ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijircce.com

Vol. 5, Issue 9, September 2017

Smart Waste Collection System based on IoT (Internet of Things)

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ABSTRACT: As we see the population is increasing day by day, the environment should be hygienic and clean. In the vast majority of the urban communities the flooded dustbins are making an unhygienic environment. This will additionally prompt the emerge of various types of diseases. This will debase the way of life. To beat these circumstances a smart waste collection system has to be developed. which can be monitored remotely and should have alert and make system efficient by automation to great extent with IOT As the extent of IoT is creating step by step viable strategies can be discovered effortlessly. Different plans were proposed and have favorable circumstances and also detriments. This paper is an overview in view of Smart Waste Collection System in based on IoT.

KEYWORDS: : IoT, Raspberry pi, Node.js, MQTT, Mosquitto

I. INTRODUCTION

Now a days we are experiencing a fast development of Smart Cities where Cities around the world are on the run to become smarter, but due to this development the quantity of waste & garbage is increases day by day. Garbage management is becoming a global problem. Due to the absence of care and consideration by the specialists the dustbins are generally appear to be flooding. It must be taken into mind by comparing experts and should think what technique can be taken after to beat this. IoT Based Smart Waste Collection System create to defeat the circumstance of floods rubbish receptacles in the diverse urban communities. The Internet of things (IoT) is the inter-networking of physical devices. This system depends on IoT(Internet of things).This system is simulated in a realistic scenario in the city, and utilizing openly accessible geo area information of the municipality owned dustbins.

II. RELATED WORK

The paper [1] proposed waste gathering system depends on waste level information from trashcans in a metropolitan zone. The information gathered by sensors is sent over the web to a server where it is put away and prepared. He gathered information is then utilized for checking and improving the day by day determination of trashcans to be gathered, ascertaining the courses likewise. Consistently, the specialists get the recently figured courses in their route. The key feature of this system is that it is designed to learn from experience and to make decisions not only on the day by day waste level status as well as on future state figure, activity blockage, adjusted cost-productivity capacities, and other influencing factors that from the earlier people can't anticipate.. The rate at which trashcans are being filled can be examined based on historical data.

Another technique [2], there are various dustbins situated all through the city or the Campus, these dustbins are given minimal effort implanted devices which helps in following the level of the refuse canisters and a remarkable ID will be accommodated each dustbin in the city with the goal that it is anything but difficult to recognize which junk receptacle is full. The venture module is partitioned into two sections Transmitter area and recipient segment. Here in the transmitter area we are utilizing 8051 microcontrollers, RF Transmitter and sensors these are joined to the dustbin. Where sensor is utilized to identify the level in the dustbin whether the dustbin is full or purge. The sensor detects the substance of the dustbin and sends the signs or the information to the 8051 microcontroller, Power Supply +9V Battery control supply is given to the 8051 microcontroller to drive the framework and the 8051 microcontroller peruses the

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information from the sensor and process the information gotten from sensor, and similar information remotely transmitted to the Central framework (Intel Galileo microcontroller) utilizing RF Transmitted. RF Transmitter is to transmit the flag frame 8051 microcontroller to the Intel Galileo microcontroller. Here RF Receiver is utilized to get the information sent by RF transmitter to the Intel Galileo microcontroller. The Intel Galileo Gen2 Microcontroller is utilized to get the information sent by the various transmitters and process the information and similar information transmitted to the Client i.e., Web Browser. In any case, similarly the quantity of parts utilized is all the more, for example, 8051 microcontrollers, IR sensors that make an over the top cost and complex codes.

Another technique [3] is that, Once the waste achieves the threshold level ultrasonic sensor will trigger the GSM modem which will constantly alarm the required expert until the point that the waste in the dustbin is squashed. Once the dustbin is squashed, individuals can reuse the dustbin. At standard interims dustbin will be squashed. In this strategy, GSM 900A modem is utilized to send the messages. It comprises of a GSM/GPRS modem with standard correspondence interfaces like RS-232 (Serial Port), USB, so it can be effectively associated with alternate devices. The ultrasonic sensor is utilized to discover the stature Of waste filled at various interims of time. They use three sensors at various heights like h/3, 2h/3 and h, where h is the height of the bin but to make it affordable and to achieve the same results, only one sensor is placed at surface level. This system has various features such as durability, affordability, prevention against damage and maintenance issues. But they require a more amount of machines and labours.

