International Journal of Mechatronics, Electrical and Computer Technology (IJMEC)
ISSN: 2305-0543 (Online), ISSN: 2411-6173 (Print)
Vol. 11(40), Apr. 2021, PP. 4976-4982

Design of an Intelligent Multifunction Corona Virus Prevention and Monitoring System Model with Biometric Identification System

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***Abstract*—This paper presents an enhanced multifunction corona virus prevention and monitoring system for early infection detection and prevention. Apart from maintaining social distance, use of facemask, face shield, personal hygiene after and during the corona virus pandemic; continuous check on individual human temperature is a necessary preventive measure. The integration of a temperature monitoring scheme as an early warning system will boost prevention rate since high temperature is a recognized symptom of corona virus in humans. Individual temperature identification in most entrance and exit points of public places has created isolation and management challenges. This design incorporates biometric recognition system to guarantee individual identification using iris pattern scanning and comparison with an already existing database through internet communication. Individual details are remotely retrieved without disagreement. The combination of several known corona virus preventive actions was applied to develop a new anticipatory model for multiple operations within a single intelligent system. The model was demonstrated with proteus simulation software integrating GSM module. The results proved the functionality of the model. Further research will consider translating the simulation into a prototype.**

Keywords—Biometric Device, Coronavirus, Intelligent Model, Multifunction, Monitoring System

I. INTRODUCTION

The negative impact of corona virus since 2019 has given rise to many inventions aimed at combating the spread of the dreaded virus. These inventions range from hand held thermometer devices as a symptom detective medium, Real time Reverse Transcription Polymerase Chain Reaction (RT-PCR) clinical confirmatory Test device and many other devices. Precautionary measures generally adopted were hand washing, application of hand sanitizers and drying actions which in no doubt have improved prevention and reduced spread of the virus, though these devices were manually operated and contact oriented[1]. Before now in many eateries, liquid soap used during hand washing are placed on the table for the users to apply which may lead to corona virus transmission. Regulating the water control nozzles of dispensers manually with hand during hand washing operation may also result to virus transmission, thus, [2]developed an automatic and contactless device for restaurant use. The device dispensed soap, water and dries the hand to reduce the chances of transmission. Hand washing, sanitizing and drying without temperature scan and individual virus status check with real-time documentation may not guarantee a virus free society when all organizations resume normal contact duties. Hence, there is an observed gap that calls for a system that can address this technological need. Educational institutions, banks, worships centers, hospital and their likes will benefit immensely from a system that has the capacity to provide both preventive and monitoring actions aimed at combating the spread of covid-19 virus. The model designed in this research has this capacity. Many preventive measures have continued to evolve with time; the design of an intelligent multifunction corona virus monitoring system model is a direct response to the need to develop autonomous systems that can function with minimal human interference in curtailing the spread of the virus. In this design, temperature monitoring, motion detection and biometric system were introduced into already existing corona virus preventive machines equipped with soap dispensing, hand washing, hand sanitizing and hand drying functions. The system assumes an existing database containing individual information ranging from images, fingerprint, eye colour recognition, residential address, phone number and others. The design takes cognizance of pattern recognition approach in human identification. This proposed design makes use of an already authorized existing system which is encrypted to handle security vulnerabilities, and also taking advantage of the introduction of the 4G and 5G

Article History:
Received Date: Jan. 12, 2021, Accepted Date: Mar. 12, 2021, Available Online: Apr. 01, 2021

network configuration, smart documentation and database monitoring is guaranteed, hence this engenders fast data capturing and processing without undue delay at its various layers of data processing and documentation. This proposed system considers larger data handling with MongoDB database structure without any loss of data or deleting the previous files to create more space for new dataset[3]. Before now MySQL, PostgreSQL and Microsoft SQL Server were in use, but the advent of the MongoDB with its scalable and flexible structure in today's cloud era application creates easier way of data documentation and manipulation[4].

This system proposed an intelligent liquid dispensing option for both water and soap without hand contact with the machine, as well as hand drying option before it releases the sanitizing fluid. The system also incorporates the temperature scanner, biometric identification and motion detection scheme and as a multifunction and intelligent device using microcontroller action.

