IOT BASED SMART TOILET AND SMART DUSTBIN

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ABSTRACT

The entire world is under the influence of the ongoing pandemic situation with the subsequent lockdown. This situation calls for smart solutions in various sectors including banking, e-commerce, etc. IoT (Internet of Things) has been proved to be the future of building smart systems in various sectors. There is an urge to create a solution that is contactless taking into consideration direct contact as the primary reason for increasing the spread of covid-19. Poor hygienic practices have worsened the situation. To curb this pandemic and create contactless systems, the concept of E-toilet and E-dustbin has been introduced. E-toilet will ensure that hygiene is well taken care of. To tackle the problem of waste, E-dustbin would prove to be beneficial. E-toilet will focus on building hygienic and cleaner toilets for society. In this paper, the working of E-toilet and E-dustbin has been discussed in brief. Also, the benefits of this model to society have been mentioned in the paper.

Keywords: Smart Toilet, Smart Dustbin, IoT, Application, Hardware, Internet of Things, Embedded Systems.

INTRODUCTION

The Internet of Things (IoT) has been contributing in developing projects which are beneficial to society. It aims at enhancing the already existing systems in the world with an innovative approach. The agricultural sector and health sector have been greatly influenced by the wonders of IoT. Also, the sectors generating energy are also immensely influenced by IoT. The prime objective of IoT is to expand the reach of the internet beyond just computers and mobile phones. IoT is something that involves the use of both software and hardware components as per our convenience.

The aim of IoT is to reach each and every sector of society and produce some useful products. Waste management is one of the predominant issues faced by society. There has to be a product developed in this very field in order to promote waste management in a better and efficient way. IoT is defined as an interconnected network of devices connected together. It should include the internet in each and every system or product produced.

The world has experienced a revolution in the field of technology using IoT. It is time to explore more about IoT and its application in each and every field possible. The expansion of IoT will prove beneficial for the world at large. The proposed system includes the E-dustbin and E-toilet which aims at promoting waste management thus, contributing to the health and hygiene of the society.[3] Taking into consideration the current pandemic situation, contactless systems are in more demand. The concept of contactless E-dustbin and E-toilet will help

reduce the spread of this pandemic. It will be beneficial to society during this situation. The internet is meant to connect the whole world together.[2][8]

The chief goal of the internet is to spread as wide as possible. The data can be shared through the internet within a few seconds in a large area. IoT focuses on building automated systems in order to ease the efforts taken by us. Many projects have already been implemented in the field of IoT and have proved to be beneficial to society. Also, many are working on developing contactless systems to control the spread of this virus. Once the product is developed, everyone will be able to use it effectively as it will be contactless.

Both the proposed systems will be automatic in nature and will contribute to the welfare of our society. E-toilet will make sure that proper health and hygiene practices are followed by each and every individual in the society. Hence, both the proposed systems will help in developing good hygiene practices nationwide.[1][5]

E-toilet plans to develop cleaner toilets. The working and functioning of E-toilet and E-dustbin are properly explained in a simple and easy manner in the further section of the paper in detailed format. The components used in both the systems are easy to get and to an extent cost-effective. Everyone can easily be able to use the E-dustbin and E-toilet and will help reduce water wastage. Both of the systems play a crucial role in waste management in society. This paper includes all the component diagrams, flow charts in order to properly explain the importance and functioning of both systems. They will help in a better understanding of the system proposed.[4][1]

