ECO-FRIENDLY TREATMENT OF SANITATION PROBLEM IN INDIAN RAILWAYS BY INTELLIGENT USE OF ARDUINO MEGA 2560

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ABSTRACT

This paper deals with the issues of management of fecal matter in Indian railways as it has been a significant problem area for Indian Railways and needs multi dimensional efforts. Present work introduces a model of automatic storage type toilet with backup storage as one of the possible eco-friendly solution of sanitation problem in Indian railways by intelligent use of microcontroller, IR Sensors and DC Motor. Author proposes to design a model by using Arduino Mega 2560 to overcome the problem defined and also to add other useful features. The hardware to be used in the present work provides a technique which allows the toilet to convert into storage type automatically while the train is standing on the platform and disposal of the fecal matter after particular speed is achieved by the train.

Keywords: *Arduino, DC Motor, Fecal matter, IR Sensor, Microcontroller, PIR sensor.*

I. INTRODUCTION

There is an expeditious need to improve the sanitation conditions of the Railway Stations. It has been a great challenge for Indian railways to find ways and means to overcome the present toilet problems.

Conventional toilets currently used in train's toilets are of flush types in which a hole is provided on the floor of train's toilet and fecal matter is discharged directly on the tracks anywhere any time. In spite of common notices issued by railway department to the passengers, requesting not to use toilets when trains are standing on the platform, it is ignored by most of the passengers. This makes the ecosystem unhygienic, creating foul smell, releasing various bacteria on station surroundings leading to various diseases. Way of discharging of fecal on the railway track is shown in Fig. 1.

Fig. 1 Discharging of Fecal on Railway Track

A recent Comptroller and Auditor General of India (CAG) report [1] observed, "Passenger amenities like toilets and urinals at stations are not commensurate with the quantum of passengers using them and are poorly maintained at many stations, thereby straining existing facilities and hampering cleanliness efforts with passengers overcrowding the station premises. This is further made complicated by the failure to prevent unauthorized persons from entering station premises."

Stagnation of waste on tracks causes discomfort to the passengers' onboard trains, when they stop near the stations. It also makes it difficult for the Railway staff to work on or near the tracks. Feces and the pathogens in them contribute to spreading of diseases and intestinal parasites. It is a matter still requiring attention and education especially in developing countries like India.

Present work provides a solution to the problem by introducing automatic storage type toilet with backup storage media incorporating many more features.

II. RELATED WORK

Hedaoo et al [2] have discussed the sanitation in Indian railway premises which is a great cause of concern. Their study aims to bring the topic in to focus so as to create the awareness that how important it is to maintain sanitation in railway premises and how environmental pollution can be controlled through railways. They focused on the need to introduce new concepts like modular toilets. Raghuram [3] has discussed the condition of toilets and trains. The consequences including unacceptable hygienic conditions particularly in the railway stations and damage to rail tracks arising due to the existing toilet system in which the coaches discharge excreta directly to the ground and the railway tracks have also been discussed. Indian Railways has suggested three toilets models i.e. modular, vacuum and chemical. Research Designs and Standards Organisation [4] emphasizes on the need of Vacuum toilet system in Indian railways for standard mainline rolling stock to flush out the toilet waste with minimum water consumption. System provides a sealed commode with an efficient flushing system and provide odour free interior of the toilets. Johari et al [5] has presented a design of tank water level monitoring system using GSM network to alert the person-in-charge through SMS. The water level is monitored and SMS is sent to the intended technician's mobile phone on reaching the critical level. Microcontroller as central processor is connected to the modem using MAX232 to interface with Hyper Terminal. Oke et al [6] have introduced a GSM based control system for electrical appliances. GSM module is used for receiving SMS from user's mobile phone that automatically enables controller to take further action like switching ON and OFF electrical appliances such as fan, air-conditioner, light etc. The system is integrated with microcontroller and GSM network interface using C language. Mishra et al [7] have presented an automatic person detection system to control AC fan and room lights by using microcontroller. IR sensor is used to control the switching ON/OFF of the light when it detects any person entered into the museum/room.

III. EARLIER PROPOSED MODEL

System already worked on [8] uses hardware implementation for mitigation of train waste at railway stations. The hardware presented in this work is specially designed for the passenger trains only. This hardware locks the door of the toilet of the train automatically when the train reaches at railway station. Out of two sensors used in hardware, one is used to sense speed of the train while the other senses the presence of the platform.

