

# **Design and Development of Sewage Blockage Clearance Robot Using Wall Climbing Robot as an Application**

Submitted in partial fulfillment of the requirements for the award of  
Bachelor of Engineering degree in Mechatronics Engineering

by

Bala Kabilan R (38090003)

Kamalinee S (38090010)



**DEPARTMENT OF MECHATRONICS ENGINEERING  
SCHOOL OF MECHANICAL ENGINEERING**

## **SATHYABAMA**

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

**MAY - 2022**



# **SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY  
(DEEMED TO BE UNIVERSITY)**

**Accredited "A" Grade by NAAC | 12B Status by UGC | Approved by AICTE**

**[www.sathyabama.ac.in](http://www.sathyabama.ac.in)**

---

**DEPARTMENT OF MECHATRONICS ENGINEERING**

**BONAFIDE CERTIFICATE**

This is to certify that this Project Report is the bonafide work of R. Bala Kabilan, S. Kamalinee who carried out the project entitled “Design and Development of Sewage Blockage Clearance Robot Using Wall Climbing Robot as an Application” under my supervision from 01.11.2021 to 10.05.2022.

**Internal Guide**

Mr. J. SENTHIL KUMAR, M.E., (Ph.D.),

**Head of the Department**

Dr. S. PRAKASH, M.E., Ph.D.,

---

**Submitted for Viva voce Examination held on 10.05.2022**

**Internal Examiner**

**External Examiner**

## DECLARATION

We **Bala Kabilan R** (38090003) and **Kamaline S** (38090010) hereby declare that the Project Report entitled “Design and Development of Sewage Blockage Clearance Robot Using Wall Climbing Robot as an Application” done by us under the guidance of Mr. J. **SENTHILKUMAR**, M.E., (Ph.D.), is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechatronics Engineering.

1) 

DATE:

2) 

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

## **ACKNOWLEDGEMENT**

**I am pleased to acknowledge my sincere thanks to the Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.**

**I convey my sincere thanks to Dr. S. Prakash, M.E., Ph.D., Head of the Department, Dept. of Mechatronics Engineering and Dean of School of Mechanical Engineering, for providing me necessary support and details at the right time during the progressive reviews.**

**I would like to express my sincere and deep sense of gratitude to my Project Guide Mr. J. SENTHILKUMAR, M.E., (Ph.D.), Assistant Professor, Dept. of Mechatronics Engineering, for his valuable guidance, suggestions, and constant encouragement that paved way for the successful completion of my project work.**

**I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Mechatronics Engineering who were helpful in many ways for the completion of the project.**

**I would like to thank Mr. Thamburaj for helping me in fabricating process. I would like to thank my parents, well-wishers and friends who were very supportive through out the tenure of my project phase.**

## **ABSTRACT**

In the recent past usage of BOT's have been growing a lot to solve multiple complicated real-world problems. Particularly robots are used widely in domains like automatic assembly of machinery, vehicle manufacturing, aerospace domains, health-care etc. In Oil and gas industry pipelines are used to transport necessary items and the pipes used for transportation are of varied diameter and can also transport hazardous gases to be used in an industry. These pipes need to be maintained proper in-order to reduce the operating cost. Multiple ways are available to clean these pipes and the key techniques used are temperature based, chemical solution based, tools such a plunger. Continuous use of these techniques erodes the inner layer of pipes and reduces its life time or even cause leakages which costs more to fix it. In many countries pipes used in sewages and industries are cleaned manually to remove any clog or scales developed inside, without using any equipment. Solution based on robotic automation is an alternative for effective maintenance of these pipes. Robotic equipment to be used in cleaning sewage pipeline needs more maturity and are not on-par with the growth seen in other areas. Existing bots cannot be used where the pipes are of varied diameter and design. Our study is to present a robot to be used in sewage pipes with varying diameter along with a working proof of our concept. Hardware and software components used in our POC are discussed in detailed along with the experiments that were conducted.

**Keywords:** Cleaning Robot, Oil and Gas Pipes, Blockage, Sewage, Ultrasonic sensors



## TABLE OF CONTENTS

| CHAPTER  | TITLE                                     | PAGE.NO    |
|----------|-------------------------------------------|------------|
|          | <b>ABSTRACT</b>                           | <b>V</b>   |
|          | <b>LIST OF FIGURES</b>                    | <b>IX</b>  |
|          | <b>LIST OF TABLES</b>                     | <b>XI</b>  |
|          | <b>LIST OF MAIN ABBREVIATIONS</b>         | <b>XII</b> |
| <b>1</b> | <b>INTRODUCTION</b>                       | <b>1</b>   |
|          | 1.1 OVERVIEW                              | 3          |
|          | 1.2 ROBOTIC/MECHANICAL TREATMENT          | 3          |
|          | 1.2.1 RODDING                             | 3          |
|          | 1.2.2 BALLING                             | 3          |
|          | 1.2.3 POWERBUCKET                         | 3          |
|          | 1.3 HYDRAULIC TREATMENT                   | 3          |
|          | 1.3.1 FLUSHING                            | 3          |
|          | 1.3.2 HYDRO JETTING                       | 4          |
|          | 1.3.3 SCOOTER                             | 4          |
|          | 1.3.4 TIES, BAGS, KITES                   | 4          |
|          | 1.3.5 POLY PIGS (TURBO AND STEEL MANDREL) | 4          |
|          | 1.4 CHEMICAL TREATMENT                    | 4          |
| <b>2</b> | <b>LITERATURE SURVEY</b>                  | <b>5</b>   |
| <b>3</b> | <b>AIM AND SCOPE OF THE PROJECT</b>       | <b>11</b>  |
|          | 3.1 OBJECTIVE                             | 11         |
|          | 3.2 SCOPE                                 | 11         |
|          | 3.3 PRESENT INVESTIGATION                 | 11         |
|          | 3.4 OVERVIEW                              | 12         |
|          | 3.5 PROBLEM STATEMENT                     | 12         |
| <b>4</b> | <b>MATERIALS AND METHODS</b>              | <b>13</b>  |

|      |                                                            |    |
|------|------------------------------------------------------------|----|
| 4.1  | ROBOTIC CLEANING DEVICE COMPONENTS                         | 13 |
|      | 4.1.1 ARDUINO UNO MICRO CONTROLLER                         | 13 |
|      | 4.1.2 ULTRASONIC SENSOR                                    | 14 |
|      | 4.1.3 MOTOR DRIVER                                         | 16 |
|      | 4.1.4 DC MOTOR                                             | 16 |
|      | 4.1.5 POWER SUPPLY                                         | 17 |
|      | 4.1.6 MOTOR                                                | 17 |
| 4.2  | KEY FUNCTIONALITIES OF CLEANING BOT                        | 17 |
| 4.3  | BLOCK DIAGRAM OF CLEANING OPERATION                        | 20 |
| 4.4  | DESIGN OF COMPUTER MODEL                                   | 21 |
|      | 4.4.1 NEED FOR DESIGN                                      | 21 |
|      | 4.4.2 ANALYSIS OF PROBLEM                                  | 22 |
|      | 4.4.3 PREPARATION OF SPECIFICATION                         | 22 |
|      | 4.4.4 GENERATION OF POSSIBLE SOLUTION                      | 22 |
|      | 4.4.5 EVALUATION                                           | 22 |
|      | 4.4.6 PRODUCTION OF DETAILED DESIGN<br>AND WORKING DRAWING | 23 |
|      | 4.4.7 IMPLEMENTATION OF DESIGN                             | 23 |
| 4.5  | ALGORITHM                                                  | 23 |
| 4.6  | DESIGN OF PROTOTYPE PARTS AND IT'S<br>SPECIFICATIONS       | 24 |
|      | 4.6.1 CATIA DESIGN FOR PROPOSED BOT'S<br>WHEEL             | 24 |
|      | 4.6.2 CHASIS                                               | 25 |
|      | 4.6.3 BLENDER                                              | 25 |
| 4.7  | SYSTEM REQUIREMENT                                         | 28 |
|      | 4.7.1 HARDWARE                                             | 28 |
|      | 4.7.2 SOFTWARE REQUIREMENT                                 | 28 |
| 4.8  | PROGRAM                                                    | 30 |
| 4.9  | FABRICATION IMAGES                                         | 31 |
| 4.10 | TOOLS USED FOR FABRICATION                                 | 41 |

|          |                                |           |
|----------|--------------------------------|-----------|
|          | 4.10.1 CUTTING MACHINE         | 41        |
|          | 4.10.2 ARC WELDING             | 41        |
|          | 4.10.3 SOLDERING               | 42        |
|          | 4.10.4 GRINDING MACHINE        | 42        |
|          | 4.10.5 DRILLING                | 43        |
|          | 4.10.6 SS FLAT PLATE           | 43        |
|          | 4.10.7 DRAIN PIPE              | 44        |
|          | 4.10.8 PVC PIPE                | 44        |
| <b>5</b> | <b>RESULTS AND DISCUSSIONS</b> | <b>46</b> |
| <b>6</b> | <b>SUMMARY AND CONCLUSIONS</b> | <b>47</b> |
|          | <b>REFERENCES</b>              | <b>48</b> |

## LIST OF FIGURES

| <b>FIGURE.NO</b> | <b>FIGURE NAME</b>      | <b>PAGE.NO</b> |
|------------------|-------------------------|----------------|
| 1.1              | SEWAGE MAN CLEANING     | 2              |
| 1.2              | SEWER CLEANING IN DELHI | 2              |
| 4.1              | ARDUINO                 | 13             |
| 4.2              | ULTRASONIC SENSOR       | 15             |
| 4.3              | DC MOTOR                | 16             |

|      |                                                                                                                                                             |    |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 4.4  | 30 RPM DC MOTORS ATTACHED TO THE WHEEL                                                                                                                      | 18 |
| 4.5  | L293D IC FOR CONTROLLING MOTORS                                                                                                                             | 19 |
| 4.6  | L293D CIRCUIT FOR BIDIRECTIONAL MOVEMENT                                                                                                                    | 19 |
| 4.7  | L293D CIRCUIT FOR BIDIRECTIONAL MOVEMENT                                                                                                                    | 20 |
| 4.8  | BASIC BLOCK DIAGRAM OF PROPOSED SET UP                                                                                                                      | 21 |
| 4.9  | CATIA DESIGN FOR PROPOSED BOT                                                                                                                               | 23 |
| 4.10 | WHEEL                                                                                                                                                       | 24 |
| 4.11 | CHASSIS                                                                                                                                                     | 25 |
| 4.12 | BLENDER                                                                                                                                                     | 25 |
| 4.13 | FULL VIEW OF PROPOSED BOT DESIGN                                                                                                                            | 26 |
| 4.14 | PROPOSED DETAILED SYSTEM ARCHITECTURE                                                                                                                       | 27 |
| 4.15 | SAMPLE CODE TO DETECT OBSTACLES                                                                                                                             | 28 |
| 4.16 | THIS PICTURE HAS TAKEN DURING THE WELDING OF MS ROD IS ATTACHING TO THE SS PLATE.                                                                           | 31 |
| 4.17 | THIS PICTURE HAS TAKEN DURING CHECKING THE MEASUREMENT WHETHER THE WHEEL IS ABLE TO MOVE FORWARD OR NOT.                                                    | 32 |
| 4.18 | THIS PICTURE HAS TAKEN AFTER THE COMPLETION OF BOTTOM PART OF THE BOT AND CHECKING THE FLEXIBILITY OF THE BOT.                                              | 33 |
| 4.19 | THIS PICTURE HAS TAKEN DURING THE FABRICATION PROCESS.                                                                                                      | 34 |
| 4.20 | THIS PICTURE TAKEN DURING ATTACHING THE SS DRILLED PLATE TO THE MS ROD USING WELDING PROCESS.                                                               | 35 |
| 4.21 | WHILE CHECKING THE WHEEL AND MOVEMENT, ONE OF THE WHEELS COMPRESSED. AFTER THIS, WE FOUND THE RECTIFICATION AND THE SS PLATE POSITION AND REDUCED THE SIZE. | 36 |