Another technique for waste management is presented [4] as follows. A dustbin is interfaced with microcontroller based system having IR wireless system alongside central system indicating current status of waste, on portable web browser with html page by Wi-Fi. Consequently the status will be refreshed on to the html page. There by to low the human resources and endeavors alongside the upgrade of a smart city vision. Considering the need of current innovation, the smart waste container can costly yet considering the need of dustbin required in India, there for they utilized based sensors to decrease its cost and furthermore make it productive in applications, and at the sender side they utilized just a Wi-Fi module to send and get information. But since of the utilization of weight sensor for recognition of measure the waste in dustbin. It will just identify the heaviness of waste; not how much level it is of. The message can be sent straightforwardly to the cleaning vehicle rather than the contractor worker's office. Hence dustbins are overseen. A Geographical Information System (GIS) transportation demonstrate for strong waste gathering that explains plans for squander capacity, accumulation and transfer has been proposed in for the city of Aansol in India. An improved directing and planning waste accumulation display is proposed for the Eastern Finland, including the use of a guided variable neighborhood thresholding met heuristic. The point of the examination was to build up an ideal timetable for trucks on characterized accumulation courses. The information from the receptacles are handled in the DSS and on the off chance that it is right it is sent to coordinators of waste gathering in this specific place and to the street police. The truck driver doesn't sit idle for holding up, he/she goes to the following point and the course is progressively described. At the point when the issue is illuminated the framework relates the course for one of the accessible trucks and the waste from opened receptacle is gathered. It is joined with dynamic steering calculations to boost the effectiveness of waste accumulation..

In paper [5] Infrared sensor (IR sensor) is utilized which is a multipurpose sensor, which can distinguish the level of trash. IR sensor discharges the light, which is imperceptible to exposed eye however the electronic parts can identify it. It comprises of IR transmitter and IR collector. The yield of IR sensor is gained by The National Instruments myrio-1900. It is an information yield gadget which is compact and reconfigurable. USB goes about as a connector between the NI myrio-1900 and have PC. It has connectors An and B that goes about as a development port and a connector C that go about as a scaled down framework port, they convey the signs and these signs are recognized by various connector names. Sensor detects level of the canister. The GUI gives the yield of what level of waste is filled. Sensor detects level of the container. The graphical portrayal to get to the yield of the sensor is as demonstrated as follows. It gives the yield of what level of waste is filled. At the point when the level in a canister is achieved the edge, the LED put at the area of the receptacle begins flickering. At the point when the squinting LED is clicked, a show opens demonstrating the area of the receptacle, status of the container, information and time when the canister gets filled, versatile number and the content to send to the concerned individual. In any case, this framework does not guarantee whether waste is cleaned or not and transportation cost is another issue.

In Paper [6] System monitors the dust bins and informs about the level of waste collected in the dustbins via a website page. For this the system uses ultrasonic sensors placed over the bins to detect the waste level and compare it with the

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dustbins depth. The system make utilization of AVR family microcontroller, LCD screen, Wi-Fi modem for sending information and a buzzer. The system is controlled by a 12V transformer. The LCD screen is used to show the status of the level of waste collected in the dustbins. While a web page is built to display the status to the user checking it. The web page gives a graphical perspective of the dustbins and highlights the waste gathered in colour in order to show the level of waste collected. The LCD screen display the status of the waste level. The system puts on the buzzer when the threshold level crossed. Thus this system keeps the city clean by giving information about the waste levels of the dustbins by providing graphical picture of the dustbins via a website page.

In paper [7], A Geographical Information System (GIS) transportation display for strong waste accumulation that expounds plans for squander capacity, gathering and transfer has been proposed in [7] for the city of Asansol in India. An improved steering and planning waste accumulation display is proposed for the Eastern Finland, highlighting the use of a guided variable neighborhood thresholding met heuristic. The point of the exploration was to build up an ideal timetable for trucks on characterized accumulation courses. The information from the receptacles are prepared in the DSS and in the event that it is right it is sent to coordinators of waste gathering in this specific place and to the street police. The truck driver doesn't sit idle for holding up, he/she goes to the following point and the course is progressively described. At the point when the issue is fathomed the sysrem describes the course for one of the accessible trucks and the waste from opened receptacle is gathered. It is consolidated with dynamic routing algorithms to boost the effectiveness of waste gathering.

