

Smart Lavatory

Nighila Ashok¹, Sarangi Subramanayan², Divya P³, Aiswarya E⁴

Assistant Professor, Department of Computer Science and Engineering, Universal Engineering College,
Vallivattom, Thrissur, India¹

B. Tech Student, Department of Computer Science and Engineering, Universal Engineering College,
Vallivattom, Thrissur, India^{2,3,4}

Abstract: In our nation, the sanitation has always been a major issue. In most significantly, this issue is not just concentrated to the rural areas but is also wide spread in urban and semi urban areas. The people do not show the same level of concern when it comes to keeping the public sanitation systems clean as they show towards the ones at their homes. Right to good health and sanitation is one of the goals to be achieved as per the Millennium Development Goals of the United Nations Organization, 2000. However in India, the scenario of public toilets is still dismal. One of the reasons for this is that the people do not bother to clean up after they use the toilet. These places are thus the breeding grounds of bacterial germs like Escherichia coli and many deadly diseases. Many people sometime prefer discomfort to using these toilets. Looking at such troubles, the decision to construct a self-flushing toilet was made that simply utilizes the weight of the person using it as its working mechanism. The system consists of a platform supported on springs and the lever arrangement that flushes after use. The lever is pivoted in such a way that it will lower itself when weight is applied downward and when the load is released, this will strike the flush and hence in this way water is flushed out to clean the toilet. The design is robust and cost effective. Sensors or any kind of electrical transducers are not required in the construction of these toilets. As the old saying goes "cleanliness is next to godliness", this is a public welfare project which aims to propagate a cleaner and hygienic society and hence, take our nation to the heights of glory. The automatic urinal flushing system has been developed in the market for a long time. However, none of them is smart. No information is collected from the traditional automatic urinal flushing system. No one knows how many times it has been used in a day. No operational status is informed unless users have to be present right in front of them.

Keywords: IoT, Smart Toilet, Sensors, Automatic Urinal Flusher, MQTT

I. INTRODUCTION

The project Development of a smart toilet for automatic flushing deals with automatic cleaning of Indian toilets without requiring any human assistance. Most of the public toilets are not clean due to the irresponsible peoples who often enforced to flush the toilet after using it. In India all the state and central government are allotting numerous funds for constructing public toilets. The central government under "SWACH BHARAT MISSION" has built a vast amount of new toilets to provide the citizens a healthy and hygienic environment. Therefore cleaning of public toilets is equally important as cleaning of household toilets. So we have developed a mechanism to flush the toilets automatically by utilizing the human weight. The mechanism does not require any external power or human concern. Rather, it just works mechanically utilizing the weight of the person sitting on it. Some automatic flushing systems do exist in the market, but they are too expensive due to their complex construction. They generally use some optical or electrical sensors to detect the presence of a person using the toilet and accordingly they operate. They are found to be used in airports, shopping malls, multiplex etc. But their use in the public toilets is not possible due to the excessive cost and frequent maintenance. In our papers we seen that when dirt is detected the alarm is raises and user has to clean toilet and when smell detected the sweeper has to come and clean the toilet. And this technique will not useful because the entire user will not clean the toilet bowl. Main problem of this paper is this system is not automatic. And in the absence of the sweeper the cleaning of the toilet is not possible.

II. THEORY

A. MQTT Protocol

MQTT is an ISO standard (ISO/IEC 20922:2016) was presented by Dr. Andy Stanford-Clark of IBM and Arlen Nipper of Arcom (now Eurotech), in 1999. It is a Client Server publish/subscribe messaging transport protocol that lightweight, simple, and easy to implement. MQTT is designed for constrained devices and low-bandwidth, high latency or unreliable networks. In a communication via MQTT protocol, MQTT broker is used to be the distribution of data. It stores, forwards, filters and prioritizes publish requests from the publisher client (the source of data) to the subscriber clients (the consumer of the data). If the publisher publishes the message with the topic data1, the three

subscribers above will receive the message. Otherwise, if the publisher publishes the message with the topic data2, only one subscriber below of the figure will receive the message. To communicate via MQTT protocol, the data generator, e.g., sensor or mobile devices must create the important two components; Topic and Message where the Topics is a string used by the broker to decision which message must be sent to which subscribers. while Message is the string data that the publisher want to publish to their subscribers.