|      |                                                                              |    |
|------|------------------------------------------------------------------------------|----|
| 4.22 | SOME OF THE FABRICATION IMAGES.                                              | 36 |
| 4.23 | THESE ARE SOME OF THE SS PLATE AFTER DRILLED.                                | 37 |
| 4.24 | THIS PICTURE HAS TAKEN DURING WELDING THE SS PLATE TO MS PIPE.               | 37 |
| 4.25 | THIS PICTURE WAS TAKEN DURING CHECK THE DIMENSION OF THE BOT.                | 38 |
| 4.26 | THIS PICTURE HAS TAKEN AFTER COMPELETING THE FABRICATION OF MECHANICAL PART. | 39 |
| 4.27 | THE BLENDER IS ATTACHED TO THE BOT AND IT IS THE FRONT VIEW OF BOT.          | 40 |
| 4.28 | CUTTING MACHINE                                                              | 41 |
| 4.29 | ARC WELDING                                                                  | 41 |
| 4.30 | SOLDERING                                                                    | 42 |
| 4.31 | GRINDING MACHINE                                                             | 42 |
| 4.32 | DRILL BIT                                                                    | 43 |
| 4.33 | SS FLAT PLATE WITH 11 MM BIT DRILLED                                         | 43 |
| 4.34 | DRAIN PIPE                                                                   | 44 |
| 4.35 | PVC PIPE                                                                     | 44 |

## LIST OF TABLES

| TABLE.NO | TABLE NAME  | PAGE.NO |
|----------|-------------|---------|
| Table 1  | ARDUINO UNO | 18      |

## LIST OF ABBREVIATIONS

| ABBREVIATIONS | EXPANSION      |
|---------------|----------------|
| DC            | DIRECT CURRENT |
| BOT           | ROBOT          |

# CHAPTER 1

## INTRODUCTION

In past days pipes were cleansed mistreatment the human labors. The labor went to enter into the pipe and he went to clean the pipe by golf shot heap of efforts and overwhelming most time. typically he even risks his life by moving into the pipe. Pipes utilized in industries contain many varieties of chemicals and harmful substances. owing to harsh atmosphere we tend to can't use human labors within the pipes. Now-a-days the human labors area unit replaced by the pipe cleanup robots. In industries the various forms of pipe cleanup robots area unit being employed for the aim of cleanup. cleanup isn't a straightforward task to perform, it needs heap of efforts. owing to the shapes and size variations within the pipes, the dimensions of the pipes and shapes attached them we tend to can't use men for all occasions.

Especially the economic pipes vary in size from millimeters to meters and contain many varieties of harmful substances within the pipe. The shapes are terribly sophisticated, and branches like T-shape, Y-shape, increaser, decreaser and elbow area unit creating the locomotion even harder. owing to the harmful substances it's necessary to use devices which will do the examination and cleanup blockages within the pipe. an easy automaton cannot fulfill all the necessities. Hence, we want to accommodate completely different techniques required for cleanup the pipe in single automaton. such a big amount of researchers area unit finding out regarding the most effective mechanism that's reaching to be used for pipe cleanup. owing to these reasons we want to develop a stronger pipe cleanup automaton to save lots of time, men and cash.

Each day many men plummet into the rotten, foul noticing waste product for improvement with none security instrumentation. Specialists United Nations agency handle the support and improvement of waste product channels square measure at expanded hazard of real sicknesses. varied passings happen because of breathless , trench collapses, falls, and presentation to chemical element or Hydrogen- compound gas. people who kick the bucket amid the requirement square measure supplanted by others, holding up to place their lives in threat truthful to achieve a living for themselves and their families. Each week, men line up for Rs 200/- that they get to scrub around 20-25 canals, golf stroke their valuable lives at the prospect. Whereas waste product improvement has over up mechanized during a few components of the state, the govt. figures advocate regarding, 800000 people still work as waste product cleaners.

In tube cities, waste product voyages over regarding fifty thousands six hundred kilometers long sewer lines at the speed of 1 meter per moment. Reports advocate that regarding twenty three thousands men and girls kick the bucket in Asian country every year doing differing types of sanitation work. Associate in Nursing inquiry at Tata based of Social Sciences has found that eightieth of the waste product cleaners kick the bucket someday recently at age sixty since of work-related prosperity problems.

Agreeing to the days of Asian country, thirty-nine out of a hundred waste product men pass away every year. accordant to a chunk within the Times of Asian country, on Admirable twenty first,2017, a waste product specialist passes on whereas improvement the sq. inside the sewer. The summary says as a result of it's the tenth passing during a push with a amount of thirty five days. "Mechanized waste product improvement is presently a selection however people still would like manual foragers to scrub their drainages," says an article in Asian country Times, distributed on October fourth, 2018.



***Fig.1.1 sewage man cleaning***



***Fig.1.2 Sewer cleaning in Delhi***

So, it's tall time to supervene upon human biodegradable pollution cleaners with tall technical school robots in decide to maintain a strategic distance from these unhappy passings and spare their valuable lives. This automaton clears the means for the biodegradable pollution specialists to screen and clean the channels while not entering into the waste. this may not cause state instep it makes a distinction for the specialists to conclude their exerting with the help of robots. This guarantees the well-being and cleanliness of the biodegradable pollution staff.

Think about assessed five million sanitation specialists in numerous urban areas over Asian nation, over totally different classes of labor like cleanup sewers, cleanup restrooms, facial slime taking care of, railroad cleanup, add squander treatment plants, community and open will cleanup, the college will cleanup, clearing and expend.

"Sewage staff still die despite manual scavenging being illicit, and therefore the govt is suspect of not doing a lot of despite large funding out there underneath Swachh Bharat."

"Mechanisation and modernization of biodegradable pollution cleanup has been fully unnoticed by the govt.," Wilson aforesaid

## **1.1 OVERVIEW**

In general blockages in pipes will be broadly speaking classified into 3 groups:

## **1.2 ROBOTIC/MECHANICAL TREATMENT**

The mechanical treatment uses DC motor supercharged balls and shafts to chop the deposits and this will be additionally classified into 3 teams particularly.

### ***1.2.1 Rodding***

Available as a manual and power-operated machine for ending grease remains plant and food rubbish and clearing the blockages to permit instrument inspections through pipelines. An extremely effective technique to perform regular maintenance.

### ***1.2.2 Balling***

Comprises of many sewer balls hooked up to the instrumentation that's compatible with varied pipes and cables perform the cleanup operation through gushing of water through the drain pipes at high speed which ends within the removal of significant dirt and grease deposits.

### ***1.2.3 Power Bucket***

Employed for performing arts specific cleanup operations wherever massive volumes of rubbish will be removed by utilizing a bucket machine consisting of winches that may effectively remove sediments from massive sewers.

## **1.3 HYDRAULIC TREATMENT**

This treatment principally involves ancient cleanup strategies like flushing and spurting to perform cleanup operations with efficiency and cost-effectively. Following square measure a number of the hydraulic treatment procedures utilized by contractors.

### ***1.3.1 Flushing***

Helps to get rid of loose sediments, harmful microorganism, and different residues inexpensively. ancient, also as unifacial modes of flushing, square measure practiced to get rid of biofilms, scales, and water contaminations.

### ***1.3.2 Hydro Spurting***

This convenient and reliable cleanup methodology involves scouring pipe walls through the appliance of water below high that eventually flushes all the rubbish and residues down the sewer. A truck equipped with a fast chicha, rubbish traps, and pick-up hoses is that the instrumentation concerned.

### **1.3.3 Scooter**

They can take away significant sediments from sewers and storm drains that have larger diameters. With the assistance of a cistern, scooter assembly, dump pick-up, and winches this setup have a protect controlled by a spring mechanism that may act as a plug to make up the pressure and increase the protect to push the scooter frame towards the downstream to hold out cleanup.

### **1.3.4 Tires, Bags, Kites**

Resembles the balling technique for cleanup accumulated rubbish and grease gift in massive sewers through the employment of rims on luggage and kites to encourage scouring action.

### **1.3.5 Poly Pigs (Turbo And Steel Mandrel)**

This simple nonetheless economical mode of cleanup the pressure pipes and water mains accomplishes the cleanup operation through mechanical and solid chemical application for the removal of scales gift within the pipelines. Turbo Pigs square measure factory-made victimization high polymer elastomeric properties that may resist abrasions and wear-tear that makes them appropriate for cleanup oil and gas pipelines. Steel rotating shaft Pigs has split-ring-based steel wire brushes that may operate in multiple directions. Silt traps. This technique gathers sediments from sewer ducts and deposits them at appropriate locations at intervals the system. The pipes square measure drained at regular intervals to assist in regular support and maintenance observe.

## **1.4 CHEMICAL TREATMENT:**

Deployment of chemical suggests that like foaming, dusting, and application of chemical solutions victimization instrumentation specifically designed to get rid of grease and roots through chemical treatments. This efficient technique of cleanup involves adding chemicals like neutralizing agents, organic chemistry enzymes, hydroxides, caustics, and biocides.

## CHAPTER 2

### LITERATURE SURVEY

**Abdullah et al (2002)** In this project the author has been victimisation within the space of the oil and gas trade is that the transport of oil and alternative fluids through as network of pipes. These pipes have accumulated quantity of slug and alternative deposits, this results in decrease in pipeline carrying capability, reduced responsibility, loss of power thanks to higher pumping pressure needed and irregular flow. In this, they need accustomed clean the inside of the pipes employing a brushing mechanism.

**Ana Sakura et al (2002)** The project team used this device is appropriate for routine cleansing method. The cleansing device is supplied with unhearable detector that's ready to observe the diameter distinction. If the diameter detected is smaller than the desired dimension, the device are going to be outlined as a blockage. The device can begin rotating till it meets the required diemension. The device has developed to scrub soft to trendy level of blockage with efficiency.

**Akshay Ashok Sonawane et al (2017)** The investigation team brought the key factors we've got thought of whereas within the method of style ar quality, safety operational, steer ability, and also the most significant one is size and form ability. Our model could be a wireless versatile pipe examination automaton that is capable to suffer a pipe with diameter in vary of 6-9 inches. they need developed the merchandise to observe numerous defects like cracks, corrosion, buckles, etc.

**Abhishek Singh et al (2017)** The aim of this project is whole mechanism is basically higher than the drain best lifting element goes within the drain .This over again reduces the injury and tear. The conveyor revolves with the sprocket that's pushed with the help of employing a motor. Once again the motor runs, the conveyor begins off evolved to flow into it and it makes the lifter to move upwards. Floating waste like bottles, plastic cans, covers...etc. is raised with the help of victimisation lifters which may be associated with the conveyor. The wastage material are raised with the help of victimisation lifter enamel and saved in an exceedingly collector bin. Once the amassing bin is full, the waste substances are eliminated from the bin mechanically. This planned device is way sort of a faraway operated vehicle the usage of Bluetooth. The device/robotic completely runs throughout the voidance mechanically.