In paper [8] assures the cleaning of dustbins soon when the waste level cross the set limit. In his management system (Internet Of Things) as the working in the field for networked radio-frequency identification (RFID), tracking the collection vehicle, Dustbin monitoring and other emerging sensing technologies. The IR sensor is goes as level detector. The assures a low budget by changing all light traffic servers into Raspberry Pi. The sensor senses the waste of the dustbin and sends the signals or the information to the ARM microcontroller then the microcontroller reads the information from the sensor and process the information received from sensor, and the same information will send to Dashboard section and this section send mail/message to respective authority person or waste collecting vehicle. If the dustbin is not cleaned in giving time, then the record is sent to the higher authority who can take necessary action against the concerned person. This system also helps to reduce the corruption in the overall management system.

III. PROBLEM STATEMENT

As we have seen number of times the dustbins are getting overflow and concern person don't get the Information within a time and due to which unsanitary condition formed in the surroundings, at the same time bad smell spread out due to waste, bad look of the city which paves the way for air pollution and to some harmful diseases around the locality which is easily spreadable.

Problems in Existing Systems

- So many dustbins in the city not filled by the waste, higher authorities not even aware about this.
- Trucks visit one location again and again in a same day.
- Time consuming and less effective.
- Trucks visit empty dustbins so many times due to lack of communication.
- More traffic and Noise.
- Difficult to find which dustbin is filled or empty.
- Cost of existing systems is very high.

IV. PROPOSED WORK

- Literature survey has been performed for collecting the details of Smart Waste Collection System based on IoT and to find out effective methods which are useful for providing hygiene environment in cities.
- All the existing system work on single level that means they only shows that garbage bin is filled or empty then the system send the status of the garbage bins to the authorities.
- Proposed system is four tier system . This system consist smart dustbins, Mini trucks, Large truck, Controller, Administrative console.

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STEPS:-

i. Check dustbins is filled with the waste or not , in particular time interval each dustbin share there status to the truck who hold the key. If waste in the dustbins cross the threshold then the status of each dustbins is send to the primary truck.

ii. Primary truck finds the shortest path for all the dustbins which filled with the waste, Identified route and all filled dustbins marked locked, and the key is transferred to the secondary truck now secondary truck able to communicate with the dustbins.

iii. Then Primary truck collect the waste of all the dustbins and that collected waste is transferred to large truck standing somewhere in the city.

iv. Now same process is followed by secondary truck and tertiary truck and key regularly rotated from primary truck to secondary truck, secondary truck to tertiary truck then tertiary to primary truck and all the waste is transferred to the large truck.

v. If dustbins not filled by the waste for a long time so this system notifies the authorities regarding the status of the dustbin which is empty for a long time.

vi. If trucks not visited the location of overflow dustbins on the given time so automatically this system notify the authorities, If the authorities not take any action regarding this complains so this system send the information to the higher authorities.

Pseudo code:

1. Start
2. Entities:
   i. Dustbins : D1, D2, D3 ... Dn;
   ii. Trucks : T1, T2, T3;
   iii.Key : K;
   iv. Controller : C; // C has:
   arrayOfDustbinsIds[D1, D2, D3..] &
   arrayOfTrucksIds[T1, T2, T3] &
   map<key,truck>.
   v. Authorities : A;
3. i. C puts map<key, T1>; // Truck having key will collect the waste and getting notified by dustbins.
   ii.C sends T1-ID to arrayOfDustbinsIds[]; // Dustbins knows to whome I have to send signal once filled.
4. if Dustbin fills > threshold
   then Dx notifies T1 : x = 1 || 2|| 3...||n;
   and notifies C : C removes Dx from arrayOfDustbinsIds[];
5. if T1's Dustbin count == 10 // count reaches to 10
   then T1 notifies C and calculates shortest path to reach dustbins to collect waste.
   5.1. if T1.locationFlag != true // this flag becomes true when T1 reaches to Dx location for collecting waste
   then T1 calls notify Authority A
   else continue
   after getting emptied Dx notifies to C to add in arrayOfDustbinsIds[]
   then after dumping all the waste when truck returns then T1 notifies C.
   then C adds T1 in arrayOfTrucksIds[]
6. C : removes T1 from arrayOfTrucksIds[];
7. C : Repeat step 3.ii // with map<key, T2>. C fetches here next truck available in arrayOfTrucksIds[] and puts in the map.
8. Stop