B. IR sensor

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion. Infrared waves are not visible to the human eye. In the electromagnetic spectrum, infrared radiation can be found between the visible and microwave regions. The infrared waves typically have wavelengths between 0.75 and 1000 μ m.

C. Internet of things

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The definition of the Internet of Things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of Things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", covering devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smart phones and smart speakers.

D. Automatic flushing system

A flush urinal-toilet disposes human waste by using water through a drainpipe to another location. A series of urinal-toilets are fitted in offices, malls, multiplexes, educational institutions, bus railway stations, airports, commercial complexes, stadia and other public places. Most have manual flushing systems like push button, trigger, pull chain, etc. however, use of such manually operated flush can spread germs and bacteria when contacted and thus users avoids to flush or lead to wastage of water if used. Now a day's laser or infrared sensor operated flushes is also used in the places of high commercial value and importance but are expensive and required continuous O&M. Therefore, the sanitary facility may remain un-flushed leading to unhygienic conditions and foul smell. Thus need for a low cost automatic flushing apparatus which can flush the right-controlled amount of water and avoid direct contact thus conserving water as well as maintaining personal hygiene and sanitation The present invention relates to a specially designed mechanical automatic urinal-toilet flusher and a mechanism thereof, which utilizes the weight load/pressure of the person using the urinal-toilet for automatic flushing the urinal- toilet with the specified or measured quantity of water to prevent odors, soil drain and scale buildup. It ensures the compulsory, regular and un-intentional flushing of the urinal-toilet without any direct hand contact of the user to the flush and also conserve water at the same time is simple and cheap, which can be fitted-retrofitted to new as well as existing water pipe line of the urinal-toilets

III. RELATED WORK

Here we introduce each papers based on the technologies used in the toilet and this are arranged in technologies bases

The aim of this paper ^[1] is to encourage people about proper toilet management and deliver the message about clean and hygienic toilet. In this paper it introduce the concept of IoT called swatch sit house, it is used to keep the toilet clean and hygienic way. In this paper different sensors are used such as smell sensor dirt sensor, sonic sensor, RFID reader. In the first phase IR sensor is used to identify the dirt present in the toilet and when the dirt is identified then alarm will increase and the user has to clean the toilet. In the second phase smell sensor is used to identify the unwanted gas and the next phase RFID reader is used to identify the sweeper and their activity. In last phase sonic sensor is used to detect the depth of the septic tank. The drawback of this paper is that toilet cleaning is not automated.

The aim of the paper ^[2] is to investigate how much clean water should be used to clean a toilet bowl in one of the public toilet. The data is taken from automatic toilet bowl flushing system and used to avoid wasting clean water and yet still provide enough water flow to clean a toilet bowl. Here different sensors are using infrared sensor, solenoid valve, ESP chip, broker and daemon. The infrared sensor is used for measuring the distsance between the sensor and user and also sends the measured data to the ESP chip which is a microcontroller .when the user leaves toilet bowl the ESP chip will send a command to solenoid flush valve to release clean water to flush the toilet bowl. After this it will send the usage data to the MQTT broker .the advantage of this paper is giving awareness among people about saving water and the drawback of the paper is it does not tell the amount of water is released.

This paper ^[3] is discus about automatic urinal flushing system. in the particular public places such as university, students may use water without any consideration of the waste for clean water. The automatic urinal flusher becomes a common devices used in public toilet and this device helps to control the amount of clean water running in urinal in the public toilet while ensuring the urinals are always flushed after it has been used. Here different sensors are used like solenoid, infrared sensor ESP chip raspberry pi and database. The ESP chip is used to control the solenoid and gathering data from an infrared sensor. Each and every time the water has been flushed, ESP informs the raspberry pi board at the server part through MQTT protocol. The raspberry pi is used as an server which runs as MQTT broker, web server and MySQL server. The advantage of this paper is it reduces chances of cross-infection from pressing flushing button and also save the clean water.