**Ajit Salunke et al (2019)** The author and project team were investigate many cleansing of pipelines in varied business environments could be a volatile and exhausting paintings that poses a danger to the human folks concerned. This painting includes the layout and fabrication of a totally freelance business pipe cleansing robotic. This robotic includes three tune widget, Associate in Nursing ahead cleansing mechanism and a body. the three tracks had been designed via method of means that of the usage of Bevel instrumentality widget which may be organized at a perspective of ninety credentials with admire to each completely different to operate interior a polygon casing fencelike via method of means that of the excessive anxiety rubber tune. Spring hyperlinks are connected to each tune for surprise absorption.

**Atul A. Gargade et al (2016)** The aim of this project is to get the chance has already come back and gone that this mechanism was found to be dead to scrub the waste matter pipes everyplace throughout the planet. additionally, this mechanism can find the unhealthful gases within the system of untreated waste. This won't prompt the joblessness of waste matter laborers nevertheless can merely create the activity less hard and a lot of advantageous for them. Thus, these robots have spick depleted frameworks everywhere the place. albeit the underlying setup might value high however it offers an honest setting for United States and our future generation.

**Anshul Mathur et al (2021)** They said within the waste material cleansing system, waste water management by the machine. waste material contaminants and sludge from domestic and industries is extracted through this project to, with stable operation, low value and smart result. The cleaner functions additionally and effectively throughout the heavier rains that have additional volume of running water with garbage and high speed. Risk of Labors catching infections or poisoning thanks to giant amounts of waste and chemicals are going to be reduced.

- It may be use for removing the waste from the waste material mechanically to forestall blockage of waste material.
- It may be use for the breakdown of solid composite waste.
- It is used nearly all told varieties of voidance (Large, Small, and Medium).

**Baluprithviraj .K.N et al ( 2021)** The most objective of this paper is to develop a Friendly waste material cleansing automaton to get rid of the blocks manually. Presently, the waste material blocks ar removed solely by means that of manual intervention. thanks to this methodology, there's a threaten to cause several health hazards. therefore a strategy has been developed to cut back the work of high human effort. during this paper, automaton with Associate in Nursing IR camera and IR detector has been used. Blocks within the waste material may be known victimisation IR

camera similarly as IR detector. The camera ceaselessly captures the image within the waste material which may be monitored victimisation computer. As the automation moves within the waste material IR detector detects the presence of block, once the block is detected.

IR detector offers the signal to the microcontroller, so the blocks may be removed by means that of arm movement of automaton.

**Collins et al (1999)** The author said that there are many factors that has got to taken into thought whereas guaranteeing the secure performance of those pipeline operations. most significant issue is hindering and sludge formation wherever many residues gets accumulated and over the time minimises the interior diameter of the pipes thereby leading to reduction of flow of liquids through them.

**Chandan. R et al (2017)** In this project they have found during this venture they've advanced the Pipeline transports oil and gases for a few distance distances. Routine renovation is significant for those pipes that keep from any abnormality matters like crack, leakage, or deposit. corrosion also can arise on the inner floor of the pipe and reduces the facility of the pipe. If the crack goes undiscovered and can become severe, the pipe will leak and, in uncommon cases, fail catastrophically. in depth efforts area unit created to mitigate corrosion. Thus, it's miles crucial to carry it completely and economically; consequently the robotic can become the utmost useful product to be had for this purpose. automatic review of the inner floor of a pipe is also dead through a cell robotic. they need designed the wheels of the robotic in any such manner in order that it will traverse inner a snakelike floor of the pipe while not slithering.

**Deepak B.B.V.L et al (2016)** The goal of this paper is to produce a outline of previous analysis on numerous in-pipe robotic systems and their operations. the main focus of this inquiry was on the approaches utilised to undertake in-pipe cleansing and examination duties.

**Ellison et al (2003)** The aim of the project is to prompt sure preventive maintenance measures starting from ancient strategies like victimisation plungers, hot water, salt water, alcohol, etc., to victimisation improvement strategies like flushing, rodding, jetting, and chemical treatments.

**Enner et al (2013)** The project members has insisted on victimisation technological suggests that to help with pipeline improvement operations. Usage of chemicals is commonly not suggested because it could corrode the surfaces of the pipelines. sure

improvement strategies are often effective for home use however might not be economical for application in industries as they'll cause severe injury to pipelines.

**Gagliardi et al (2000)** The project team suggests an in depth study involving the usage of pipelines across the world for multiple applications right from distribution of water, gas, oil, and different fluids inside the countries to worldwide transport of fluids spanning many kilometers and accommodation of compatibilities between varied pipe dimensions used for this transportation.

**Gobinath.M et al (2019)** While reviewing the project the author found there is a chance has already come back and gone that this automation was found to be dead to wash the biodegradable pollution pipes all over throughout the planet. additionally, this automaton can find the venomous gases within the system of untreated waste. This won't prompt the joblessness of biodegradable pollution laborers nonetheless can merely create the activity less rigorous and additional advantageous for them. Thus, these robots have spick-and-span depleted frameworks everywhere the place. although the underlying setup could value high however it provides an honest atmosphere for United States of America and our future generation.

**Korra Dileep et al (2003)** In this paper, the author have Wall ironed form of pipe improvement and review robots were terribly helpful for the locomotion within the vertical pipes. this kind of automaton contains versatile links which will offer a sufficient quantity of force which is able to facilitate the body to maneuver in vertical pipes while not slithering. the target of this project is to wash the pipe and review automaton for the industrial applications. To develop associate in-pipe automaton for pipelines with dynamic diameters.

**Jyothsna. C et al (2019)** The author and project team planned the machine is intended with the motive of serving to the biodegradable pollution cleaners to stop them from obtaining littered with serious diseases as a result of going in the evacuation. The death rate of biodegradable pollution cleaners is dire. it's time that this machine ought to be enforced to wash the biodegradable pollution pipes everywhere the planet. Moreover, this device can facilitate to search out the toxic gases within the drain which is able to facilitate the authorities to curb the selling of untreated raw waste from the industries into the drains. (this can this may|this can) not result in state of biodegradable pollution employees however will simply create the task easier and healthier for them.

**Najafi et al (2005)** The project team initiated the general needs that has to be thought-about before improvement are:

- Contractors should possess some suggests that of rubble collector ensuing from improvement operations.
- Appropriate disposal web site should be set ahead and correct permits should be obtained.
- The improvement contract should be granted solely to those contractors WHO have previous expertise and skilled personnel with the required experience.
- Most significantly safety precautions should be adhered to.
- The potency of the improvement method depends upon the instrumentation utilised, that should be operated by directions such by the makers.
- He conjointly bestowed an in depth review of the effectiveness of improvement strategies that area unit practiced by industries worldwide.

**Nguyen Truong-Thinh et al (2011)** They invented the Pipe cleansing and review robotic is one in every of the new principles of skilled carrier robots. Sewer pipes area unit sometimes of non-man-access classification (much but zero. eight m diameter). during this paper, a pipe-cleansing and review robotic significantly designed for this characteristic is planned. This paper provides a different technique for the layout associated improvement of cleansing robots in an unknown pipe space. To do so, we propose a different slicing technique for cleansing paintings additionally to associate underwater review technique.

**Saurabh S Banka et al (2020)** When author developing this Product, they need got advanced a different pipe cleansing and review robotic hole totally on Automation is advanced for prolonged distance cleansing of pipelines with special diameter series. This structural layout makes it possible to understand the variation in pipe diameter and therefore the firmness of frame posture.

**Seeta G et al (2002)** The author said in this project, the essential objectives of a sewer review automaton area unit to navigate into the tunnel, capture high-resolution pictures, and turn back to the entry purpose for extraction betting on the depth of tunnels, allowable hazard level, and restricted or no human intervention is allowed. the utilization of robots for sewer tunnel review is comparatively new, significantly in deep tunnels with restricted access. (Inspecting the depth of the biodegradable pollution employing a Camera).

**Ramanathan S et al (2019)** During this project their aim to interchange the manual add drain cleansing by introducing a semi-automated system in An economical thanks to management the disposal of wastages and with regular filtration of wastages. In their model, a piston of gas is connected to a rope of wire that successively is plus kinematic linkages. The linkage from the frame is to be submerged into the waste matter. once the gas piston is motivated, the grippers that square measure provided at the lowest expand and collect the solid wastes from the waste matter. Ultimately their catchword is to fabricate a machine that's efficient also as economical in operating.

**Dr Ramaprabha .P.S el al (2018)** The author said in this paper, the larva inspects sewer strains for cracks, corrosion, obstacles, pipage gift, etc. A digital digicam mounted a pinnacle the larva includes out keep streaming of the inside of the pipeline. These visuals square measure regarded through the operator in an exceedingly computer code program to be recorded for destiny reference. once locating the character of the pipage gift withinside the main, the robotic features a neutralizing agent to be able to reduce the harmful gases gift withinside the sewer. once the identity of crack, corrosion, etc., and once neutralizing the gases humans may {additionally |may also may additionally} additionally input the sewer to revive the corrosion of the pipe through sandblasting, recoating, etc. By that the lifetime of the pipe is extended. Thus, this tool effectively decreases all of the predicaments associated with waste matter cleansing and examination.

**Vaani I et al 2017** The author investigating the new idea of Digital digicam established a top the robotic contains out keep streaming of the inside of the pipeline. These visuals square measure thought of through the operator within the computer code program to be recorded for destiny reference. moreover, the robotic is equipped with a proximity sensing element on the front of its frame to find the presence of an impediment within the front of it. because the robotic nears the impediment, the rotary engine begins off evolved reducing through the impediment, thus, clearing the impediment. Thus, this tool properly decreases all of the predicaments associated with waste matter cleansing and examination. Thus, this device effectively decreases all the predicaments related to waste matter cleansing and examination.

## **CHAPTER 3**

### **AIM AND SCOPE OF THE PROJECT**

### **3.1 OBJECTIVE**

1. The objective of this project is to design a pipe cleaning and blockage clearance robot
2. To develop an BOT to clean the pipe which can go in U, T bend.
3. To develop a BOT of single mechanism for both locomotion and cleaning.
4. To implement a blockage clearance robot using Ultrasonic sensor.
5. To develop better cleaning device.

### **3.2 SCOPE**

The main scope of this project is to design a pipe cleaning robot which can go in bends, pipe increaser, decreaser which helps the society and hereafter no person goes inside sewage pipe as it was before. Its applicable for detecting blockage in pipe by the use of ultrasonic sensor. Its applicable for long and different diameter of pipes cleaning.

### **3.3 PRESENT INVESTIGATION**

The present invention in sewage cleaning is Bandicoot Robot- Spider-shaped robot that can cleans manholes and sewers with precision. It has been successfully completed a trial run in Thiruvananthapuram, unclogging five manholes filled with plastic, filth, medical waste and sediments. This robot works with the help of its arms and limbs and cleans the sewage by taking out at a single place. Our project goes inside the sewage pipe and detects the blockage if is there the it removes the blockage inside the sewage pipe.

### **3.4 OVERVIEW**

Lot of works has been done on the pipe cleaning robot up to now. Many types of robots had been invented and in that many of them is not in use. In this project a lot of literature study has been done to understand the mechanism of various types of in-pipe robots. Literature work is also done on various sensors that they are used for cleaning of Sewage blockage pipe for detecting the flaws and blockage in the sewage pipe.

### **3.5 PROBLEM STATEMENT**

Pipe cleaning is exceptionally critical for the correct support of Sewage blockage pipe. But cleaning isn't a straight forward errand. Destructive substances which are accumulated within the pipe make it exceptionally troublesome for people to work within the channels. The changing distance across of channels from few millimeters to a few meters are too a major calculate. To overcome the estimate various issues are to anticipate human intercession in sewage pipe cleaning a sewage pipe robot with reasonable highlights needs to be created in this venture.