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Vol. 5, Issue 9, September 2017

V. PLATFORM

- Node.Js
- Raspberry pi 3
- Raspbian
- Mosquitto Server

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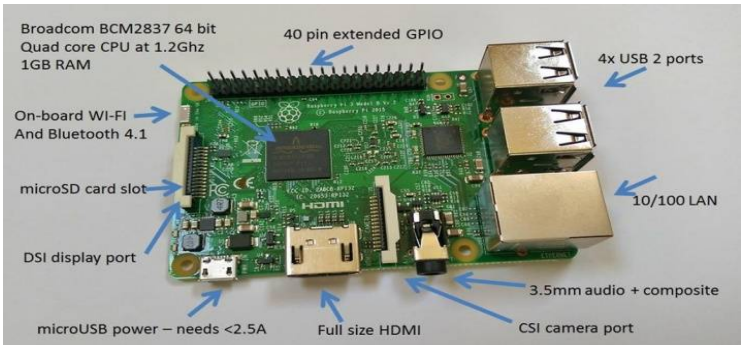
Node.Js:

Node.js isan open-source, cross-Platform JavaScript run-time environment for executing JavaScript code server-side. Historically, JavaScript was used primarily for client-side scripting, in which scripts written in JavaScript are embedded in a webpage's HTML, to be run client-side by a JavaScript engine in the user's web browser. Node.js enables JavaScript to be used for server-side scripting, and runs scripts server-side to produce dynamic web page content *before* the page is sent to the user's web browser. Consequently, Node.js has become one of the foundational elements of the "JavaScript everywhere" paradigm, allowing web application development to unify around a single programming language, rather than rely on a different language for writing server side scripts. Though .js is the conventional filename extension for JavaScript code, the name "Node.js" does not refer to a particular file in this context and is merely the name of the product. Node.js has an event-driven architecture capable of asynchronous I/O. These design choices aim to optimize throughput and scalability in Web applications with many input/output operations, as well as for real-time Web applications (e.g., real-time communication programs and browser games)[11].

Raspberry Pi3:

Several generations of Raspberry Pis have been released. The first generation (**Raspberry Pi 1 Model B**) was released in February 2012. It was followed by the simpler and cheaper **Model A**. In 2014, the Foundation released a board with an improved design in **Raspberry Pi 1 Model B+**. These boards are approximately credit-card sized and represent the standard *mainline* form-factor. Improved A+ and B+ models were released a year later. A "Compute Module" was released in April 2014 for embedded applications. The **Raspberry Pi 2** which added more RAM was released in February 2015. A **Raspberry Pi Zero** with smaller size and reduced input/output (I/O) and general-purpose input/output(GPIO) capabilities was released in November 2015 for US$5. **Raspberry Pi 3 Model B** released in February 2016 and is bundled with on-board WiFi, Bluetooth and USB boot capabilities. As of January 2017, **Raspberry Pi 3 Model B** is the newest mainline Raspberry Pi. Raspberry Pi boards are priced between US$5–35. On 28 February 2017, the **Raspberry Pi Zero W** was launched, which is identical to the Raspberry Pi Zero, but has the Wi-Fi and Bluetooth functionality of the Raspberry Pi 3 for US$10[10].



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Raspbian:

Raspbian is a Debian-based computer operating system for Raspberry Pi. Since 2015 it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the family of Raspberry Pi single-board computers[10].