Indian railways have 114,500 km of total track over a route of 65000 km and 7500 stations. While travelling by the train everyone expect healthy and hygienic surrounding. Feel uncomfortable due to the waste on the platform and the allied foul smell. Creates bad impression on foreign tourist .sanitation problem cause due to system in which train toilets dispose human waste openly on to tracks. In this work ^[4] they are using two mechanisms. They are sewage disposal mechanisms and track changing mechanisms. In the sewage disposal mechanisms, the ultrasonic sensor and position sensor is used. The ultrasonic sensor can detects the depth of the sewage tank and the position sensor detects the proper place to dispose the sewage. After the proper detection of particular place, the solenoid valve on. Then the sewage disposal is done.

In this work ^[5] Bio toilet tank is human waste disposal mechanism in area with no infrastructure facilities. That is easy to operate alternative to the tradition waste disposal system. In that project are two doors in tank, the one input door and second exit door. The input door is on top of the tank and exit door is assembling inside the tank. The doors are open and close by using pneumatic cylinder. RPM controller is used to measure the speed of the train and transfer those details to proximity sensor, which can sends control over the train; Pneumatic cylinder is control by using RPM controller, Proximity sensor, and Compressed air tank. So, whole system is controlled with train speed. If the train speeds exceed 30 km/h then exit door will open and total waste depositor drop in tracks and input door is close. Input door is open when train is under 30 km/h speed

The main aim of this paper ^[6] will be helpful for promoting the clean India project in majority the paper focuses on the sweepers working activity so that we can stop using contaminated toilets. The required components are turbidity sensors, buzzer, gas sensor, aurdino UNO, GSM, IR sensor and WIFI module. The methodology of the paper can be described in three phases. In the first phase, IR sensor will sense the dirt in the toilet, if dirt presents it will produce a beep sound. So the people should flush the toilet so that can encourage people for good manners in the toilets. In the second phase the gas sensors detects the unwanted gases released inside the toilet, there will be present range set inside. If range increased an alert message will be send to the sweeper .in third phase the turbidity sensor will sense for bacteria's, if its level increased, then also an alert message send to sweeper. It will monitor to sweeper before and after cleaning the toilet. Through this sweeper will realize their roles and responsibility. Advantage of the paper is that using this methodology it makes everyone to strictly flow the cleaning is not possible in the absence of sweeper.

The paper ^[7] developed a smart toilets a public toilet management and encouragement system using Bluetooth low energy beacons and readers. This provides an effective system for management of public toilets in the residents in surrounding area and rewards the people who show good behaviour change. The paper proposed to bring a behavioural change in using toilets. The methodology of the paper concentrates on BLE beacons and readers. The readers will detect the nearby beacons so that we can detect the nearby beacons so that we can detect the presence of specific users at specific locations. At starting we link every beacon id with unique aadar card number of local users so that when they are matched each other they get enrolled .there after whenever the user uses the toilet with that unique card number count will be updated and stored in database and frequency of visit will be updated and stored in database and frequency of visit will be stored in cloud server .the frequency check of every sub toilets are updated and if usage frequency is less than to people per house then a red signal will be given to cleaner ,so the cleaner should clean it .by the end of each month an analysis made ,we find the person with good behaviour change will be reward.