*I.*COMPONENTS

A. Arduino Mega

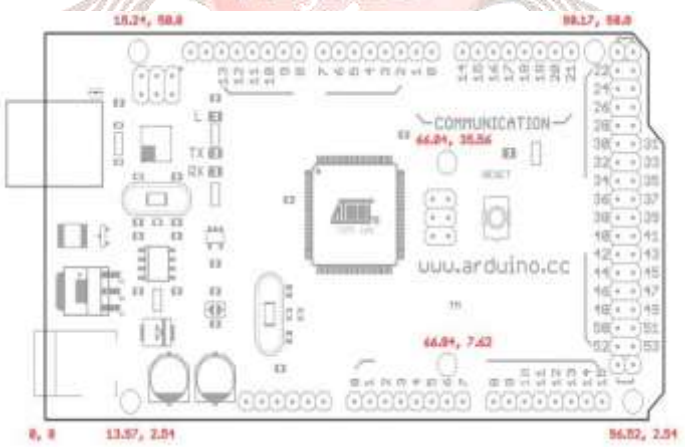

Figure 1: Arduino Mega

Arduino Mega is a microcontroller board based on 8-bit ATmega2560. It consists of other components such as crystal oscillator, serial communication, voltage regulator, etc. Arduino Mega has 54 digital input/output pins (out of which 15 can be used as PWM outputs), 16 analog input pins, a USB connection, A Power barrel jack, an ICSP header, 16MHz crystal oscillator and a reset button. The 14-digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in Arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

Serial Pins 0,19,17,15 (Rx) and 1,18,16,14 (Tx): Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.

External Interrupt Pins 2, 3, 18, 19, 20, 21: These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.

PWM Pins 2 - 13, 44 - 46: These pins provide an 8-bit PWM output by using analogWrite() function.

AREF: Used to provide reference voltage for analog inputs with analogReference() function.

Reset Pin: Making this pin LOW, resets the microcontroller.

A. NodeMCU

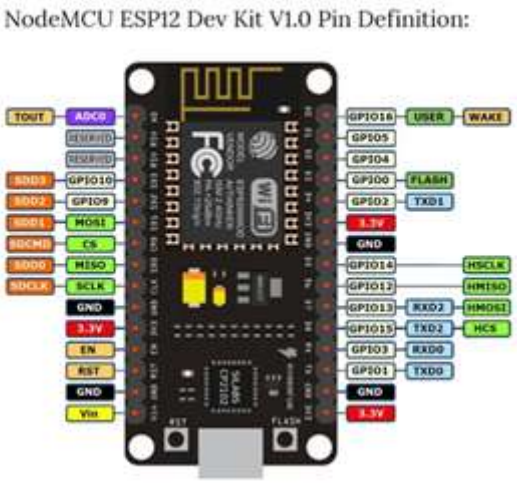

Figure 2: NodeMCU

It is an Arduino board which can be used for transmitting sensor data on the website for that it uses HTTP and MQTT protocol. It has an in built WIFI module (ESP8266) for that purpose. It has a public view for everyone to view the stored data and the graphs, it can be accessed only by link. It even has a private view which can be only be viewed by authorized person after login. When the website is created it generates an API key which can be shared and accordingly, we will can insert sensor data in it. It has 1 analog pin and 8 digital pins for programming with different sensor. IT even has a TX and RX pin for communication with different boards. It requires 3V of power supply which can be provided by any type-b charging wire. But if a 5 volts supply is provided then the board would heat up and stop working.

B. GSM module

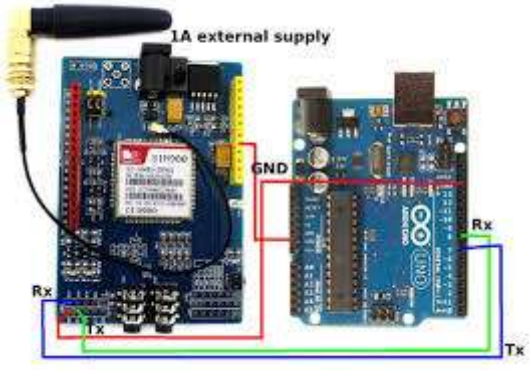

Figure 3: GSM module

It consists of a chip or circuit for connection with the GSM. It uses 2G sim card. This connection can be made with the help of a mobile phone or by using a computer. The status of GSM module is indicated by led blinking. Blinking every 1 second means the GSM module is working but hasn't connected. Blinking every 2 seconds means requested data connection is active. Blinking every 3 seconds means it has made contact with the cellular network.

C. Servo motor

Figure :4 Servo motor

Servo Motor is a motor which converts the electric energy into mechanical steps. A Servo motor can rotate 180 degrees. It requires PWM pin for input (Example: digital pin 6,8). It is basically a DC motor with a variable resistor and some gears. It is useful when we want to rotate our motor at particular angle only.