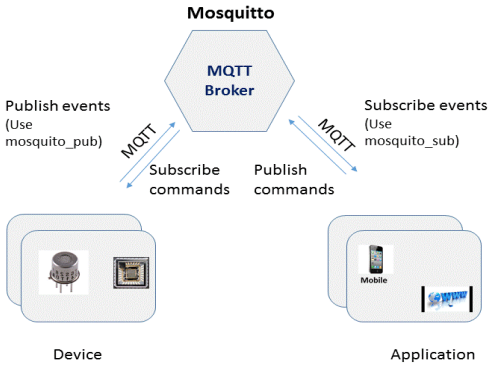
Mosquitto Server:

MQT(Message Queue Telemetry Transport) is an ISO standard (ISO/IEC PRF 20922) publish-subscribe-based "lightweight" messaging protocol for use on top of the TCP/IP protocol. It is designed for connections with remote locations where a "small code footprint" is required or the network bandwidth is limited. The publish-subscribe messaging pattern requires a message broker. The broker is responsible for distributing messages to interested clients based on the topic of a message. Andy Stanford-Clark and Arlen Nipper of Cirrus Link authored the first version of the protocol in 1999.

The specification does not specify the meaning of "small code footprint" or the meaning of "limited network bandwidth". Thus, the protocol's availability for use depends on the context. In 2013, IBM submitted MQTT v3.1 to the OASIS specification body with a charter that ensured only minor changes to the specification could be accepted. MQTT-SN is a variation of the main protocol aimed at embedded devices on non-TCP/IP networks, such as ZigBee.

Historically, the "MQ" in "MQTT" came from IBM's MQ Series message queuing product line. However, queuing itself is not required to be supported as a standard feature in all situations.

Alternative protocols include the Advanced Message Queuing Protocol (AMQP), Streaming Text Oriented Messaging Protocol (STOMP) the IETF Constrained Application Protocol, XMPP and Web Application Messaging Protocol (WAMP).



MQTT Method:

MQTT defines methods (sometimes referred to as *verbs*) to indicate the desired action to be performed on the identified resource. What this resource represents, whether pre-existing data or data that is generated dynamically, depends on the implementation of the server. Often, the resource corresponds to a file or the output of an executable residing on the server[12].

Connect

Waits for a connection to be established with the server.

Disconnect

Waits for the MQTT client to finish any work it must do, and for the TCP/IP session to disconnect.

Subscribe

Waits for completion of the Subscribe or Unsubscribe method.

Unsubscribe

Requests the server unsubscribe the client from one or more topics.

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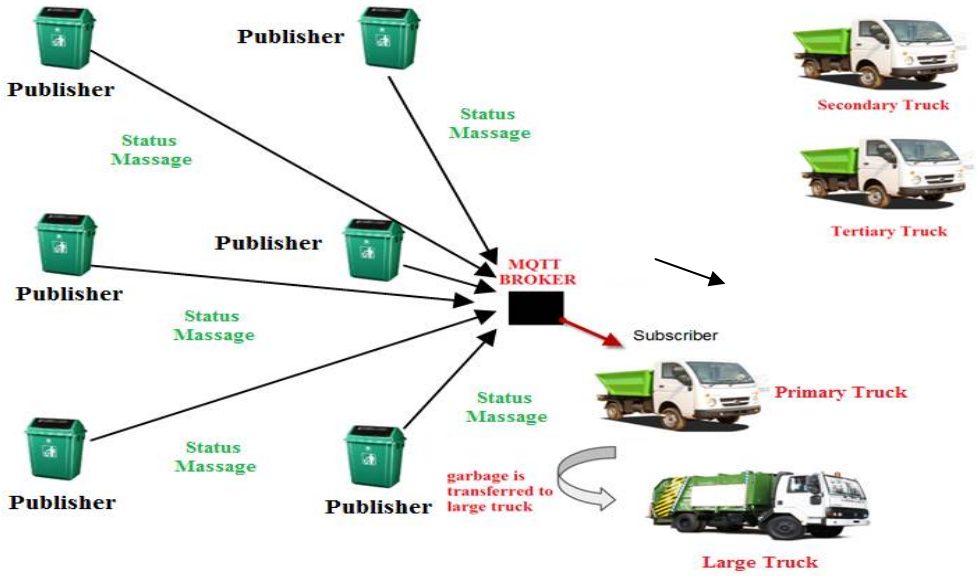
Publish
Returns immediately to the application thread after passing the request to the MQTT client.