Nowadays smart urinals are available all over the world but neither of them are smart. This paper ^[8] provides a solution for the existing problems related to water scarcity and wastage of water in toilets and unhygienic conditions raised due to bad odours. This paper exactly deals about the automatic flush system. Large no. of people uses toilets but only a few people has the mindset to clean the toilet or to flush the toilet. Due to this mindset, a lot of dirty waste material has to keep inside it. This leads to many diseases caused by bacteria or virus. As a solution this paper introduces smart urinal mech automatic flushes in the toilets system send message to caretaker. The implemented devices help to control the amount of water flowing in urinals in the toilets, so that we can ensure that the urinals are always flushed. The system will also send message to caretaker, in situations of water scarcity in storage tank. So that the caretaker can fill the tank accordingly .it is implemented using Arduino UNO, water level sensors, ultrasonic sensors and odour sensors, relay submersible water pump and gsm module. The advantage for the paper is that it can control the water flow inside urinal and can alert the caretaker if there is water scarcity and it also senses the bad odour using smell sensor and

spread fragrance to remove odour. Disadvantage is that we can't manually understand the water level so that we can prevent situations of water scarcity while using the toilet.

In this work ^[9] says that during the washing process, we lose some water. To save the water, using of the automatic faucet is seemed to be the best way. However, most of automatic faucets are the faucet's turning off delay, but people may have the difference hand washing behaviours. So, the delay may be too slow for some people but it may be too fast for some others. If it is too fast, some washers may wash their hands again because they feel that their hands are not clean. If it is too slow, we lost some water. To solve these problems we have an idea to use the IoT (Internet of things) technology to Increase the performance of the automatic faucets. From the concept of IoT is everything can connect to the Internet, so we can collect some data from everything around us to be used to improve the intelligence of devices e.g. the automatic faucets. The automatic faucet developed on ESP8266 with the infrared sensor to control the solenoid valve. Moreover, we develop the communication between hardware and software to collect the data and control the turning off delay of the faucet. In the part of our software, it includes the MQTT broker to manage publish/subscribe of data. We implement the daemon (implement with python) to subscribe for the data that the hardware publishes to the broker. Moreover, we implement the web application that can publish the delay time to the broker for changing the hardware turning off delay time. The advantage of this is ,it maximize the water saving and the contentment of each group of users.

This paper ^[10] examines one probable way to cut the wastage of clean water used in a public toilet. The system uses MQTT as an underlying communication protocol. The protocol is used in gathering, governing, powerful and correcting the system. The results in the testing environment show that using a flushing duration for 2.5 seconds is enough to satisfy most users while wasting clean water as less as possible. The AFP detects if there is an object in front of its infrared sensor. When a user stands in front of the urinal, an infrared sensor can detect the user. If the user keeps staying in front of the sensor for 3 seconds continuously, it is considered that a user is currently using a urinal. After the urinal has been flushed AFP unit also sends a MQTT message about it usage data to the server part. In server part, it receives the usage data from AFP unit. The usage data will be stored into a database for a future use.

The system ^[11] is controlled and monitored by using programmable logic controller PLC Step 7-200 from Siemens and Supervisory Control and Data Acquisition SCADA systems respectively. The principal component analysis PCA method is applied for clustering and distinguishing among different gases, Home monitoring is a promising technology to deal with the increasing amount of chronically ill patients while ensuring quality of medical care. Most systems available today depend on a high degree of interaction between the user and the device. Especially for people relying on advanced levels of care, this scheme is impracticable. In this paper we are presenting an "intelligent toilet" performing an extensive health check while being as simple to use as a conventional toilet. Main focus of the system is to support the treatment of diabetes and chronic heart failure, but additional applications are possible. Here the sensors like PT1000 sensor, Pressure sensor, and RFID reader are used here. PT1000 sensor used to measure the thigh temperature. Pressure sensor is used measure the pressure of the base portion of the toilet. Using RFID reader is used to sense the particular person result. It needs designing of the base portion of the toilet. It can sense all test results of patients through the toilet usage

The Sanitation plays an important role in a development of the country. This work is ^[12] the developing country like India sanitation has to be taken care seriously as it may affect the growth of future. But in India it has been failed in implementing the techniques for maintaining proper sanitation. The major reason is, most of the Indian population does not have toilet facilities and they do open defecation. One of the best methods to avoid open defecation is that, first to provide the infrastructure facilities where ever necessary. Mostly in northern side of India open defecation is not considered as a different. There mostly men prefer open defecation .The next is maintaining the infrastructure so that it can be used efficiently and effectively by the visitors. The first and the foremost thing is proper and frequent cleaning of the open toilets. So municipality has taken many steps to improve the maintenance of the open toilets, still it is not maintained as expected. Now, they have even started using many technologies to achieve this. So the workers are available or they attempt to do the duties properly, the most important difficulties they face in many places are availability of sufficient water for cleaning the toilets .The various techniques for efficiently using the water for cleaning toilets are discussed. The advantage is that it had done a survey about the techniques proposed in the literature for efficiently maintaining the open toilets.

