

# IOT Assisted MQTT for Segregation and Monitoring of Waste for Smart Cities

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**Abstract**—In this paper, we propose a design for segregation and monitoring of waste using Message Queuing Telemetry Transport (MQTT) in order to manage the waste collection. Smart waste management is essential for maintaining clean environment. Because, now-a-days unorganized and non-systematic waste collection is the major issue in the society. Therefore, in need of solution to collect waste in effective manner. The solution for this problem is given by embedded IoT system that will monitor the amount of waste deposited, for which an integrated platform where segregation and monitoring of waste have been presented. In segregation part, wastes are separated as dry waste and wet waste and in monitoring part, the bins with dry and wet wastes are embedded with sensors and the level of bin is transmitted via IoT. IoT is the system of interrelated computing devices which transfer data without requiring human to human interaction, it also introduce economical solution for massive data collection. The proprietary communication protocol that is used for transmission is MQTT. This protocol is the very light weight protocol used for messaging, designed with embedded systems, sensors and mobile applications in mind.

**Index Terms**—Segregation, Monitoring, NodeMCU, Telemetry, MQTT broker

## I. INTRODUCTION

There has been a steady increase in Population rate. This results to a plenty of problem. One of the major problems are increase in waste generation, presently India produces 42.0 million tons of wastes per year with less collection efficiency. Improper collection of wastes leads to environment pollution, affects the ecosystem, generates bad odor, which may be the root cause for spreading more diseases. The key issue of improper collection is overflowing of garbage pin at public places.[1]

Recent article said, according to CPCB (Central Pollution Control Board) estimate India generates close to 26,000 tons of plastic per day and a little over 10,000 tonnes a day of plastic wastes remains uncollected. Another survey by TERI (The Energy Resources Institute) has found that almost 90% felt that improper management of wastes in India posed a moderate to severe health risks. This survey covered eight cities including Coimbatore, Delhi, Guwahati, Indore, Jamshedpur, Kanpur, Mumbai and Pune. The main focus for the survey was on the waste related issues. On-behalf of those waste collection issues, close to 50% of people did not have waste properly collected from their houses. Necessary steps should be taken to solve these issues.

This paper brings out the remedy for the collection issue through embedded IoT system. Embedded means a stand-alone device with no operating system which uses microcontroller (executes dedicated tasks assigned by the user) or microprocessor (a programmable device that perform some arithmetic and logical operations) to perform a single job. IoT helps to develop effective methods and systems which bring betterment in human lifestyle and introduces promising and economical solutions; hence it suits in all domains. Thus, embedded IoT system gives remedy for waste collection issue. It consists of two parts as mentioned before, the segregation part and the monitoring part.[2]

In the segregation part, waste is collected and the waste which collected is separated into dry waste and wet waste. The separation involves a mechanical part where waste is travelled through conveyer belt and if it is a moist waste the moisture sensor will detect it and that waste is thrown into the wet bin or else it is thrown to dry bin. The level of these wastes are sensed by ultrasonic sensor and when it reaches

above the threshold level, the level of the waste is transmitted to cloud server through MQTT (Cloud server is a power physical or virtual infrastructure that performs application and information processing storage) where the data can be stored and retrieved anywhere at any time.

MQTT is the light weight, network protocol for publish-subscribe that exchanges the messages between devices. This protocol uses TCP/IP for data transmission. It has very strong delivery guarantees.

There are 3 modes- fire-and-forget (a type of missile guidance), at-least-once and exactly-once. Cloud MQTT is the broker which supports all three modes.

MQTT client is the client, which can be subscribed to the published messages in the garbage system, so that through cloud, any client which subscribed can be able to grab the threshold value at the corporation office (message published). The message can also be viewed in mobile application also.

## II. SEGREGATION PART

The segregation part consists of a waste collection system, Arduino UNO, Arduino IDE moisture sensor, Power supply, DC Motor and Servo motor.

### A. Arduino UNO:

The Arduino UNO is a popularly used open source microcontroller board that contain ATmega 328p microcontroller. It runs on Arduino IDE and it contains a set of digital and analog I/O data pins that are used to interface the board with other electronic components.

TABLE I. ARDUINO DISCRPTION

<b>Operating voltage</b>	<b>5v</b>
<b>DC current</b>	20mA
<b>Input voltage</b>	7 to 20 v
<b>Clock frequency</b>	16MHz
<b>Flash memory</b>	32KB

### B. Arduino IDE:

Arduino is an open-source platform and supported on windows, Linux and MAC OS. Any Arduino board can use this software. NodeMCU a microcontroller unit can also use Arduino IDE. The main code, called sketch, created on the IDE platform will generate a Hex File which is then

transferred and uploaded in the board. The IDE environment contains two parts: editor and compiler. This environment supports C and C++ languages.