Below listed shortcomings were observed in this model:

a) It was not passenger friendly.
b) On reaching a station there was fear of getting locked inside the toilet.
c) It was designed only for passenger train only.

IV. FECAL MATTER ESTIMATION

There are three sources of fecal matter generation in Indian Railways:

a) Railway stations
b) Toilets in trains
c) Use of railway tracks for open defecation

There is an added complexity due to discharge of fecal matter from the toilets in trains, due to mobility of the trains. Fecal matter from passengers at the stations and tracks, being in a stationary context, should be more manageable.

Present work has focused on the solution to manage the fecal matter disposed at stations while the train is stationary.

V. CONVENTIONAL TRAIN TOILET

The traditional method of disposing human waste from trains is merely to deposit the waste onto the tracks using a method known as a 'Hopper Toilet.' This ranges from the toilets being a hole in the floor of the train, to a full flush system. The hole in the floor system where waste is deposited on the track is still in use in many parts of the world but it can be considered crude or unhygienic and it litters Railway lines and can produce health risks if the train is passing over a public waterway. Fig. 2 shows conventional toilet in trains.

Fig. 2 Conventional Train Toilet

Passengers may be discouraged from using toilets while the train is at a station. Although there are solutions where toilets are automatically locked when the train pulls into a station but that is not the passenger friendly solution.

VI. PROPOSED WORK

The main objective of the work is to develop a system of a train toilet using hardware to manage the fecal matter when the train is standing on the station.

In this system, when train reaches the station, the system detects it and converts the conventional toilet into a storage type toilet. The door of the toilet is not locked and passengers are free to use toilet any time. When the train starts running and achieves a particular speed, the fecal matter is disposed/ released. Apart from this, with

the smart use of microcontrollers and sensors many more features and modifications to the system have been proposed to enhance its utility and make it more and more passenger friendly. They are:

a) It provides a controlled discharge toilet system, which stores fecal matter in stationary condition and avoids dirtying stations.
b) The storage tank is emptied slowly when speed of the train exceeds predetermined limit.
c) It has replaceable storage system.
d) It takes care of water consumption.
e) An air exhaust system (fan) is introduced which works only when the train is standing on platform.
f) An automatic water flush system is introduced.
g) The lighting system in the toilet glows automatically only when it is under use.
h) There is an announcement/display system in the train when a station arrives.
i) It has additional information system to the passengers which provides information regarding speed of train.
j) The system provides automatic horn system making passengers aware of leaving or approaching platform.

VII. METHODOLOGY

The main objective of the present work is to develop a system of a train toilet using Arduino Mega to manage the fecal matter when the train is standing on the station. In this system, when train reaches the station, the system detects it and converts the conventional toilet into a storage type toilet. The door of the toilet is not locked and passengers are free to use toilet any time. When fecal storage is filled with fecal then a backup storage is provided which replaces filled storage to store the fecal. When the train starts running and achieves a particular speed, the fecal matter is disposed/ released. If we want to dispose the fecal manually then a manual switch is also provided to dispose the fecal matter.

Paper also focuses on many more features and modifications integrated to the system which enhances the utility of the proposed model and makes it more and more passenger friendly.

An Over View of Arduino: Arduino is a small microcontroller board with a USB plug to connect to computer. It has number of connection sockets that can be wired up to external electronics, such as motors, relays, light sensors etc. They can either be powered through the USB connection from the computer or from a 12V battery. They can be controlled from the computer or programmed by the computer and then disconnected and allowed to work independently.

Arduino Mega: It is the one of the biggest one of the Arduino family; it is based on ATmega 2560. It has 54 digital input/output pins (of which 16 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports) and a 16MHz crystal oscillator. Fig. 3 shows Arduino Mega board.

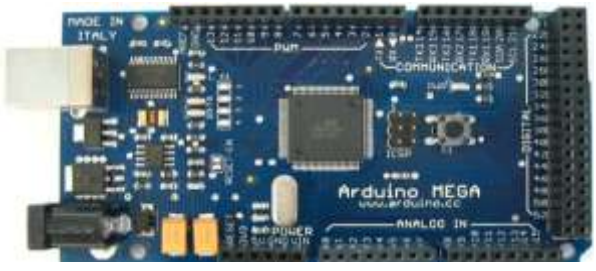

Fig. 3 Arduino Mega Microcontroller development Board

Sensors to be used in this hardware are listed below:

a) Infrared speed sensor: It senses the speed of train as the train approaches the railway stations. Speed of the train goes on decreasing and becomes zero at the railway station and provides a signal to the microcontroller. This sensor is also used for the disposal of the fecal matter after particular speed is achieved by the train.

b) Infrared obstacle sensor: This sensor is used to locate the position of the station. It gives the signal to the microcontroller when station has arrived.