II. LITERATURE REVIEW

Prior to the outbreak of corona virus pandemic, [2]developed an automatic soap, water and hand drying machine for eatery usage which was the basis for the corona virus preventive machine design. The possibility of dispensing soap and alcohol-based hand sanitizer automatically was proposed by [5], considering the fact that continuous physical contact with soap and sanitizer container may transmit corona virus. The author suggested that hospital and other public places should adopt it. However, there was no incorporation of water dispenser for hand washing. [6]opined that human hands were one of the major means of transmitting corona virus and developed an automatic contactless hand sanitizing machine to effect hand disinfection with hand detection scheme. The design in this research has the sanitizing fluid, pump and sensing system such that when it detects human hand, the sanitizer fluid drops in considerable quantity with means of identifying the user.

Similarly, manual operated soap spraying and hand washing machine using pedal operated clutch without drying and identification scheme was developed by[1].The authors suggested that Artificial intelligence may aid automatic dispensing. [7]detected some fraud associated with Human identification system and proposed that iris pattern for biometric authentication could mitigate identification fraud. They developed a prototype system, carried out tests with over 59 volunteers and results obtained showed that no two persons have the same iris pattern on earth. The design in this paper introduced the inclusion of iris pattern biometric identification system for easy tracking of corona virus suspected persons. However, another system was developed to include iris pattern image identification, image extraction and reprocessing, [8][9][5].This system was adopted in this design for corona virus patient authentication and identification.

[3][4] opine that MongoDB has a larger data handling capability unlike the MySQL, PostgreSQL and Microsoft SQL Server. The advent of the MongoDB introduces data scalability and flexibility structure which has made today's cloud era much improved. Its application creates easier way of data documentation and manipulation.

[10] research suggests that the mobile global communication system today will witness fast internet services with the introduction of the fifth-generation network (5G). In view of the 5G network introduction [11] undertook a literature survey on other available networks like 2G, 3G and 4G and concluded that 5G will be of tremendous advancement as compared with the existing networks. [12] stated that the growing economy and its complete dependency on digital applications requires a stronger, more flexible and faster network connectivity in order to meet the ever-increasing global connectivity demand. Many IOT gadgets like laptops, mobile phones, smart cities, and other devices which require smart network sharing, will appreciate the 5G technology. The intelligent multifunction corona virus prevention and monitoring system model with biometric identification system will exhibit high speed internet connectivity characteristics with its 5G enabled network connectivity. The literature so far reviewed show that existing corona virus monitoring and control systems lack the combination of modern technologies, like intelligent fluid dispensing system, biometric identification system, temperature monitoring, database documentary and IOT system in a single functional system. The design in this research adopts smart multi-function system for corona virus early detection, prevention, monitoring, and control with remote capabilities.

III. METHODOLOGY

A. Materials and Methods

This system is made up of mechanical and electronic components. The mechanical components are material deployment vessels, flow transmission lines and the design casing. Whereas the electronic components are Arduino Uno board, Atmega328 micro-controller, ultrasonic sensor, motors, display devices, temperature sensor, GSM Module, Biometric device, power supply, push button, transistors and relays. The architectural design for this model is scalable as the component specifications and models are detailed below.

Design Specifications:

$Volume\ of\ the\ Water\ Tank = 50,000cm^3$

$Volume\ of\ the\ Soap\ tank = 10,000cm^3$

$Volume\ of\ the\ Sanitizer\ Tank = 10,000cm^3$

$Volumen\ of\ the\ Compressed\ Air\ Cylinder = 50,000cm^3$

$Inlet\ Pipe\ size = 0.1524m$

$Outlet\ Pipe\ size = 0.0254m$

$Motor\ Voltages\ rating(V) = 220v$

$Motor\ Current\ Rating(I) = 6.7amps$

$Motor\ Speed(N) = 300rpm$

$Power\ Factor\ (\emptyset) = 0.8$

$$AC\ Motor\ Pump\ Power\ Rating\ (P) = VICos\emptyset = 220 \times 6.7 \times 0.999 = 1474w \approx \mathbf{1500w}$$

It also has a feedback mechanism for each functional unit. The design is divided into nine subsystems: display, thermal detection, central control, motion detection, GSM module, Biometric module, power supply unit, reservoir and material deployment subsystems. This system adopts an enhanced

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global system for mobile communication technology (GSM) for its design configuration because of its ability to interface with any generation of network connectivity. Each of the sub-units optimally functions independently and are jointly brought together through the microcontroller intelligent action.