### C. Moisture sensor:

The moisture content is above threshold level, then it is a wet waste. The moisture content is measured using two probes. These two probes allow passage of current to object and finds it resistance value and from that moisture content is measured.

### D. Power supply:

The electrical device that supplies electric power is called power supply. It is also defined as the rate at which electrical energy is transferred by the circuit to the load. The main use of power supply is to convert current from a source to voltage, current and frequency in-order to power the load referred as electric power converters. It also performs current limiting for safety aspects, shutting off the current in terms of electrical fault (an abnormal electric current ex. short circuit occurs when current overflows the normal load and open circuit if current is interrupted due to some failure).  $V_{in}$  pin can be used to power external 5V sensors. Logic shifter is connected between sensor and GPIO pin to boost 3V to 5V when there is a need to control 5V sensor with the help of GPIO's NodeMCU.

### E. DC Motor:

A class of rotary electrical machines called DC motors, converting direct current electrical energy into mechanical energy. All DC motors have either electro-mechanical or electronic mechanism to change directions of current periodically. Existing direct current lighting power distribution systems are used to power DC motors. By varying the supply voltage or by changing the strength of current in the field windings, the speed of the motor can be controlled. Here, the DC motor is used to run the conveyer through which the waste thrown is travelled.

### F. Servo motor:

Servomotor is a linear actuator (that creates motion in straight) or rotary actuator (that produces rotary motion or torque) which controls angular or linear position, acceleration and velocity. Actuators are responsible for moving and controlling mechanisms. It consists of three parts: they are,

output sensor, controlled device and feedback system. Even though servo motors are not specific class of motor it is referred as motor suitable for use in closed-loop control system. At the point when the wet waste is recognized by the moisture sensor, servo motor rotates 90 degree. The entryway associated with servomotor will stop the section of waste and toss it into the wet bin. In the event that it is a dry waste the motor stays in the first position.

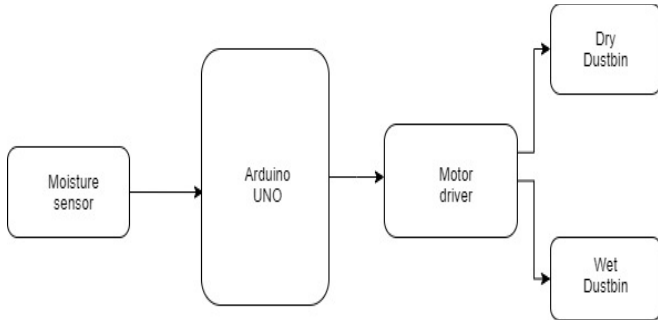


Fig. 2.1. Working of Segregation Part

In this part, the wastes passing through the conveyer are sensed by the moisture sensor. The moisture content sensed (through Arduino IDE) is uploaded to Arduino board. If it exceeds the fixed threshold level, the waste will be considered as wet and servo motor connected with waste collection system will throw out it into the wet bin, in other case, the dry waste will be thrown into dry bin. Thus, segregated waste will be monitored in monitoring part.[3]

### III. MONITORING PART

Monitoring part uses ultrasonic sensor, NodeMCU, MQTT Broker and MQTT Client. The Monitoring part invokes the use of MQTT, which is the light-weight protocol mainly used as machine to machine internet connectivity protocol.[4]

#### A. NODEMCU:

NodeMCU is a microcontroller unit i.e., system on a chip consisting of wi-fi module called ESP8266. Like Arduino, serial communication protocols like UART, SPI are supported by NodeMCU. The application can be developed on NodeMCU using Arduino IDE. On-board Micro USB connector used to supply power to NodeMCU There are 17 GPIO pins, RST and FLASH are on the development board. There is an incorporated LED indicating output which is user programmable.

#### B. ULTRASONIC SENSOR:

Ultrasonic sensor is an sensor which measures the distance of an object by utilizing the ultrasonic sound waves

the transducer is used to send and receive ultrasonic pulses that gives the information about object. The transducer act as a microphone for transmission and reception. The sensor works by sending sound waves, an ultrasonic pulse sends from ultrasonic transmitter travel through air and when there is an obstacle, ultrasonic sound reflects back again to the sensor (ultrasonic receiver module). The distance can be calculated by using travel time and speed of sound in air. There are 4 pins in ultrasonic sensor namely VCC, Trigger, Echo and Gnd.