With the help of the signals provided by the combination of the above two sensors, the toilet automatically converts into storage type when the station is reached.

c) Weighing sensor: It is used to sense whether the storage tank of the toilet system is filled or not. If storage toilet system is filled, then sensor provides a signal to the microcontroller and filled storage system is replaced by backup storage system.

d) Water level sensor: It senses the water level in toilet tank. If water level is below the marked point inside the tank then sensor provides a signal to the microcontroller. Microcontroller provides information to the next station authority person/train supervisor, to compensate water level in toilet tank.

e) Occupancy sensor: It senses the presence of any person inside the toilet. If toilet is under use then this sensor automatically turns ON the toilet light otherwise light remains OFF. This way the sensor automatically saves electrical power.

The flow chart describing hardware implementation used in proposed work is shown in Fig. 4 (a), (b), (c).

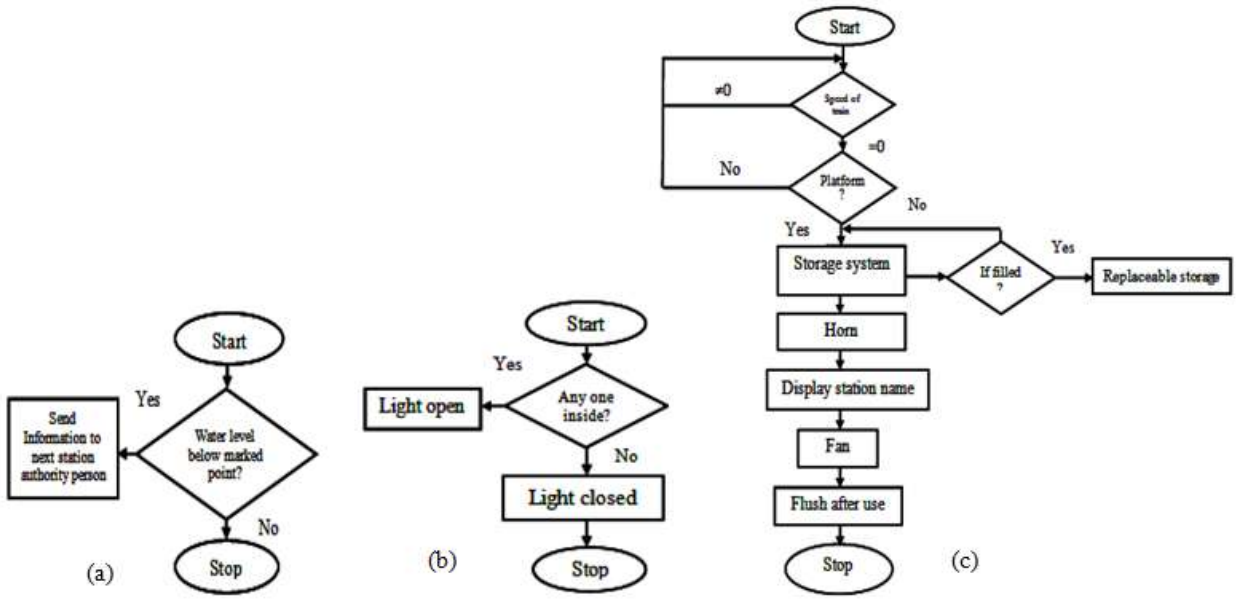

Fig. 4 (a) Water Level Sensing Flow Chart (b) Occupancy Sensing Flow Chart (c) Main System Flow Chart

The block diagram of hardware implementation to be used in the proposed work is shown in Fig. 5 (a), (b) and (c).