## CHAPTER 4

### MATERIALS AND METHODS

#### 4.1 ROBOTIC CLEANING DEVICE COMPONENTS

The design engineering methodology involved in development of cleaning equipment comprises of both hardware and software components. Depending upon the residues and diameter of pipelines dealt with the components too can be modified to accommodate the changing requirements. The general components involved in constructing a cleaning device.

##### *4.1.1 Arduino Uno Micro Controller*

This small controller is an open supply, easy-to-use programmable card which might be simply integrated with electronic comes and might be interfaced with alternative boards like Raspberry Pi to regulate LEDs, servos, and motors as an output.

The board consists of fourteen digital I/O pins out of that six square measure pulse breadth modulation outputs, half-dozen analog I/O pins, together with programmable IDE through B USB cable.

The Arduino UNO could be a customary board of Arduino. Here UNO means that 'one' in Italian. it had been named as UNO to label the primary unleash of Arduino computer code. it had been conjointly the primary USB board discharged by Arduino. it's thought-about because the powerful board employed in numerous comes. Arduino.cc developed the Arduino UNO board.

Arduino UNO relies on AN ATmega328P microcontroller

. it's simple to use compared to alternative boards, like the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and alternative circuits.

The Arduino UNO includes half-dozen analog pin inputs, fourteen digital pins, a USB connector, an influence jack, And an ICSP (In-Circuit Serial Programming) header. it's programmed supported IDE, that stands for Integrated Development setting. It will run on each on-line and offline platforms.



***Fig.4.1 Arduino***

ATmega328 Microcontroller - it's one chip Microcontroller of the AT family. The processor code within it's of 8-bit. It combines Memory (SRAM, EEPROM, and Flash), Analog to Digital device, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and generator.

ICSP pin - The In-Circuit Serial Programming pin permits the user to program victimisation the computer code of the Arduino board.

Power semiconductor diode Indicator - The ON standing of semiconductor diode shows the ability is activated. once the ability is OFF, the semiconductor diode won't light.

Digital I/O pins- The digital pins have the worth HIGH or LOW. The pins numbered from D0 to D13 square measure digital pins.

TX and RX LED's- The eminent flow of information is depicted by the lighting of those LED's.

AREF- The Analog Reference (AREF) pin is employed to feed a reference voltage to the Arduino UNO board from the external power provide.

Reset button- it's accustomed add a push to the association.

USB- It permits the board to attach to the pc. it's essential for the programming of the Arduino UNO board.

Crystal Oscillator- The quartz oscillator encompasses a frequency of 16MHz, that makes the Arduino UNO a robust board.

Voltage Regulator- The transformer converts the input voltage to 5V.

GND- Ground pins. the bottom pin acts as a pin with zero voltage.

Vin- it's the input voltage.

Analog Pins- The pins numbered from A0 to A5 square measure analog pins.

The operate of Analog pins is to browse the analog detector utilized in the association. It may act as GPIO (General Purpose Input Output) pins.

#### **4.1.2 Ultrasonic Sensor**

Ultrasonic sensors have been utilised for several years and is the perfect choice for distance measurement as well as object detection whose principle is based on

estimation of time taken for their emitted ultrasonic pulse to bounce off an object and return back.

Several autonomous robots and automated vehicles make use of ultrasonic sensors due to their capabilities and flexibility in their operation and performance.

Ultrasonic sensors are used primarily as proximity sensors. they'll be found in automobile self-parking technology and anti-collision safety systems. ultrasonic sensors also are employed in robotic obstacle detection systems, additionally as producing technology. compared to infrared (IR) sensors in proximity sensing applications, unhearable sensors don't seem to be as liable to interference from smoke, gas, and different mobile particles (though the physical parts are still tormented by variables like heat).



***Fig.4.2 Ultrasonic sensor***

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, which converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components which is the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

Ultrasonic sensors are used primarily as proximity sensors. They can be found in automobile self-parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems, as well as manufacturing technology. In comparison to infrared (IR) sensors in proximity sensing applications, ultrasonic sensors are not as susceptible to interference of smoke, gas, and other airborne particles (though the physical components are still affected by variables such as heat).

### 4.1.3 Motor Driver

In order to manage motors victimisation different controller devices like Wireless systems, microcontrollers etc., motor drivers are used that acts as Associate in Nursing interface between the motors and therefore the management circuits.

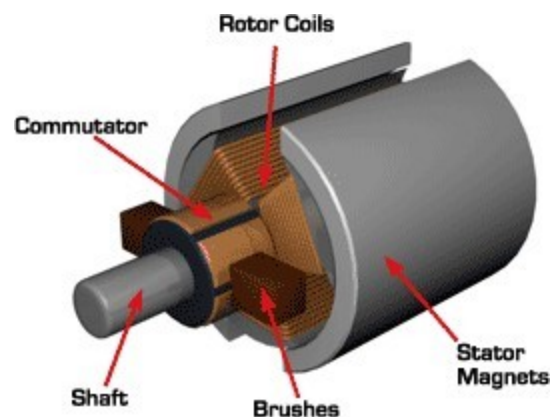
Basically motors consume high power whereas the controllers want lesser power, motor drivers converts low-current management signals to higher-current signals which will operate a motor.

Some low current motor drivers accustomed management autonomous robots are L293D , L298N.

293D could be a typical Motor driver or Motor Driver IC that permits DC motor to drive on either direction. L293D could be a 16-pin IC which might management a group of 2 DC motors at the same time in any direction. It means you'll management 2 DC motor with one L293D IC. VCC is that the voltage that it desires for its own internal operation 5v; L293D won't use this voltage for driving the motor. For driving the motors it's a separate provision to {supply to produce} motor supply VSS (V supply). L293d can use this to drive the motor. It means that if you would like to control a motor at 9V then you would like to {supply to produce} a provide of 9V across VSS Motor supply.

The maximum voltage for VSS motor provide is 36V. It will provide a scoop current of 600mA per channel. Since it will drive motors Up to 36v thus you'll drive pretty massive motors with this l293d.

### 4.1.4 DC Motor



**Fig.4.3 DC Motor**

Depending upon the motor drivers for automaton profiles supported their size, its weight, its speed, operation, and application setting DC motor choice is completed. additionally to facultative the battery usage to facilitate quality, DC motors is wide employed in artificial intelligence on account of their options like speed variation and

torsion. whereas tiny DC motors are employed in tools and appliances larger ones will be employed in electrical vehicles, elevators etc.,

A DC motor is associated degree electrical machine which converts electricity into energy. the fundamental working rule of the DC motor is that whenever a current carrying conductor places within the field, it experiences a mechanical force.

For a DC motor : torsion is proportional to coil current - this suggests dominant torsion needs merely dominant the motor DC current - simply achieved with an easy DC drive.

#### **4.1.5 Power Supply**

Appropriate power provide is required to modify on the motors, operate the sensors and brain of the robots. In accordance to deployed application, power sources may be chosen.

Commonly used power sources area unit fuel cells, generators, single and 3 phase power, gas pressure, batteries etc.,

The board will treat associated external provide from six to twenty volts. If equipped but 7V, however, the 5V pin could provide but 5 volts and therefore the board could become unstable. If mistreatment quite 12V, the transformer could overheat and injury the board. The suggested vary is seven to twelve volts.

#### **4.1.6 Motor**

In this project we used six DC motors for wheels three at top wheels and another three at bottom wheels which are 30 r.p.m motors. And also, 100 r.p.m mounted on front of Robot.

### **4.2 KEY FUNCTIONALITIES OF CLEANING BOT:**

Cleaning BOT is intended to perform the following key functionalities in-order to be effectively deployed in pipes.

- Central Manager / Controller
- Revolve
- Sense
- Protect
- Clean

Arduino Uno micro-controller board is used to manage the actions attached to the BOT. Micro-Controller specification.

**Table 1: Arduino Uno**

| Attribute     | Value  |
|---------------|--------|
| Input voltage | 8-12 V |

|                     |        |
|---------------------|--------|
| Max Voltage         | 25 V   |
| Digital Input Ports | 6      |
| Analog Input Ports  | 6      |
| Speed               | 16 mhz |
| Weight              | 25 g   |
| Memory (Flash)      | 32 KB  |

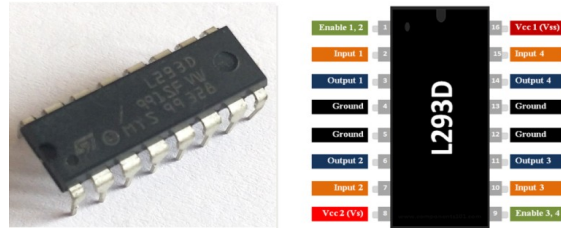
Board used in proposed set up has 14 input / output ports. Selected hardware is an open source and available in both 8 bit and 32 bit variants. This is an integral core component in proposed set up which decides the actions based on the output of sensors. BOT is made up of six wheels and there are multiple ways to enable the rotation of wheels attached. Servo motor or



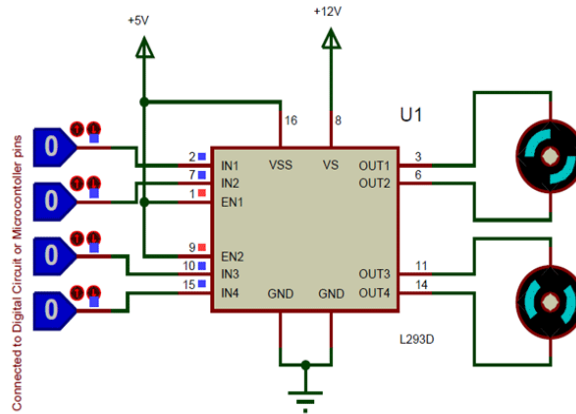
***Fig 4.4: 30 RPM DC Motors attached to the wheel***

DC powered motors are generally used to trigger the wheel movement. Proposed prototype uses six 30 RPM DC motors, these motors are attached to the wheels to enable back and forth movement. One 100 RPM motor is used to control the shaft used for cleaning.

L293D motor driver integrated chip is used to drive the DC motors. Prototype uses this chip since one chip has the capability of managing two motors and the direction of each motor can be controlled individually.



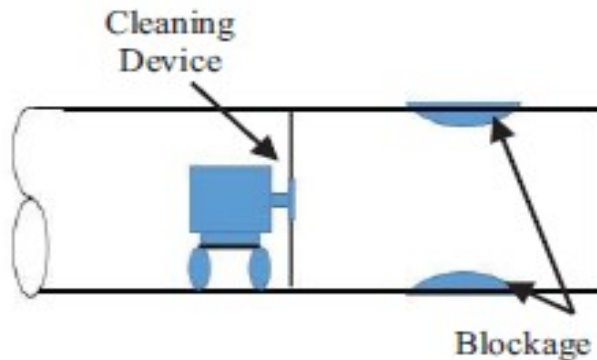
**Fig 4.5: L293D IC for controlling Motors**



**Fig 4.6 : L293D Circuit for bidirectional movement**

Motor drive IC is triggered by H-Bridge rule and due to this bi-directional movements (either clockwise or anti-clockwise) are possible. Circuit connection for the same is defined in Figure 3. Input pins in the above circuit are connected directly to the microcontroller which controls the voltage and the rate at which the wheels move. Table 4 defines the input and output required to get a bidirectional movement for two wheels

Ultrasonic sensors are used to detect any blocks inside the pipes. Since sound waves are used the accuracy of these sensors are more than 98 %. Since these motors are used inside pipes the motors need to be shielded properly to improve life time. Aluminium, PVC, ABS cases are few ways to shield the prototype. Our model uses ABS case for protection.