VI. IMPLEMENTATION

1. Raspberry Pi installed over mini truck will have Mosquitto Server installed. Along with necessary perquisites.
2. Mini truck raspberry pi will act as subscriber for method named "Garbage".
3. All nearby dustbin raspberry pi will be publisher for method named "Garbage".
4. Whenever any dustbin will be in full status, it will publish garbage method.
5. The active mini truck will receive all massages at a particular time from all full status dustbins.
6. The massages will have dustbins ID's whose fixed location is in mini truck raspberry pi database.
7. The mini truck will navigate according to decided path and collect garbage and dustbins status is set to empty.
8.



VII. COMPARISON OF EXISTING AND PROPOSED WORK

S.NO.	PARAMETERS	EXISTING WORK	PROPOSED WORK
1.	DUSTBIN STATUS	BASED ON HISTORICAL DATA(Around two years of historic data)	BASED ON CURRUNT STATUS(In real time)
2.	TIER	SINGLE TIER (Only dustbins filled or empty status is received at authority admin console.)	FOUR TIER (The system is automated at dustbin tier, mini truck tier & admin console, large truck management is kept manual.)

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3.	FUEL CONSUMPTION	SUBJECT TO WORKING BASED ON HISTORIC DATA, IMPROOVEMENT NOT UPTO LARGE EXTENT	LOW(Since key control is rotatedly transferred between available mini trucks so only one mini truck move at a time.)
4.	ROUTE OPTIMIZATION	BASED ON HISTORICAL DATA	BASED ON REAL TIME ALEART OF FILLED DUSTBINS
5.	TRUCK VISITING	VISIT FILLED DUSTBINS AS WELL AS EMPTY DUSTBINS	VISIT ONLY FILLED DUSTBINS
6.	IGNORED DUSTBINS IDENTIFICATION	THERE IS NO MACHANISM AVAILABLE	TWO CASES ARE IDENTIFIED A. DUSTBINS NOT FILLED FOR NUMBER OF DAYS GREATER THAN THRESHOLD LIMIT. B. FILLED DUSTBINS NOT MARKED DUE TO COMMUNICATION FAILURE.

VIII. CONCLUSION AND FUTURE WORK

This implementation has been performed for collecting the details of Smart Waste Collection System based on IoT and to find out effective methods which are useful for providing hygiene environment in cities. As the level of waste in the dustbins crossed the threshold, it will be informed to the corresponding authority, if it was found ignored by the authority then the details will be forwarded to the higher authority to take necessary actions. Thus a hygiene and clean environment can be provided. This survey helps in identifying all possible smart waste collection methods that can be implemented to make city clean.

In relation to future work directions. The mechanism can be enhanced upto one more tier for bigger truck. If identify dustbin having faulty raspberry pi and not working at all so it will be notify to the corresponding authority.

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ISSN(Online): 2320-9801
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International Journal of Innovative Research in Computer and Communication Engineering

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Vol. 5, Issue 9, September 2017

BIOGRAPHY

Dr. Neeraj Shukla was born in Jabalpur (MP), India, in 8 November 1967. He received the B.E. degree in electrical engineering from the Government Engineering College Jabalpur , Madhya Pradesh, India, in 1991, and the M.Tech. in Computer Technology & Application from UIT, Bhopal and Ph.D.degrees in Computer Science & engineering from the Maulana Azad National Institute of Technology, Bhopal (MP), India, in 2006 and 2013, respectively.He joined Gyan Ganga College Of Technology, Jabalpur,Madhyaa Pradesh, India, in 2008. Since 2008, he has been with the, Gyan Ganga College Of Technology, RGPV University, where he is currently a Professor.

Mr. Shashank Shukla was born in Jabalpur (MP), India, in 18 August 1990. He received the B.E. degree in Computer Science & engineering from the Gyan Ganga College Of Technology, Jabalpur , Madhya Pradesh, India, in 2013. Currently he is a Research Scholar in the Computer Science & Engineering Department, Gyan Ganga College of Technology, Jabalpur(MP).