The main intent of this paper ^[13] is to deliver clean and hygiene toilet awareness among the people. All the public toilets should be clean and hygiene way. In our country, our government has introduced the scheme called "Swachh Bharat" (Clean India). The Keeping toilet uncontaminated is the one of the objective of Clean India scheme. This paper can be helpful to encourage the clean India project. It can show the major part in clean India scheme. In India, changes in statistic and socio-social condition, enhanced wellbeing mindfulness and data innovation have extensively changed the standpoint of medicinal services area. As customers are more aware and educated, quality of healthcare has become a

vital feature in Indian healthcare industry of late. As a solution of this problem we have developed an idea of smart washroom system. This device helps to control the amount of clean water running in urinals in the toilets while ensuring that the urinals are always flushed after it has been used. It also prevents the chances of any infection from pushing flushing button. And if there is a no water the system will send message to the caretaker and with the help of message the caretaker can refill the water to the storage tank for time to time. In this paper, a smart urinal automatic washroom system is proposed. The advantage is ,It will reduce human efforts by automatic cleaning.

In this paper ^[14] will present a smart toilet which does not focus only on a bowl or the wash basin but entire toilet cleaning frequency. Here we are optimizing the resources usage specifically sweeper used in every building. And this implementation involves the complete IoT system from sensory level to data management system with Cloud-based Integration. Here this system is divided into three phases; in first phase is sensory phase. In this phase raspberry pi is act as microcontroller, PIR sensor will detect the user in the toilet and push off button is for sweeper for to press after completing the cleaning. The data's obtained from the sensors will send to the cloud system and it is the second phase and last phase is mobile management phase in this manger can know which toilet is dirty then they will send message to sweeper. And the users also know which toilet is clean. In this method we avoid queue in front of toilet and the drawback is sweeper can mislead the manager.

The main purpose of this work ^[15] is to develop a simple smart green building using IoT, fog and cloud technologies. This system work in both MySQL and NoSQL databases, but choice of the work is depending on our need. To analyse the audio and video data collected in the building along with the images taken in the CCTV. In this work is giving a smart city concept using IoT devices through the help of cloud technology. Here various sensors are used to identify the activity is done in the city. A small prototype of the proposed architecture has been implemented in a lab environment to demonstrate the effectiveness.

This work ^[16] is also a technology of IoT and cloud technology. In this system will explain how to effectively control the home. Here the implementation is possible through flip architecture. And it also as a app for user to control the house. This system is very helpful in monitoring and controlling smart home environment. Here we can check air quality, if the lights are on or not. This system will increase standard of living and drawback is that lack of privacy.

The paper^[17] proposed the a smart toilet that can monitor our physiological parameters including ECGs, body weight and body fat ratio and also provide health management function the electrodes mounted on the smart toilet seat will measure the ECG and bioelectrical impedance. The system uses Bio-impedance techniques as non non invasive, simple and inexpensive method used for body composition study. The system hardware consist of three parts first part is the instrumentation block it measure the weight and it also measures the ECG signal processed using digital filter. The second part is the local computer transmission block that is responsible to transmit data measured from the first block to the remote computer and can provide voice alert and information displayed on graphical interface. The third part is the remote computer end. This part consists of Bluetooth module that receives the information from instrument into the computer that saves and analyses the data. It uses regression analysis to find the correlation, coefficient which help to find weight and bioelectrical impedance. The advantage of the paper is that it can be used in health monitoring to find the current health status of particular person disadvantage is that accuracy of weight and bioelectrical impedance will be changed depending upon the sitting position.