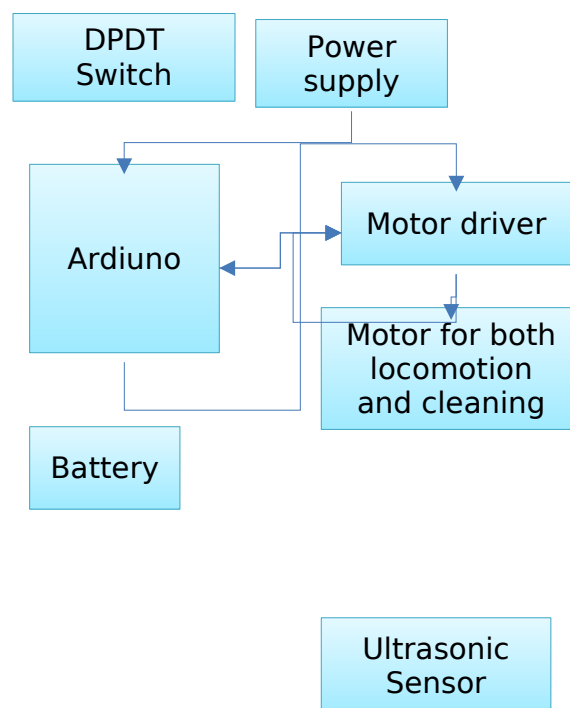
**Fig 4.7: L293D Circuit for bidirectional movement**

Depending on the context of usage Nylon cables along with rubber shafts can be used for cleaning the blocks inside pipes or sewages. Ultrasonic sensors detect the blockage, once the block is detected a dc motor is activated which rotates the shaft to clear the blockage.

#### 4.3 BLOCK DIAGRAM OF CLEANING OPERATION:

Block Diagram of Process flow:

Block diagram in figure represents the basic set up that explains how the micro controller is attached to motor driver and Ultrasonic sensor. Communication between ultrasonic sensor and Microcontroller is bi-directional. When the sensor detects any blocks 50 cm away it signals the microcontroller, which then triggers the 100 RPM motor to clear the blocks.



**Fig 4.8 Basic block diagram of proposed set up**

#### 4.4 DESIGN OF COMPUTER MODEL:

Proposed set up follows 7 stage Mechatronics design principle as mentioned below.

1. Need for Design
2. Analysis of Problem
3. Preparation of Specification
4. Generation of possible solution
5. Evaluation
6. Production of detailed design and working drawing
7. Implementation of design

#### ***4.4.1 Need For Design***

Mechatronics makes conceivable the combination of actuators, sensors, control frameworks, and computers within the design process. Beginning with the essential plan, and advancing through the fabricating stage, Mechatronics plan upgrades the parameters at each stage to deliver a quality item in a brief cycle time.

#### ***4.4.2 Analysis Of Problem***

Some time recently creating or planning the item there ought to be a issue. So that, the item ought to fathom the issue. The most objective of this venture is to unravel the issue of sewage specialists and to decrease the passing rate of sewage specialists and to actualize the BOT in Sewage pipe.

#### ***4.4.3 Preparation Of Specification***

The design should meet the desired performance specifications. Therefore, specification of the necessities must be ready 1st. this can state the matter definition of special technical terms, any constraints placed on the answer, and also the criteria that may be accustomed appraise the look. Drawback statement includes all the functions needed of the look, at the side of any fascinating options.

#### ***4.4.4 Generation Of Possible Solution***

This arrange is known as conceptualisation arrange. The conceptualisation step is to decide the components, components, materials, handle of setup that in a few combination or other result in a plan that fulfills the require. Typically the key step for utilizing creativity and creativity. A crucial perspective of this step is union.

Amalgamation is the method of taking components of the concept and organizing them within the appropriate arrange, measured and dimensioned within the appropriate way.

Outline arrangements are arranged for various conceivable models which are worked out in adequate points of interest to show the implies of getting each of the specified functions.

#### **4.4.5 Evaluation**

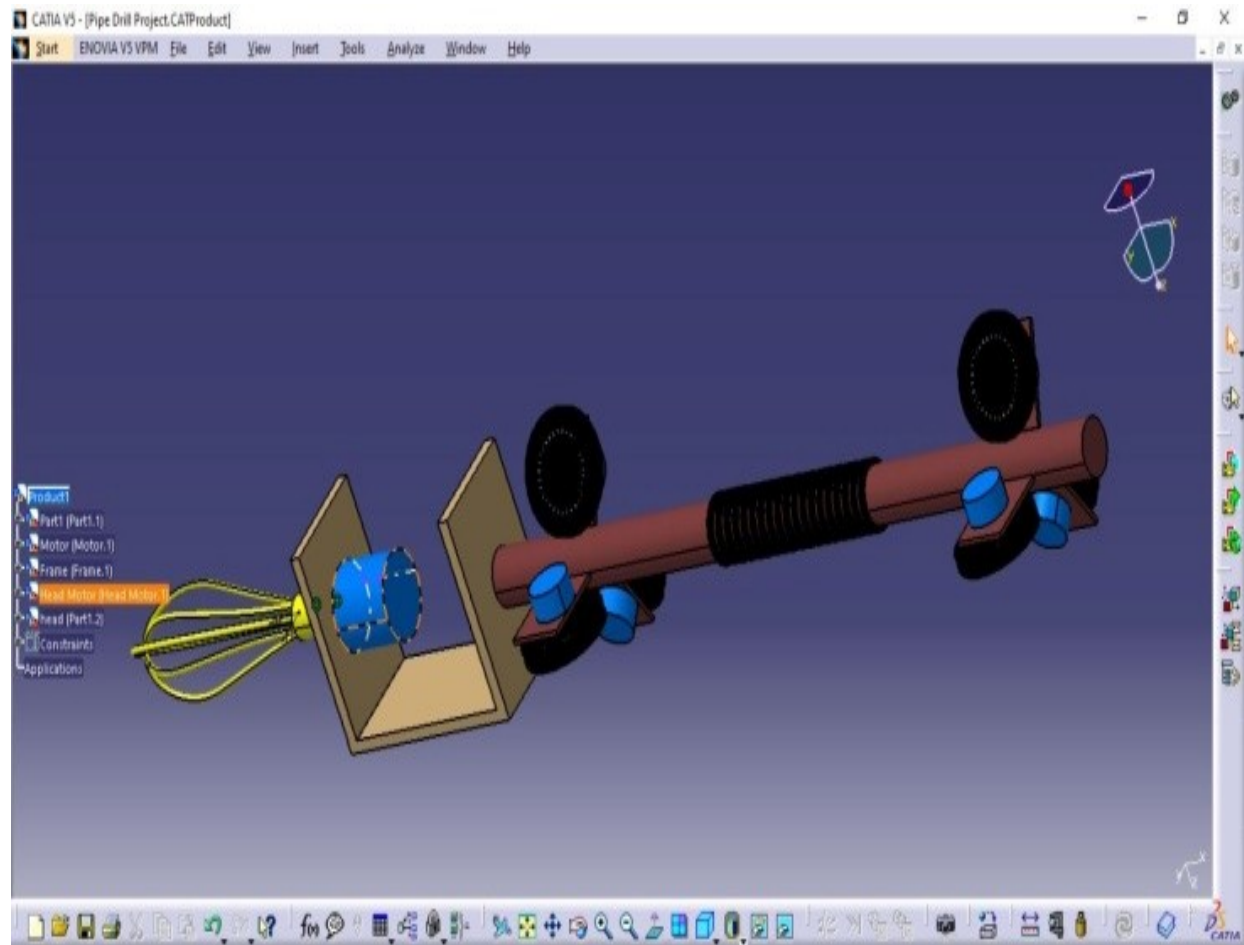
This organize includes a includes a exhaustive investigation of the plan. The assessment organize nitty gritty calculation, regularly computer calculation of the execution of the plan by utilizing an expository demonstrate. The different arrangements gotten in organize 4 are dissected and the foremost appropriate one is chosen.

#### **4.4.6 Production Of Detailed Design And Working Drawing**

The concluded drawing must be appropriately communication is to the individual who is reaching to make. The communication should be verbal introduction or a plan report. Nitty gritty designing drawings of each and every components and the gathering of the machine with complete the detail for the fabricating prepare are composed within the plan and report.

#### **4.4.7 Implementation Of Design**

The components were as per the drawings are manufactured and assembled as a whole system.



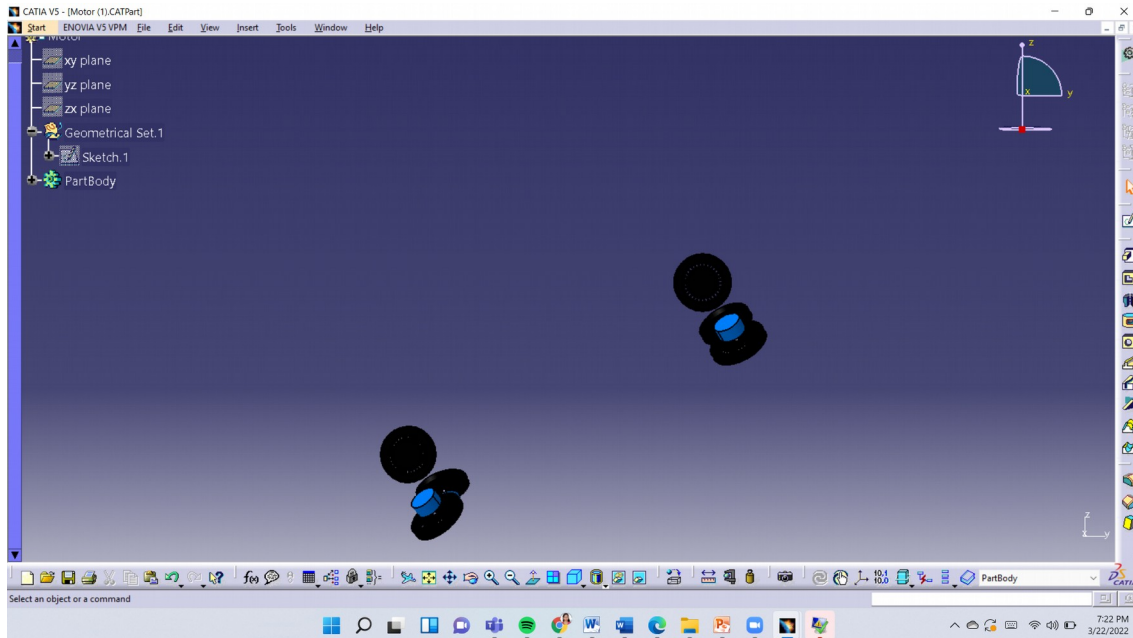
***Fig.4.9 CATIA design for proposed BOT***

## **4.5 ALGORITHM**

1. Connect Power supply to micro controller
2. Output of Microcontroller is connected to L293D IC which in turn controls the movement of wheels.
3. Move Robot forward using appropriate trigger
4. While the BOT moves forward check the output of micro controller.
5. Detect obstacle around 50cm using ultrasonic sensor and trigger 100r.p.m motor, if it doesn't detects the obstacle it doesn't rotate.
6. Wait for the cleanup operation to complete and move forward.
7. Repeat steps 3 till 6 until the pipeline is cleaned.