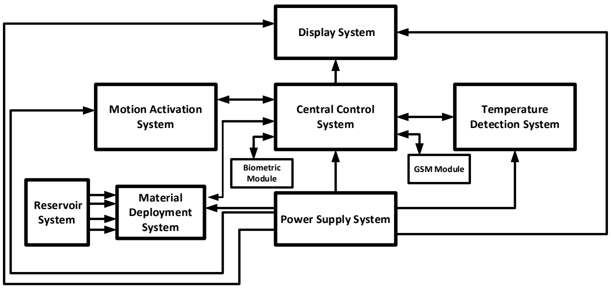

Figure 1: Block diagram of an Intelligent Multifunction Corona Virus Prevention and Monitoring Model

B. Electrical and Electronic System Design

In Figure 1, the reservoir system is where the soap, water, dry air and sanitizer are stored for deployment; the material deployment system has a four-way non return valve inlet system and a one-way outlet system for the delivery of the resources such that when the system is activated, the self-operated machine functions as designed in figure 2. In figure 2 the soap discharge point (SDP), water discharge point (WDP), Hand drier point (HDP) and sanitizer discharge point (SDPT).

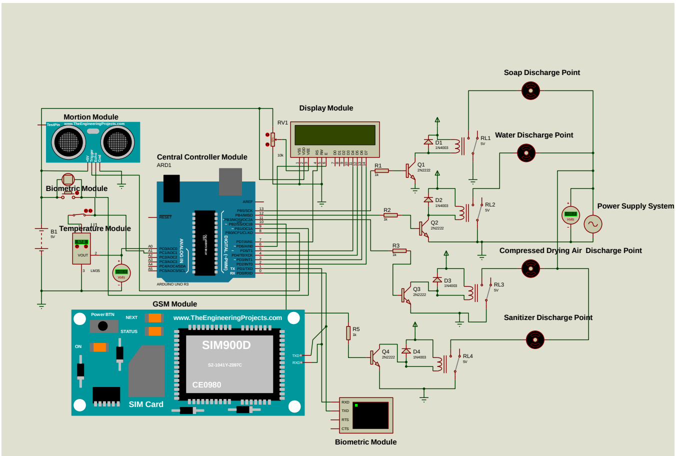

Figure 2: Circuit diagram of Intelligent Multifunction Corona Virus Prevention and Monitoring Model

Individuals are identified through their eye iris pattern captured by a biometric sensor. The ultrasonic sensor detects the human hands at a specified distance, the system is activated with priority to soap dispenser first, followed by that of the water, and these are done automatically. The hand dryer dries the hand and the sanitizer dispenser is activated to dispense on the awaiting hands. Simultaneously, the temperature of such individual is checked and displayed on the liquid crystal display unit. If the temperature threshold for a normal human body is exceeded, the buzzer alarm activates and the identification details of the person is transmitted to appropriate authority through Internet of Things device (GSM module). The eye iris pattern identification system is linked to individual database through an already documented bio-information. The person can be traced to avoid further spread of the disease. The system material deployment unit continuously compares the quantity of water, soap and sanitizer to refill it to their respective levels. The three fluids are housed in different vessels, likewise the compressed hot air, but they are connected through non-return valves to a single discharge tap point. The process stops as the hands receives sanitizer fluid. The overall system is managed by the central controller with C++ code (see appendix A). The system is designed to be powered by solar energy.