D. RFID Reader

Figure 5: EM-18 RFID reader

It is a reader which reads data from the RFID card. When a RFID card is brought near this reader then the card gets energized and starts transmitting its value which it reads. It has 8 pins out of which VCC, Ground, 2 output pins, sel pin are used. Every RFID card contains 26 characters.

E. Ultrasonic sensor

Figure 6: Ultrasonic sensor

This component works at a frequency of 40Hz. It can measure distance between 2 - 400 cm. It consists a transmitter and a receiver. Distance can be found as we know the speed of the ultrasonic frequency and the time taken. The major advantage of ultrasonic sensor over IR sensor is that sunlight doesn't affect its reading.

F. Light emitting diode

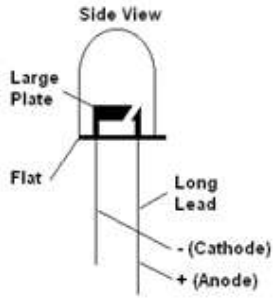

Figure 7: LED

LED known as light emitting diode glows when current is passed through it. It is a semiconductor device. This effect is due to electroluminescence. Electroluminescence occurs when electrons in the semiconductor recombines with electron holes, releasing energy in the form of photons. They are available in different colors. These colors are determined by the energy required for electrons to cross the band gap of the semiconductor.

G. Float switch

Figure 8: Float switch [15]

It is a type of level sensor mainly used for detection of the level of liquid filled in a particular drum or tank. It can be used in various ways like an alarm or an alert when the tank is full. In E-toilet, it can detect if the water level has gone below a certain limit.

H. Buzzer

Figure 9: Buzzer

A buzzer can be mechanical, electro-mechanical, or piezo-electric. Warning systems, user clocks, etc. include the usage of buzzers. We can change its frequency by changing its input voltage. It ranges from 0-255.

I. DC Motor

Figure 10: DC motor

It converts electrical energy into mechanical energy. This motor is bidirectional. It requires a separate motor driver to amplify the output current.

J. Smoke detector

Figure 11: Smoke detector

A smoke sensor uses a radioactive material placed between the two electrically charged plates which ionizes the air between them but when smoke is detected it disrupts the flow of current this change is noted which determines the amount of smoke around. We should handle this sensor with care as it gets hot after a few minutes of use.

K. Ammonia sensor

Figure 12: Ammonia sensor

The working of ammonia sensor is similar to that of Smoke sensor just the change in value of disruption is different which accounts to the presence of ammonia. Even ammonia sensor must be handled with care as it heats up after a few minutes of working.

L. LCD 16*4

Figure 13: LCD 16*4

A 16*4 display is used to print any message. It supports 255 different characters everything from ASCII, digits and even some Japanese. The grid used to display individual character is a set of 5*8 pixel.

M. IR Sensor

Figure 14: IR sensor

Infrared sensor or IR sensor is an electronic device which can detect the surrounding objects. It is generally used to measure heat or detect the motions. The infrared spectrum emits some kind of thermal energy which can only be detected by IR sensors. These energies are invisible to our eyes.IR consists of 2 parts

1. Emitter: It is an IR LED
2. Detector: It is simply a photodiode which is sensitive to the IR light of same wavelength which is emitted by IR LED.

When IR light falls on the photodiode, the resistances and these outputs change in proportion to the magnitude of the IR light received.