## 4.6 DESIGN OF PROTOTYPE PARTS AND IT'S SPECIFICATIONS

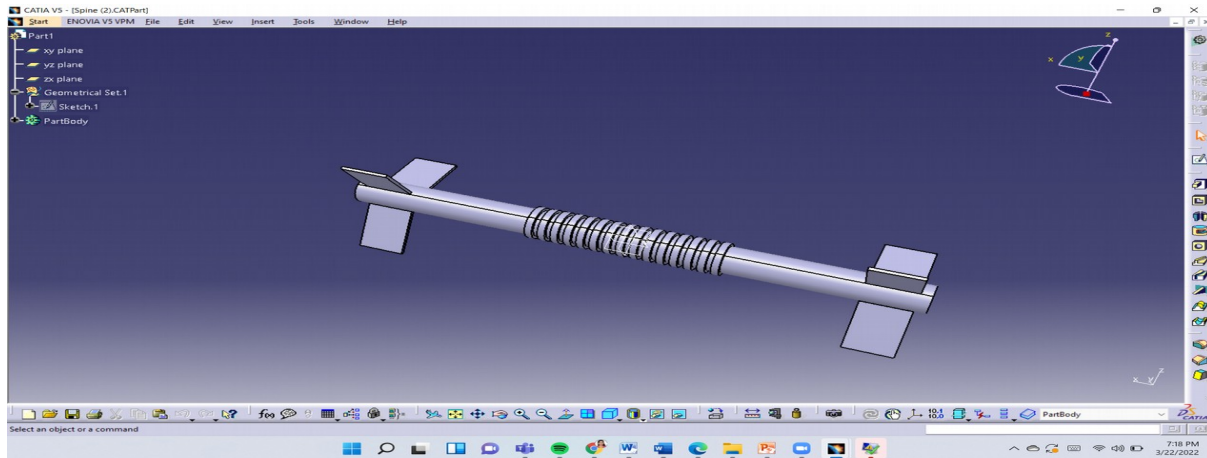
### 4.6.1 Catia Design For Proposed BOT's Wheel



**Fig.4.10 (a) Wheel**

Motor a device that uses petrol, gas, electricity, etc. to produce movement and makes a machine. This device helps us for the movement and transportation of our robot. The above image is the Catia design of Wheel, in this wheel we will be attaching the 30 r.p.m motor for locomotion. Totally, there are three wheels and three motors which is mounted on front of the BOT, and another three motors is attached to the respective wheels in bottom of the BOT.

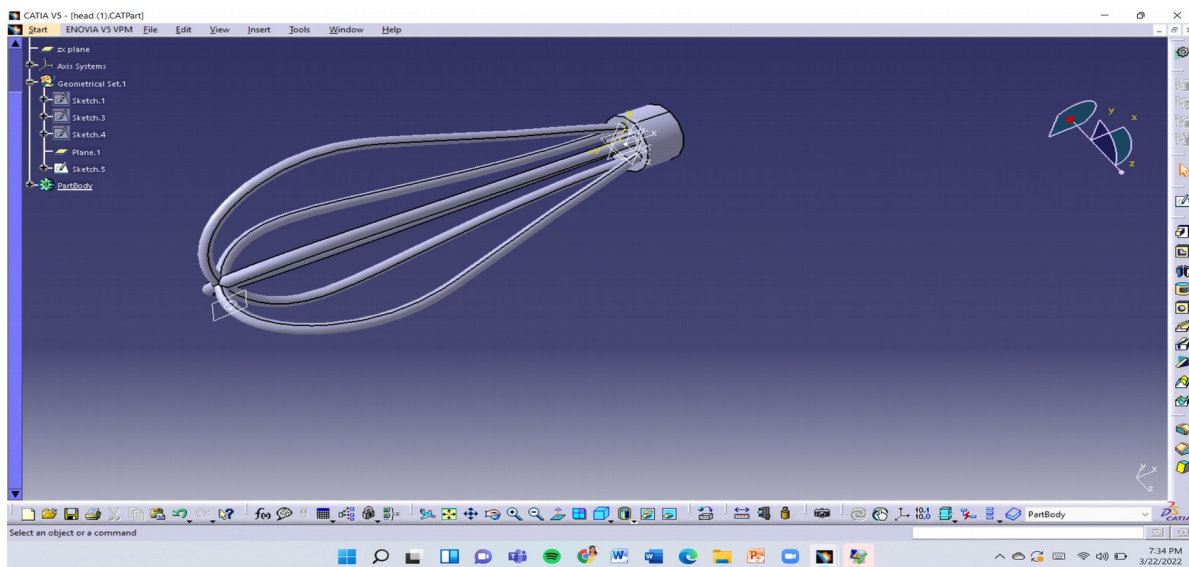
### 4.6.2 Chassis



**Fig. 4.11 Chassis**

Chassis the metal frame of robot onto which the other parts fit. This chassis/framework is made up of stainless steel and plastic(spring type).The plastic which gives the flexibility to move in U, T shaped bends.

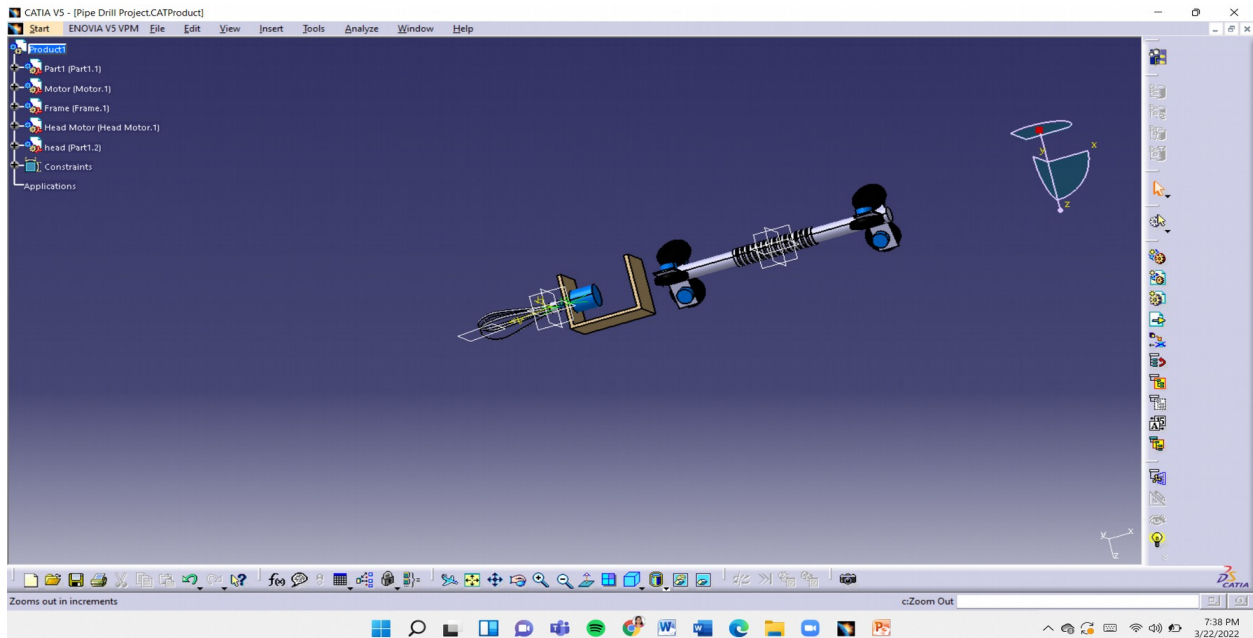
#### **4.6.3 Blender**



**Fig.4.12 Blender**

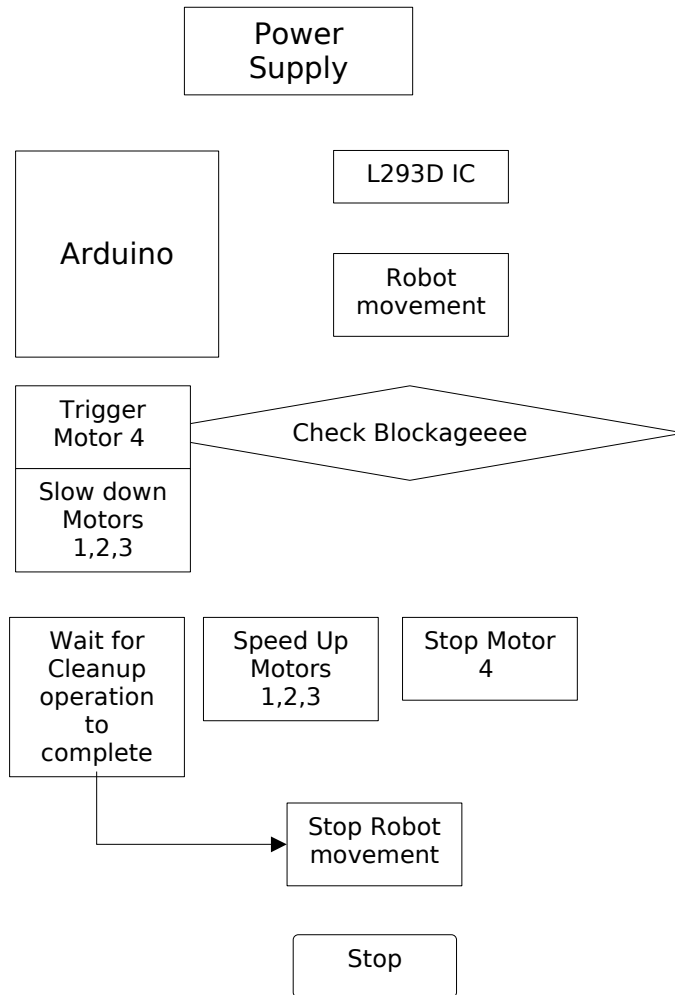
Blender is a grinding (breaking up particles) process that breaks down solid wastes into small pieces. So that the solid blockage is broken. This connected with a 100 rpm motor for its grinding process.

#### **4.6.4 Full View Of Proposed BOT Desgin**

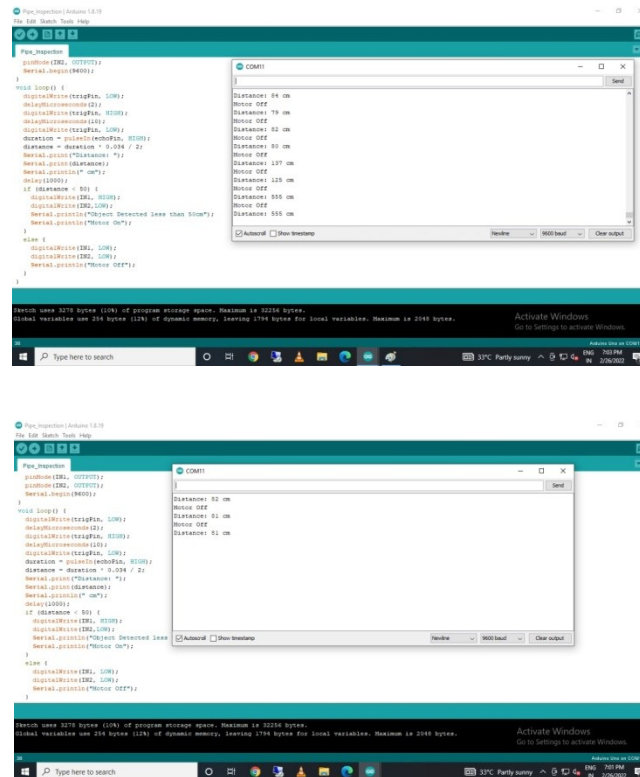


***Fig.4.13 Full view of Proposed BOT Desgin***

The above image is the proposed Design of BOT, in this as we said in the above image we have designed the BOT. The BOT will be moving in forward motion, the wheels of motors will works in 30 r.p.m speed, and the power supply will be in ON condition. After, the where the object or blockage has been detected the Blender will start rotates with the speed of 100 r.p.m motors the Blender will work. And, it will rotates the Blender until the blockage is removed.