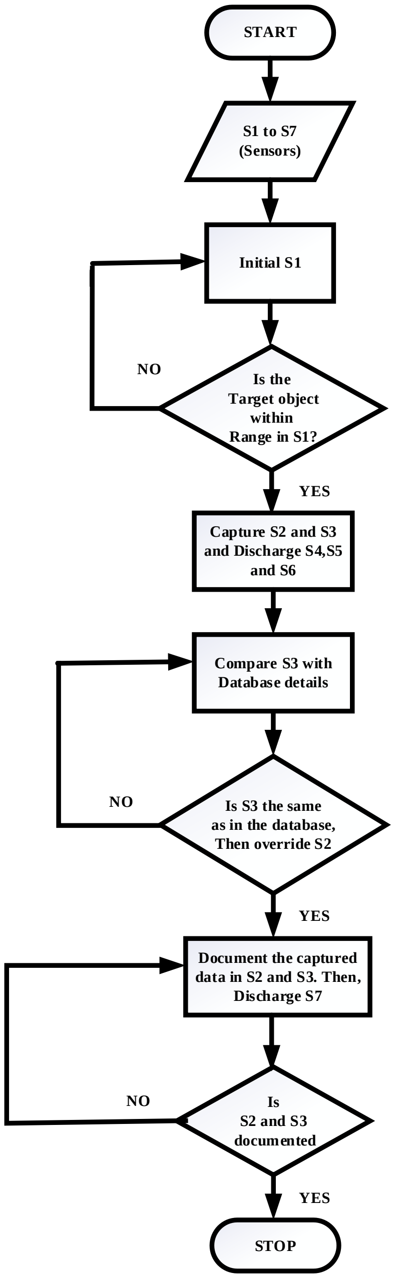

Figure 3: Flow Chat for the Intelligent Multifunction Corona Virus Prevention and Monitoring Model

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Legend

S1 facilitates Position Sensing
S2 facilitates Temperature Sensing
S3 facilitates Biometric Sensing
S4 facilitates Soap Discharge
S5 facilitates Water Discharge
S6 facilitates Sanitizer Discharge
S7 facilitates Dry Air Discharge

Pseudo Code

Input S_1 *to* S_7;
Initialize S_1;
If the target object is within design range in S_1,
then capture S_2 *and* S_3 *and Discharge* S_4, S_5 *and* S_6;
If the target object is not within design range in S_1,
then initialize S_1 *again; and Compare* S_3 *in the database,*
if S_3 *is the same as in Database, then, document all* S_2 *above normal temperature;*
If S_3 *is not the same as in the database,*
then activate an alarm to communicate an intruder, else,
document the captured data in S_2 *and* S_3 *and Discharge* S_7
If S_2 *and* S_3 *are documented,*
then stop the system.
If S_2 *and* S_3 *are not documented,*
then document the captured data in S_2 *and* S_3 *for intruder detection.*

C. *Mechanical System Design*

The Mechanical system Model consists of the followings:

i. **Four inlet material discharge Terminal pipes**: These inlet pipes convey four different materials from the reservoir; soap, water, sanitizer and compressed air. Each pipe is interlocked with individual non-return valve into one outlet. The model is also designed to automatically refill the sanitizer fluid, water and compressed air at certain threshold.
ii. **Waste water discharge Terminal**: This is where the waste water will be discharged for further recycling into use.
iii. **Waste fluid Control Vessel**: This is where the waste water discharged is directed to avoid contaminating the environment.

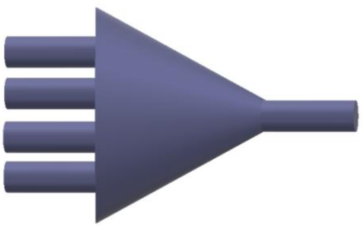

Figure 4: The internal design of 4-into-1 material transport system for intelligent multifunction corona virus prevention and monitoring system model

D. Electrical Components

i. **Solar Power assembly**: The design uses solar energy with its associated devices to power the entire system.

ii. **Ultrasonic Device**: The ultrasonic sensor is used to detect human presence.

iii. **Temperature Detection Device**: The temperature sensor detects human temperature status.

iv. **Biometric Device**: The device is used in scanning the human iris for individual recognition and documentation. In Iris scanning system, measurement is carried out using human iris patterns through individual peculiar eye colour, since it has been proven that no two persons have the same iris. Biometric identification uses human iris to recognize individuals, given that when an iris is illuminated, light from the invisible infrared captures the unique patterns in the human eye for identification.

iv. **System Status Device**: This device indicates the system operational status. It shows blue when the ultrasonic sensor detects human presence. It also shows green when the human iris has been captured. When the temperature is measured it indicates yellow. The indicator blinks white colour to show that the four steps in one process have been completed successfully.

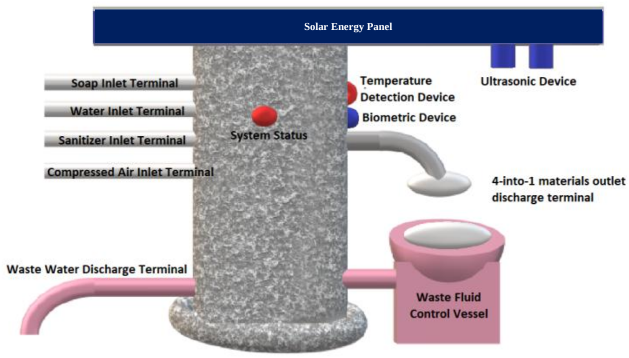

Figure 5: Complete Proposed Mechanical Model for the intelligent multifunction corona virus prevention and monitoring system

The overall system is managed by the central controller in figure 2 and is housed by a stainless metal material.