II. COMPONENT DIAGRAM

A. E-toilet component diagram

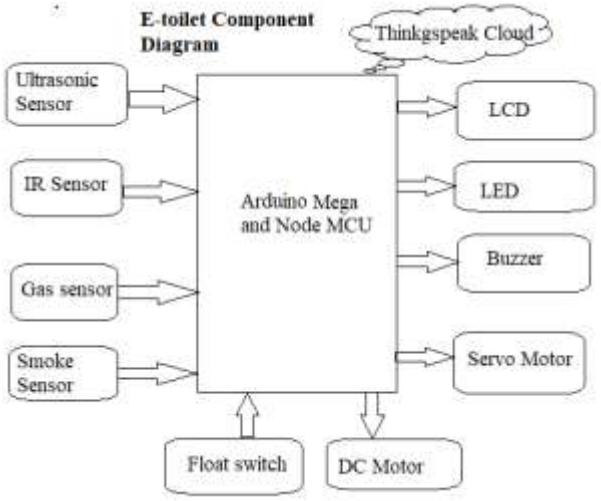

Figure 15: E-toilet component diagram

This is the basic block diagram of how the system will work and the sensors and other components have also been mentioned in the given diagram above. Arduino Mega and NodeMCU will be used as the brain of the whole system. Ultrasonic sensor, IR sensor, ammonia sensor, float switch and smoke sensor are the input components that will send the data to Arduino Mega and NodeMCU. The ultrasonic sensor is used to measure the distance and after measuring it will send the data to the microcontroller. IR sensor is also used for measuring the distance but the difference between the IR sensor and the ultrasonic sensor is that the IR sensor gets easily affected by sunlight and so its accuracy decreases in front of sunlight. Therefore, IR sensors are used at only those places where the exposure to sunlight is minimal. The main reason for smoke sensors is to provide security to the system from catching fire and stop people from smoking. These sensors sense the gases and updates to Thingspeak cloud through Arduino mega and NodeMCU. A float switch is required to check if the tank has sufficient amount of water.

The output components for this system are LCD, LED, Buzzer, Servo Motor and DC Motor. The LCD displays whether the Toilet is in working condition or not. LED glows and dims as the person enters and exits which will be detected by ultrasonic/IR sensor. As previously mentioned, that smoke sensor updates the information on the cloud but along with that a buzzer makes a sound to alarm nearby people to stay away and take some measures. Servo motor is to control the flow of water. DC Motor is used for the exhaust fan so that no foul smell is left and if any smell is detected by the ammonia sensor then it will check if no one is inside, then auto cleaning is done so that the toilet is usable.

Thing speak cloud is used to store and analyse data that which area requires more cleaning or more toilets and also to alert the authorities if any smoke is detected.

B. E-dustbin component diagram

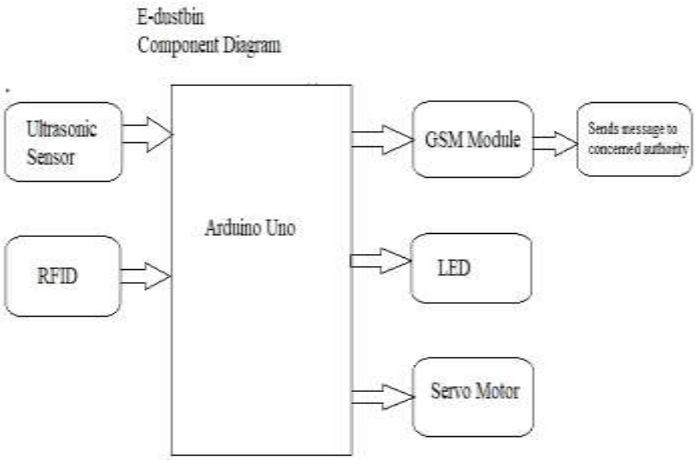

Figure 16: E-dustbin component diagram

Here, the block diagram of E-dustbin includes components which are connected to each other in order to complete the circuit. The microcontroller used for this system is Arduino Mega. The input components for this system are RFID and Ultrasonic Sensor. Ultrasonic sensors are again for contactless opening and closing of the lid as well as for measuring the amount of garbage filled. This information is sent to Arduino Uno for further processing. RFID tag is used when the bin is completely filled and authorities come to open the bin. This is used for the identification of authority. The output components are GSM module, LED and Servo Motor. The GSM Module is used to send messages. LED is used to provide information how much the bin is filled and the servo motor is for opening and closing of the lid.