***Fig.4.14 Proposed detailed System Architecture***



**Fig 4.15 Sample Code to detect obstacles**

## 4.7 SYSTEM REQUIREMENT

### 4.7.1 Hardware

Hardware used in our prototype is discussed in the previous section which includes Arduino, 6 DC Motors, Ultrasonic sensor, L293D motor driver IC, 100RPM DC motor and 12V 1Amp power supply

### 4.7.2 Software Requirement

Arduino IDE Version 1 was used for this project on Windows 10 machine. Sketches with extension .ino were saved in a local repository. CPU and baud rate configuration in the IDE was varied as per the input data and it was used appropriately in boot-load instructions. Core program was developed in 'C' and embedded in this prototype.

## 4.8 PROGRAM

```
#define echoPin 2
#define trigPin 3
const int IN1 = 4;
const int IN2 = 5;
long duration;
int distance;
void setup() {
  Serial.begin(9600);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(IN1, OUTPUT);
  pinMode(IN2, OUTPUT);
  Serial.begin(9600);
}
void loop() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = duration * 0.034 / 2;
  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");
  delay(1000);
  if (distance < 50) {
    digitalWrite(IN1, HIGH);
    digitalWrite(IN2, LOW);
    Serial.println("On");
  }
  else {
    digitalWrite(IN1, LOW);
    digitalWrite(IN2, LOW);
  }
}
```

```
Serial.println("Off");  
}  
}
```

#### 4.9 FABRICATION IMAGES



**Fig.4.16**

*This picture has taken during the welding of MS Rod is attaching to the SS plate*



**Fig.4.17**

***This picture has taken during checking the measurement whether the wheel is able to move forward or not.***



**Fig.4.18**

***This picture has taken after the completion of bottom part of the BOT and checking the flexibility of the BOT.***



***Fig.4.19***

***This picture has taken during the Fabrication process.***



**Fig.4.20**

***This picture has taken during attaching the SS drilled plate to the MS rod using welding process.***



**Fig.4.21**

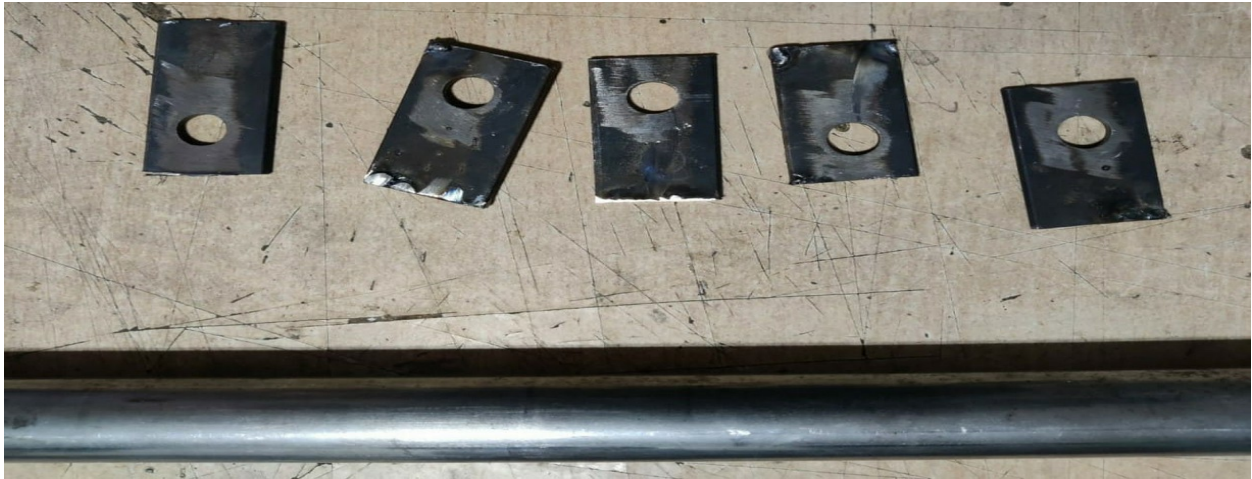
***While checking the wheel and movement, one of the wheels compressed. After this, we found the rectification and the SS Plate position and reduced the size.***



**Fig.4.22**

***The Mechanical part of the BOT has successfully went inside the Pipe.***

Some of the fabrication images:



***Fig.4.23***

***These are some of the SS plate after drilled***



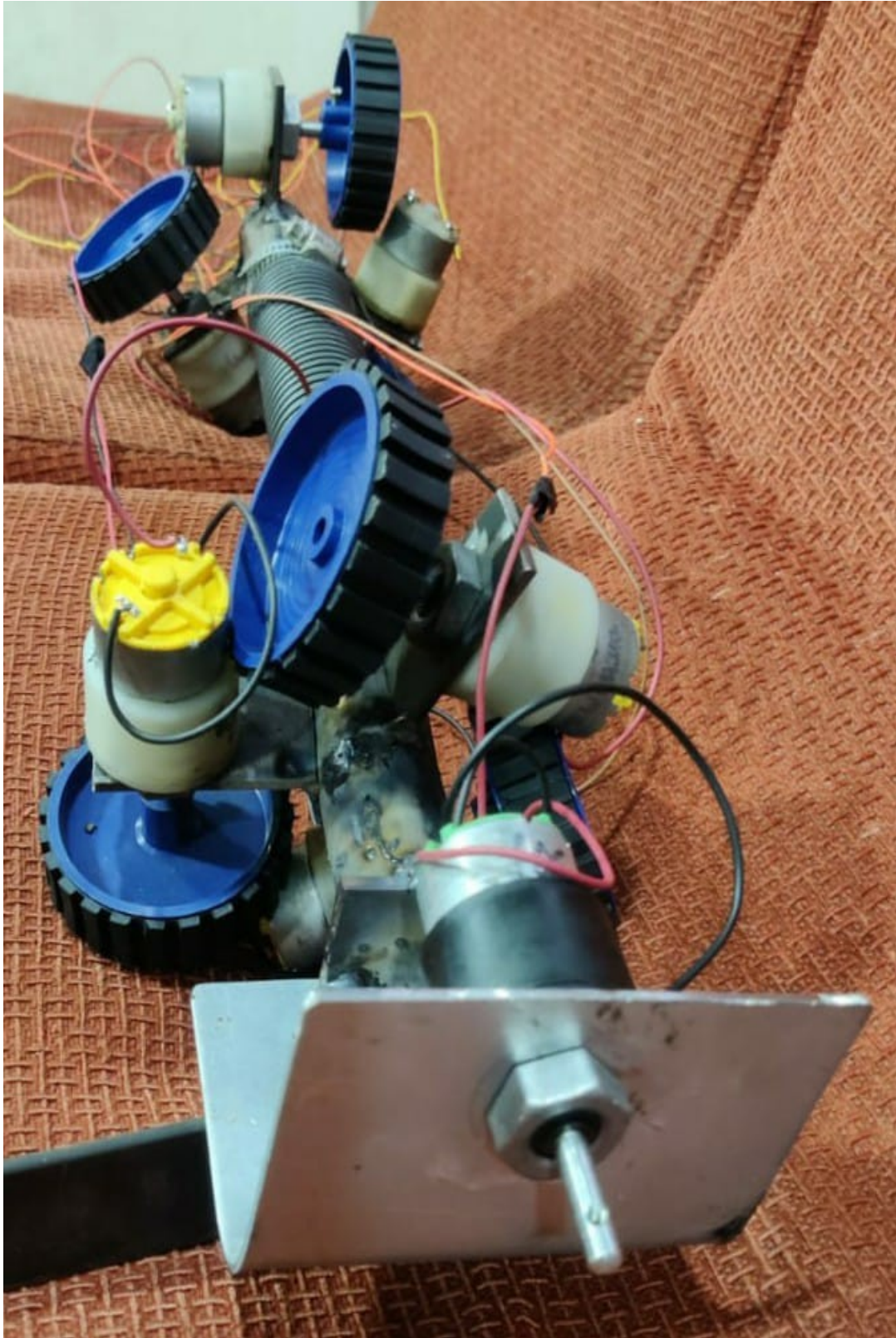
***Fig.4.24***

***This picture has taken during welding the SS Plate to MS pipe***



Fig.4.25

This picture was taken during check the dimension of the BOT.



**Fig.4.26**

***This picture has taken after compeleting the fabrication of Mechanical part.***



**Fig.4.27**

***The blender is attached to the BOT and it is the front view of BOT.***

## 4.10 TOOLS USED FOR FABRICATION

### 4.10.1 Cutting Machine



**Fig.4.28 Cutting Machine**

A machine used for extirpation components of articles from layers of material card webs or knit. The technically attainable depth of cutting of the layer depends on the planning of the cutting machine and on the thickness and properties of the materials. Cutting machines could also be movable or stationary.

### 4.10.2 Arc Welding



**Fig.4.29 Arc Welding**

Arc welding attachment could be a attachment method that's wont to be part of metal to metal by victimization electricity to form enough heat to soften metal, and also the liquified metals, when cool, end in a binding of the metals. it's a kind of attachment that uses a attachment power offer to form an electrical arc between a metal stick ("electrode") and also the base material to soften the metals at the purpose of contact.

#### **4.10.3 Soldering**



**Fig.4.30 Soldering**

When connection of 2 metals in an exceedingly attachment method, like employed in PCB assembly, flux is needed to realize a real science bond. That ensures the solder joint does not crack or come back loose even with the every day wear-and-tear. during this project, we have a tendency to used flux to affix the copper wire as a result of it provides a powerful bond and unable to tear simply.

Soldering may be a method during which 2 or a lot of things area unit joined along by melting and golf stroke a filler metal into the joint, the filler metal having a lower temperature than the conterminous metal. mixer is fastened with motor and therefore the wires area unit soldered.

Soldering irons area unit most frequently used for installation, repairs, and restricted production add physical science assembly. High-volume production lines use alternative attachment ways. massive irons is also used for attachment joints in sheet objects.

#### **4.10.4 Grinding Machine**



**Fig.4.31 Grinding Machine**

A grinding machine, usually shortened to grinder, is one in every of power tools or machine tools used for grinding. it's a kind of machining exploitation Associate in

Nursing abrasive wheel because the cutting implement. every grain of abrasive on the wheel's surface cuts a little chip from the piece of work via shear deformation.

Grinding is employed to end workpieces that has to show high surface quality (e.g., low surface roughness) and high accuracy of form and dimension.

#### **4.10.5 Drilling**



**Fig.4.32 Drill Bit**

A drill could be a tool used for creating spherical holes or driving fasteners. it's fitted with a touch, either a drill or driver chuck. with manual sorts dramatically decreasing in quality and conductor powered ones proliferating. A drilling machine, conjointly known as a drill press, could be a powerful tool accustomed cut a spherical hole into or through metal, plastic, wood, or different solid materials by turning and advancing rotary drill bits into a piece of work.

This drilling cutlery (Drill Bit) is command within the drill press by a chuck and fed into the work on variable speeds. The speed and feed ought to be set properly and agent has to be provided for the required finished half. The drilling machine can't solely be applied within the drilling method however is additionally helpful for several different machining operations.