The paper^[18] is concerned about the quality of public toilet facilities in deals with the study of public toilets to ensure the quality of public toilets that matches the technology and economic life of the people there are two common consequences regarding the public toilets the first is there were quality of designs of public facilities as well as air services it includes at public toilets that built in the great expense does not meet its standard second is that people does not try to use public toilets under government rather than prefer toilets available in public places such as restaurants, hotels etc. To find the solution paper introduces a way to have direct talk with public that the prepared questionnaires intent to collect General information about the important problems faced by the people while using public toilets by analysing the responses from people government had taken different actions to encourage use of public toilet and ensure the quality of public toilets the advantage of the paper is that the government can easily find the problems of paper regarding public toilet and sort using different actions according to study new facility such as automatic doors hand dryer devices new cubicles for women's toilets are implemented

This paper ^[19] deals railroad tracks need to be periodically inspected and monitored to ensure safe transportation. It introduced a new algorithm for inspecting railway ties and fasteners that takes advantage of the inherent structure of this problem. We have been able to benefit from scalability advantage of deep convolution neural networks despite the limited amount of training data in some of the classes. This has been possible by setting up multiple tasks and cooperatively training a shared representation that is effective on each of them. We have showed that not only is possible save computation time by reusing the computation of intermediate features, but also that this representation results in better generalization performance than traditional features.

In large areas in our planet, water is a limited resource and with the population growth, there will be a necessity for even more water. This work^[20] is one of the significant water consuming facilities is the flush toilet. We suggest an automatically adjusting of the water amount released in each flush by a facility capable of analysing the content of the toilet bowl and accordingly making a decision how much water should be released in order to wash out this content. Unlike the common flush toilets, the decision about the amount of water will not be between just two options and furthermore this decision will be taken automatically.

IV. CONCLUSION

These papers will create awareness among the people about the proper sanitation. It makes use of Internet of things, which is a rapidly growing technology. And these papers are telling technology used in the toilet. This system will make everyone to strictly follow the cleanliness and proper sanitation in the toilets. It prevents the many new contagious diseases that spread due to improper sanitation of the toilets. Thus by using technologies in the smarter way, we can maintain the cleanliness which is next to the godliness. Keep Clean, Be Safe.

ACKNOWLEDGMENT

We utilize this opportunity to convey our gratitude towards all those who have helped us directly or indirectly for the completion of our work. We deeply and wholeheartedly thank **Mr. Sanal Kumar T S** -HOD, Computer Science and Engineering for his extreme valuable advice and encouragement. We especially thankful to our guide and supervisor **Ms. Nighila Ashok** -Assistant Professor, Computer Science and Engineering for giving me valuable suggestions and critical inputs in the preparation of this paper. We would like to extend our sincere gratitude to all faculty of Computer Science and Engineering department for the support and suggestions that helped us in the development of our work to what it is now. We thank our parents and friends for the mental support provided during the course of our work at the times when our energies were the lowest.