IV. SIMULATION RESULT AND DISCUSSION

In table 1, the ultrasonic sensing device is configured to capture objects with height ranging from 1.5240m to 1.9812m corresponding to 5v and 3.5v sensor voltage. Within this range the sensor output is active. This implies that the system will reorganize human presence within the height range of 1.5240m to 1.9812m. On the other hand, between 0.1524m to 0.9144m height range, the sensor is inactive but

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ON. This range of heights are likened to heights below adult humans. The system can also be reprogrammed to take care of children heights. However, care must be taken to avoid false activation by nonhuman animals. At 0.000m height, the sensor output is zero volts making the system to be in off mode, this implies that the system is in OFF mode.

Table 1: Ultrasonic Sensor Results

Object Height (m)	Sensor Voltage (v)	Sensor Status
1.9812	5	Active Mode
1.8288	4.5	Active Mode
1.6764	4	Active Mode
1.5240	3.5	Active Mode
0.9144	3	Inactive Mode
0.7620	2.5	Inactive Mode
0.6096	2	Inactive Mode
0.4572	1.5	Inactive Mode
0.3048	1	Inactive Mode
0.1524	0.5	Inactive Mode
0.000	0	Off Mode

In table 2, the temperature response of the sensor was monitored through sensor voltage variation. The temperature sensing device was configured to recognize voltage input from 3.5v to 5v corresponding to temperature from 35ºC to 40ºC. The sensor is configured to read from 35ºC to 37ºC as Normal temperature. While temperatures from 3.75ºC to 50ºC are read as Abnormal temperatures. These temperatures outside the normal temperature range are transmitted through the GMS device for documentation.

TABLE 2: TEMPERATURE SENSOR RESULTS

Detected Temperature (ºC)	Sensor Voltage (v)	Sensor Functional Status
40	4.0	Abnormal mode
39.5	3.95	Abnormal mode
39	3.9	Abnormal mode
38.5	3.85	Abnormal mode
38	3.8	Abnormal mode
37.5	3.75	Abnormal mode
37	3.7	Normal Mode
36.5	3.65	Normal Mode
36	3.6	Normal Mode
35.5	3.55	Normal Mode
35	3.5	Normal Mode

In table 3, the simulation result shows that on the system attaining the input voltage of 5v, the controller initiates the fluid discharge action and biometric scan within the voltage output of 4.5 to 5v.

TABLE 3: FLUID DISCHARGED AND BIOMETRIC SENSING RESULTS

Component	Input Voltage(v)	Output Voltage(v)	Remarks
Biometric Sensor	5	4.5 to 5	Capture eye iris pattern
Soap discharge motor	5	4.5 to 5	Discharge soap
Water discharge motor	5	4.5 to 5	Discharge water
Sanitizer discharge motor	5	4.5 to 5	Discharge sanitizer
Compressed air discharge motor	5	4.5 to 5	Discharge compressed air

The proposed model was simulated with proteus software and regulated by microcontroller codes. The four-input pipe for material deployment was represented with four dc motor pump systems. When the ultrasonic sensor detects human presence, the system initializes and the indicator shows that the system is ON but there will be no action until the person’s eye iris scan is completed. After the biometric scan completion, the system activates the motor pump1 to supply the soap; and thereafter water is supplied through motor pump 2, followed by the (sanitizer) motor pump 3 and motor pump 4 rotates to release the compressed air to dry hands. The proposed system simultaneously captures the person’s temperature. If the temperature falls below the set-threshold; the system automatically resets from it feedback and clear its memory, but if the temperature is above the set-threshold; the system documents the information on the cloud. If the person appears again that same day or another day on the same machine, the device on scanning the eye iris identifies and re-assesses the person and adds the results to his or her database. The Biometric system is created to help identify individuals, so that the person can be traced to avoid further spread of the disease. The system material deployment unit continuously compares the quantity of the water, soap and sanitizer to refill them through their respective vessels. The three fluids are housed in different vessel likewise the compressed hot air; but are connected separately. Non-return valves are used to connect the four resources to the single discharge tap point. The process stops as the hands receives the sanitizer; the overall system is managed by the central controller and designed to be powered by solar energy. The proposed intelligent multifunction corona virus prevention and monitoring model with biometric identification system would be useful in the banks, hospitals, places of worship, schools and others public places. Post pandemic prevention and monitoring would be guaranteed with this model. The provision of manual or automatic hand washing device, sanitizer, drying and the temperature detection systems separately without documentation cannot guarantee post-corona virus monitoring and evaluation of public health status. Matching of individual bio-data with test results is required to sustain a corona virus free society. This system takes into consideration a large data size; hence it is built with a MongoDB database structure, which is capable of handling bigdata size without any loss of data or deleting the previous files to create more space for new dataset.