#### C. MQTT

MQTT stands for Message Queuing Telemetry Transport which is one of the protocols used in IoT. It is light weight messaging protocol with high data rate even at low internet speed. The mechanism of MQTT involves four sections: publish/ subscribe, message, topic and broker.[5]

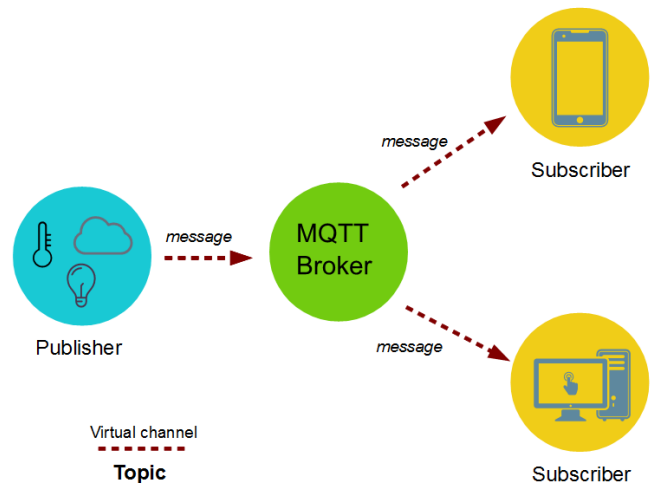
*Publish/subscribe:* During publish, client sends message to broker and client will receive message form broker during subscription.

*Message:* Information that has to be transfer.

*Topic:* Publisher and subscriber access the message through topic.

*Broker:* Clients can communicate through brokers like Cayenne.

One can send commands to control output as well as publish output from sensor to client. The main advantages of using MQTT protocol are high throughput and high delivery



grantee.

Fig. 3.1. MQTT Protocol



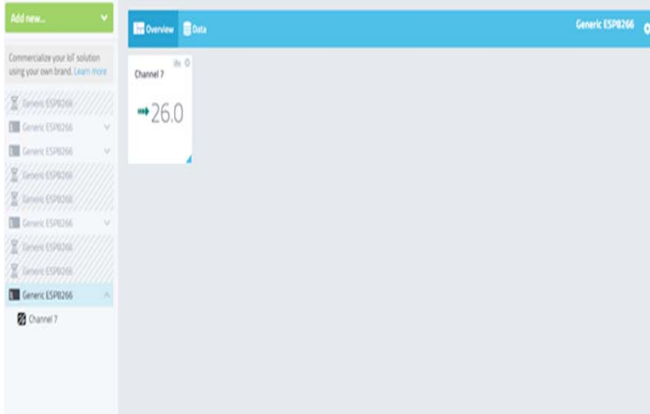


Fig 4.5. Instantaneous Data at MQTT Broker  
(Cayenne server)

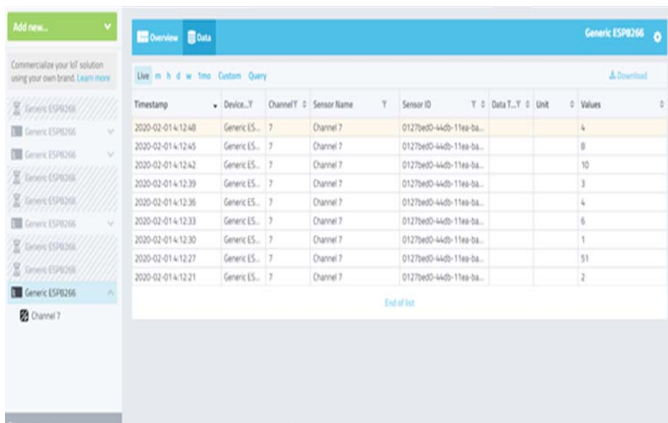


Fig 4.6. Live data stream describing waste level  
(Cayenne server)

## V. CONCLUSION

Every-day, the technological advancements related to development of smart cities are going on. There are many obstacles affecting those developments. One such hindrance is improper collection of wastes. The traditional schemes used were inefficient. The alternate strategy proposed in this paper provided effective collection of wastes, by mostly concentrating on monitoring the level of wastes which in turn reduces the human time and effort which results in healthy surroundings. Thus, the prototype of proposed design for efficient waste management technique was implemented successfully. In future, this paper will encourage others to explore the waste management sector and to develop the robust strategies. With proper support, it is evident to develop this design into a fully functional project for the development of smart cities.

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