REFERENCES

- [1]. Mrs.K.Elavarasi, Mrs.V.Suganthi , Mrs.J.Jayachitra.DEVELOPING SMART TOILETS USING IOT. International Journal of Pure and Applied Mathematics Volume 119 No. 14 2018, 611-618
- [2]. Klaiwad Boonyakan, Naratsaporn Heamra, Attawit Changkamanon.Water Efficient Toilet: Setting a Suitable Automatic Flushing Duration. The 3rd International Conference on Digital Arts, Media and Technology (ICDAMT2018)
- [3]. K. Osathanunkul, K. Hantarkul, P. Pramokchon, P. Khoenkaw and N. Tantitharanukul, "Design and Implementation of an Automatic Smart Urinal Flusher", International Computer Science and Engineering Conference (ICSEC2016), Chiang Mai, Thailand, Dec, 2016, pp 14-17.
- [4]. A. D. Kadge, A. K. Varute, P. G. Patil, P. R. Belukhi "Automatic Sewage Disposal System for Train", International Journal of Emerging Research in Management & Technology (Volume5, Issue-5), May 2016.
- [5]. Pandya Chintan, Yadav Jatin, Kareliya Sanket, Darshan Adeshara "AUTOMETIC WORKING BIO-TOILET TANK FOR RAILWAY COACHES", International Journal of Advance Engineering and Research Development Volume 2, Issue 10, October -2015C.
- [6]. Mithya V, Divya Prabha.N, Sisma Samlein S, Madhumitha M. Smart Toilets using Turbidity Sensor. International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-5S March, 2019
- [7]. Ms. Nidhi R Mishra, Mr. Paras M Suri, Dr.(Mrs.) Shalu Chopra. Smart Toilets using BLE Beacon Technology. Proceedings of the International Conference on Communication & Electronics Systems (ICCES 2018) IEEE Xplore Part Number:CFP18AWO-ART; ISBN:978-1-5386-4765-3
- [8]. Nafeesa Muntashar, Sahana KN, Saniya Shilledar. SMART URINAL MECH-AUTOMATIC FLUSH. JETIR June 2018, Volume 5, Issue 6
- [9]. K. Hantrakul, P. Pramokchon, P. Khoenkaw, N. Tantitharanukul, and K. Osathanunkul, "Automatic Faucet with Changeable Flow based on MQTT protocol", International Computer Science and Engineering Conference (ICSEC2016), Chiang Mai, Thailand, 14-17 Dec, 2016.
- [10]. Kitisak Osathanunkul, Kittikorn Hantrakul, Part Pramokchon, Paween Khoenkaw and Nasi Tantitharanukul "Configurable Automatic Smart Urinal Flusher based on MQTT Protocol", IEEE 2017.
- [11]. Thomas Schlbusch and Steffen Leonhardt "Intelligent Toilet System for Health Screening" RWTH Aachen University, Pauwelsstr. 20, 52074 Aachen, Germany
- [12]. Shaik A Johny Begam, A.Siva Prabhu, S.Vijay Simha, T.Siva Prasad, Y.Gnana Teja "Design Of Smart Washroom System For Clean And Green Environment", International Journal of Reasearch in Advent Technology, Special Issue, March 2019.
- [13]. V.Sudha, N.Jeba, R.Akhiladevi "A Survey on the Modern Technologies used in Public Toilets", International Journal of Recent Technology and Engineering, November 2018
- [14]. R Kanesaraj Ramasamy , Venushini Rajendran and Sevangthi Murthy. SMART TOILET: An IoT Implementation for Optimization of Resources. Knowledge Management International Conference (KMICe) 2018, 25 -27 July 2018, Miri Sarawak, Malaysia
- [15]. Dutta, J., & Roy, S. (2017, January). IoT-fog-cloud based architecture for smart city: Prototype of a smart building. In Cloud Computing, Data Science & Engineering-Confluence, 2017 7th International Conference on (pp. 237-242). IEEE.
- [16]. Malche, T., & Maheshwary, P. (2017, February). Internet of Things (IoT) for building smart home system. In I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC), 2017 International Conference on (pp. 65-70). IEEE.
- [17]. Ji-Jer Huang, Sheng-I Yu, and Hao-Yi Syu. Development of the smart toilet equipment with measurements of physiological parameters. 2012 9th International Conference on Ubiquitous Intelligence and Computing and 9th International Conference on Autonomic & Trusted Computing.
- [18]. KIN WAI MICHAEL SIU. DESIGN QUALITY OF PUBLIC TOILET FACILITIES. International Journal of Reliability, Quality and Safety Engineering Vol. 13, No. 4 (2006) 341-354
- [19]. Xavier Gibert, Member, IEEE, Vishal M. Patel, Senior Member, IEEE, and Rama Chellappa, Fellow, IEEE. Deep Multitask Learning for Railway Track Inspection. IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS
- [20]. Yair Wiseman. Adjustable and Automatic Flush Toilet. Computer Science Department, Israel, wiseman@cs.biu.ac.il