V. CONCLUSION

An intelligent multifunction corona virus prevention and monitoring model with biometric identification system was designed. This model is an enhancement to the already developed corona virus monitoring system given that the temperature detection system is added to the soap, hand washing, hand drier and sanitizing machine. Other improvements to the existing systems are the introduction of ultrasonic and biometric sensors that serve dual purposes; first for system activation and second for data recognition due to the matching of individual temperature status with respective bio-information database. With the inclusion of the eye iris recognition system to this proposed device, it would guarantee individual identification as they are linked to their respective database in the internet which would help in retrieving their details remotely without disagreements. For every new data entry, the database fetch and validates the entries of the new dataset with MongoDB structure, thus, validates the system performance benchmark. This model would find applications in most entrance and exit points of public places such as banks, hospitals, institutions of learning and places of worship and among others. The model was simulated with proteus and codes (C++ Language) were written in Arduino IDE and embedded in Arduino Uno microcontroller. The results prove that the designed system was functional as input and output voltage levels of components were within functional limits. Further research on this design will consider actualizing its physical model to assess real time performance.

Acknowledgment

We thank the Almighty God for the inspiration of this design. We also acknowledge all the various sources as contained in the reference for their scholarly contributions.

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Appendix A: C++ Code for the intelligent multifunction corona virus prevention and monitoring model

```
#include<LiquidCrystal.h>
LiquidCrystal lcd (7,6,5,4,3,2);
const int trigPin = 8; // Trigger
const int echoPin = 9; // Echo
const int sensor1 = A0; //Temperature input
const int sensor2 = A1; //Biometric input
const int motor1 = 13; // soap
const int motor2 = 12;// water
const int motor3 = 11;// sanitizer
const int motor4 = 10;// dryer
byte degree symbol [8] =

{

0b00111,
0b00101,
0b00111,
0b00000,
0b00000,
0b00000,
0b00000,
 0b00000

      };

void setup ()

     {

Serial.begin(9600);
pinMode (sensor1, INPUT);
pinMode (sensor2, INPUT);
lcd.begin (16,2);
lcd.createChar(1, degree_symbol);
lcd.setCursor(0,0);
lcd.print ("Multifunction Coronavirus   ");
lcd.setCursor(0,1);
lcd.print ("Monitoring and Control System ");
delay (4000);
```

```
lcd.clear();

}


void loop ()
{

int sensor1=analogRead(A0);
int sensor2=analogRead(A1);
if (sensor1 && sensor2 == 500);
pinMode (trigPin, OUTPUT);
pinMode (echoPin, INPUT);
pinMode (motor1, OUTPUT);
digitalWrite (motor1, HIGH);
delay (3000);
digitalWrite (motor1, LOW);
pinMode (motor2, OUTPUT);
digitalWrite (motor2, HIGH);
delay (3000);
digitalWrite (motor2, LOW);
pinMode (motor3, OUTPUT);
digitalWrite (motor3, HIGH);
delay (3000);
digitalWrite (motor3, LOW);
pinMode(motor4, OUTPUT);
digitalWrite (motor4, HIGH);
delay (3000);
digitalWrite (motor4, LOW);
 float temp_reading=analogRead(sensor1);
float temperature=temp_reading*(5.0/1023.0) *1000;
delay (10);
lcd.clear();
lcd.setCursor(0,0);
lcd.print ("Temperature in C");
lcd.setCursor(4,1);
lcd.print(temperature);
lcd.write(1);
lcd.print("C");
delay (1000);
}
```


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