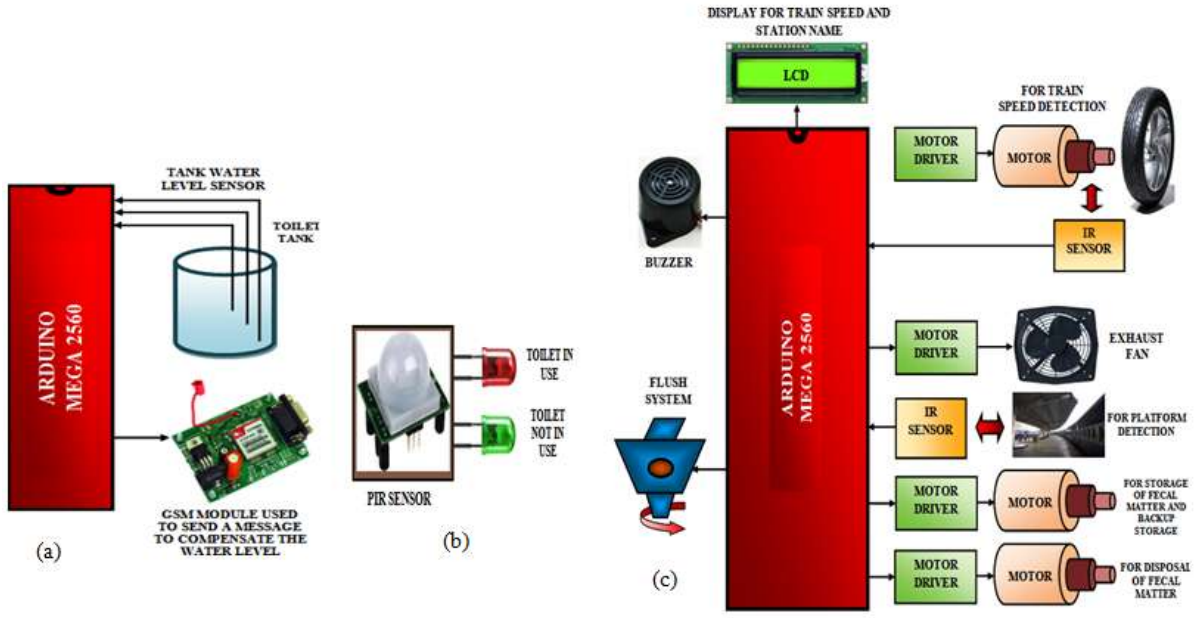

Fig. 5 (a) Water Level Sensing System Block Diagram, (b) Occupancy Sensing System Block Diagram, (c) Main System Block Diagram

VIII. EXPECTED RESULTS

The following outcomes are expected by the author from the proposed work:

a) Proposed system will provide an effective and efficient solution to the defined problem in Indian railways.
b) The solution provided will be eco-friendly, economical and electronically operated making Indian railways more passengers friendly.
c) Proposed system will have provision of converting toilet automatically into storage type while the station is reached thus providing controlled discharge toilet system.
d) Proposed system will be efficient enough to stop dirtying stations while train is standing on the station.
e) Proposed system has replaceable storage system which will automatically replace the filled one with a new empty storage system in toilets.
f) Effective use of hardware will enable the system to dispose the collected waste only when the speed of the train exceeds predetermined limit.
g) Problem of using toilet in emergency will be rectified and like the previously worked on system there will be no fear of getting locked inside the toilet while the station is reached.
h) Proposed system keeps a check on water consumption. Automatic detection and alarming of the water level in tank will provide information to the next station authority person/train supervisor, to compensate water level in toilet tank.
i) Proposed system automatically saves electrical power by using automatic lighting system which glows automatically only when toilet is under use.
j) Proposed system provides an announcement/display system in the train when a station is arrived which will keep all passengers informed well in advance about the station arriving and problem of skipping any station while sleeping may also be solved.

Proposed system provides many more other additional features like an air exhaust system (fan), automatic water flush system, automatic horn system making passengers aware of leaving or approaching the platform and additional information system for speed of train which are essential to make ones journey full of comfort and happy.

IX. CONCLUSIONS AND FUTURE SCOPE

The solution provided is eco-friendly, economical and electronically operated making Indian railways more passengers friendly.

a) Proposed system has provision of converting toilet automatically into storage type while the station is reached thus providing controlled discharge toilet system.
b) Problem of using toilet in emergency will be rectified.
c) Proposed system provides many more other additional features like an air exhaust system (fan), automatic water flush system, check on occupancy in toilet, obstacle detection, water level indicator and additional information system for speed of train which are essential to make ones journey full of comfort and happy.

In future more work can be carried out on the proposed system and more features can be incorporated like to prevent ticketless travellers to avoid ticket checks and to keep a check on sexual assaults etc.

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