*III.***WORKING**

Flow chart of E-Toilet

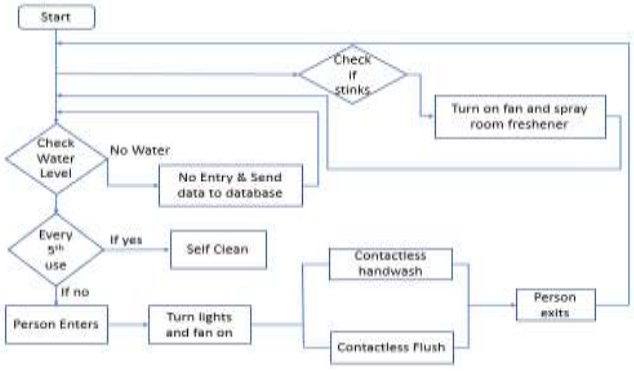

Figure 17: E-toilet Flowchart

A. E-toilet

Here, when a person enters the toilet, it will be sensed by the ultrasonic sensor and the lights and fan will be switched on automatically and will be switched off when the person leaves. Also, with the help of an IR sensor, there is a contactless hand wash and flush. The ammonia sensor senses the ammonia stink and automatically sprays the room freshener. Smoke sensor is also included to make sure that no one smokes in the toilet. Whenever the floor has to be cleaned, it would check if no one is inside then the door automatically gets locked.

The proposed system works on odd number algorithms. Whenever a person enters or exits our E-toilet a counter is incremented by 1. First person enters and the counter is equal to one and when he/she exits the counter is incremented to two. So, when the count is 10 i.e., 5 persons have used the toilet, the door automatically gets locked for cleaning purposes. We made sure that our washbasin was directly above the flush tank so that the same water can be reused. Thinkspeak connection is used for the detection of ammonia and smoke at the admin side. The water-level is also detected using float switch and if enough water is not available then it gives a signal that the admin side via database and it will display a apology message for no water on LCD display and the door won't open if there is no one inside.

B. E-dustbin

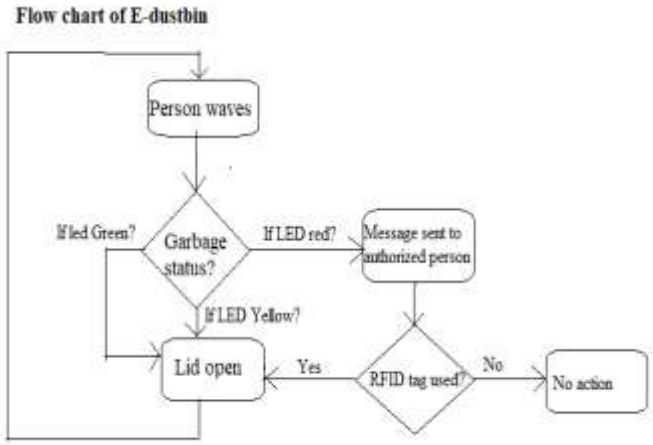

Figure 18: E-dustbin Flowchart

Whenever a person gestures his hands over the lid of the dustbin, the ultrasonic sensor senses it and opens the lid. The opening of the lid depends on the depth of the garbage present in the dustbin. For that purpose, a LED is used to show the status of the depth of the garbage. The depth of the garbage in the dustbin is measured using the ultrasonic sensor. When the dustbin is empty, the LED glows green while when the bin is half filled the status of the garbage is set to orange. When the garbage reaches till the lid of the dustbin, the LED glows red. After the dustbin is full of garbage, the lid automatically shuts. Only the person from the cleaning authority will be able to open the lid so that they can empty the garbage and make the dustbin available for other garbage. The lid will be opened only with the help of RFID tag. In this way, the mechanism of E-dustbin works.

RESULT

Table 1 Results

Condition	Successful/Unsuccessful	Comment
Ultrasonic sensor distance detection	Successful	The distance is measured correctly in 9/10 cases giving an accuracy of 90%
Ammonia detection	Successful	Ammonia is measured sensed in 8/10 cases giving an accuracy of 80%
Smoke Detection	Successful	Smoked is sensed correctly in 8/10 cases giving an accuracy of 80%
GSM message sending	Successful	A message is sent correctly in 10/10 cases giving accuracy of 100%
RFID recognizing tag	Successful	RFID tag is recognized by RFID card reader in 10/10 cases giving an accuracy of 100%
IR Sensor distance measurement.	Successful	The distance is measured correctly in 8/10 cases giving an accuracy of 80%
Updating data to Thingspeak	Successful	Data is updated to Thingspeak after every 15 seconds in 10/10 cases giving accuracy of 100%

CONCLUSIONS

Models E-toilet and E-dustbin were built successfully and were found highly efficient. The sensors gave expected and accurate results. The response time of the system was high and it fulfilled the requirements of cleanliness and hygiene. This system can be widely used in pandemic situations to avoid spread of the virus.

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