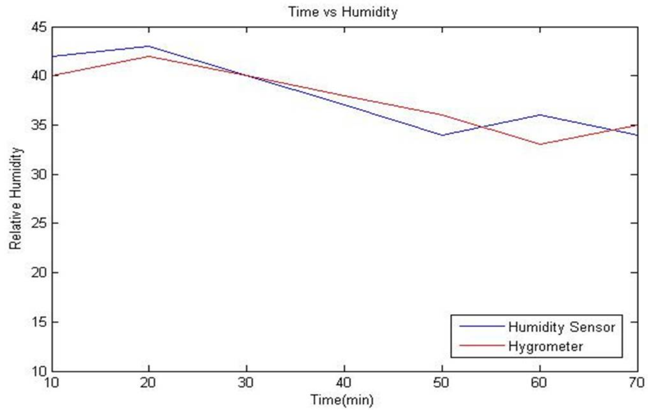

Fig 7: Graph of Humidity of SY-HS 220 & Hygrometer

From the graph of Temperature and Humidity it is observed that the system observations and the observations of standard calibrated system are nearly same.

V. CONCLUSION

The data pertaining to the temperature and relative humidity gathered by system is very closely agrees with the data measured by commonly available and calibrated systems. The system is simple in design and cheaper that can be implemented in agriculture and green house projects for monitoring of weather main parameters viz. temperature and humidity. For parameters like light intensity, air velocity and other the sensor system can be interfaced easily with system reported in the paper.

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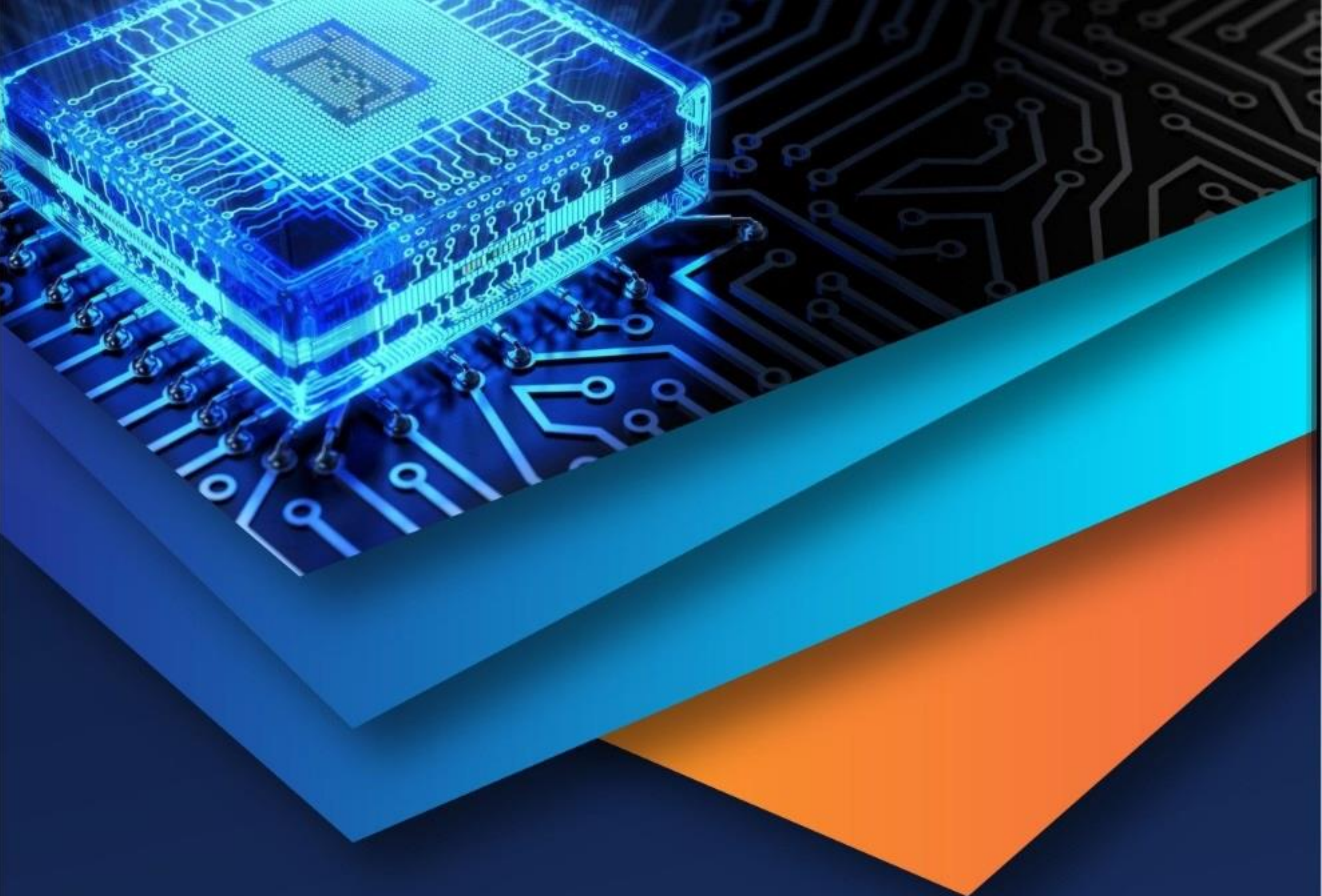

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