#### **4.10.6 Ss Flat Plate:**



**Fig.4.33 SS Flat plate with 11 mm bit drilled**

First the stainless steel pipe is cut using the cutting machine into two parts. According to the measurements. Flat tabs are welded to the stainless steel pipe at both the cut SS pipes. The flexible pipe connects the both SS pipe and gives flexibility for the movement of the chassis. Motors are assembled at the flat tabs.

The wheels are fixed to the motors for moving, And one motor for the blender. The wires are fixed to motors and its soldered to each and every motor.

#### **4.10.7 Drain Pipe**



**Fig. 4.34 Drain pipe**

Here, we used this drain pipe and two clamp's in topper body of chasis and bottom body of the chasis. With the help of the clamp and drain pipe we connected the both the sides. Because of this, our BOT can work in U bend and T bend also.

#### **4.10.8 PVC Pipe**



**Fig. 4.35 PVC pipe**

PVC-U is that the commonest PVC kind for pipes and fittings together with transportation of drink, soil and waste, sewerage and underground voidance and industrial applications. Pipes and fittings fabricated from PVC-U have several edges.

## **CHAPTER 5**

### **RESULT AND DISCUSSION**

Regular cleaning of pipelines is pivotal in maintaining towards its service and life. Depending upon the nature of the issue, cost and the pipe lines involved cleaning methods and equipment's differ accordingly. BOT designed for cleaning can help in automatic clearance of sewage blocks and this reduces any human involvement. Economically efficient and reliable cleaning equipment has been proposed by our approach that can effectively perform routine as well as emergency cleaning which can offer robust and enhanced performance. Certain recommendations to improve its working with respect to its assembly and fabrications are taken into account as a part of future enhancement to make its operation even more versatile and sought after.

## **CHAPTER 6**

### **SUMMARY AND CONCLUSIONS**

The work executed in this paper to create a sewage blockage clearance robot for the sewage pipe due to solid wastes and covers etc. Sewage pipe cleaning by labours is unethical and very harmful to them due to chemicals in waste. We here provide a fully automated sewage cleaning robot to clear the blockage by the blender. By the use of ultrasonic sensor the blender turns only when there is a blockage. As this project is based on national cleanliness, human health and society, it involves many benefits to society, industries and to labours without immoral activities. By doing this project, we have succeeded in this. We hope this BOT will play major role in this universe.

## REFERENCES

- [1] *Ajay Sharma, Ankur Singh, Mahipal Singh, AUTOMATIC DRAINAGE CLEANING SYSTEM, IJERT, 2019, Vol 8, Pg No 237-242.*
- [2] *Ajit Salunke, Swapnil Ramani, Sujay Shirodkar, Osburn Vas, Kedar Acharya PIPE CLEANING ROBOT, ICNTE, 2019, Vol 3, Pg 75-79.*
- [3] *Askhay B Rakate, Shripad R. Latange, AkshyaKumar B Navale, Vinayak G Nalkar, Kagade V R, DESIGN AND FABRICATION OF IN – PIPE INSPECTION ROBOT, GRD Journalfor Engineering, Vol 2, 2017, Pg No83-86.*
- [4] *Atul A. Gargade , Dr. Shantipal S. Ohol, DEVELOPMENT OF IN-PIPE INSPECTION ROBOT, ISOR – JMCE, 2016, Vol 13, Pg No 64-72.*
- [5] *Baluprithviraj. K.N, Madhan Mohan.M, Madhan Mohan.M, Sakthivel . P, DESIGN AND DEVELOPMENT OF SEWAGE CLEANING MOBILE ROBOT , ICICT, 2021 , Vol 8, Pg No 813-819.*
- [6] *Fouziya SSulthana, Vibha K, Sudhanshu Kumar, Sneha Mathur, Tarang Ashutosh Mohile, MODELLING AND DESIGN OF A DRAIN CLEANING ROBOT, ICAME, 2020, Vol 6, Pg No 25- 32.*
- [7] *Kaushik M B, Karthikeyan P, Jothilingam A, DESIGN OF PIPE-INSPECTION ROBOT FOR ALL PIPELINE CONFIGURATIONS, IJERT, 2018, Vol 4, Pg No 80-84.*
- [8] *Jyothsna, Prabhu, Devayani, Gunasekhar K, Srimaheshwaran, Dr. K. Ramesh SMART DRAINAGE CLEANING SYSTEM, IJEE, 2019, Vol 11, Pg No 370-375.*
- [9] *Md Shahnauze Ahsan, Mohammed Saifuddin Munna, Abu Nayeem, Design IMPLEMENTATION OF A DRAIN CLEANER ROBOTIC VEHICLE, ICECTE, 2019, Vol 9, pg No: 268-271.*
- [10] *Murasu. R, Velmurugan S, Vivek Asalan T, DESIGN , FABRICATION, AND PERFORMANCE ANALYSIS OF PIPE LINE INSPECTION ROBOT, IJMTER, 2016, Vol 3, Pg No 240-246.*

[11] Nagadeepan A, Hersha himlan J, Guruyogeshwaran J, Balaji S, AUTOMATIC DRAINAGE CLEANING SYSTEM, IJESMJ, 2018, Vol 7, Pg No- 190-195.

[12] *Ramanathan. S, Sudharshan R, Karthik B, Mohammed Suhail A, S. Chiranjeev* SEWAGE CLEANING MACHINE, IJRAR, 2016, Vol 6, Pg No 124-129.

[13] Ramaprabha P S, Supriya P, Prianka R, Preeta V, Priyadarshini N.S, IMPLEMENTATION OF SEWER INSPECTION ROBOT, IRJET, 2018, Vol 05, Pg No 1653 – 1657.

[14] Saaurabh S. Satpute, Vitthal R. Darole, Pravin Khadero, Pankaj B Hiralkar, AUTOMATIC SEWAGE CLEANING SYSTEM, IJAERD, 2018, Vol 5, 96-101.

[15] Vaani I, Simerna J. Sushil, Vani Kunjamma U.S, Akshaya Ramachandran, Dr. Thulasi Bai V, B. Thyla 6, BHRTYARTANA A PIPE CLEANING AND INSPECTION ROBOT, ICSSS, 2017, Vol 7, Pg No 422-425.

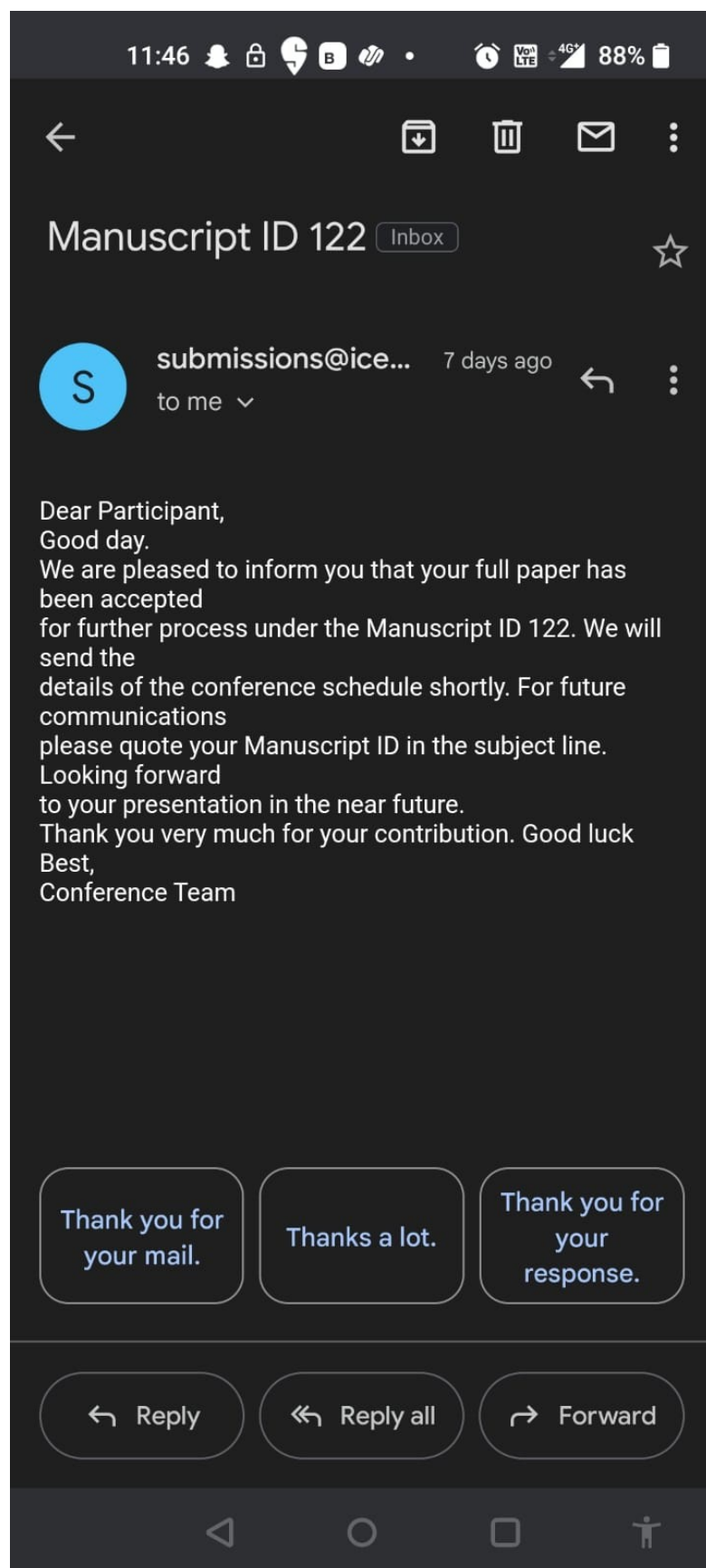
## Kamalinee 24.04\_Plag

### ORIGINALITY REPORT

|                  |                  |              |                |
|------------------|------------------|--------------|----------------|
| <b>19%</b>       | <b>16%</b>       | <b>4%</b>    | <b>15%</b>     |
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

### PRIMARY SOURCES

|          |                                                                                                                                  |           |
|----------|----------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>1</b> | <b>www.javatpoint.com</b><br>Internet Source                                                                                     | <b>4%</b> |
| <b>2</b> | <b>www.ijaiem.org</b><br>Internet Source                                                                                         | <b>2%</b> |
| <b>3</b> | <b>ethesis.nitrkl.ac.in</b><br>Internet Source                                                                                   | <b>2%</b> |
| <b>4</b> | <b>Submitted to National Institute of Technology, Rourkela</b><br>Student Paper                                                  | <b>2%</b> |
| <b>5</b> | <b>Submitted to Madanapalle Institute of Technology and Science</b><br>Student Paper                                             | <b>1%</b> |
| <b>6</b> | <b>Submitted to Institute Of Applied Technology</b><br>Student Paper                                                             | <b>1%</b> |
| <b>7</b> | <b>en.wikipedia.org</b><br>Internet Source                                                                                       | <b>1%</b> |
| <b>8</b> | <b>Baluprithviraj K. N., Madhan Mohan M., Kalavathi Devi T., Sakthivel P.. "Design and Development of Sewage Cleaning Mobile</b> | <b>1%</b> |





## DESIGN AND DEVELOPMENT OF SEWAGE BLOCKAGE CLEARANCE ROBOT USING WALL CLIMBING ROBOT AS AN APPLICATION

J.Senthilkumar<sup>1</sup>, S.Venkatesan<sup>2</sup>, S.Sivasaravanan<sup>3</sup>, Kamalinee.S<sup>4</sup> and Bala Kabilan.R<sup>5</sup>

*j.senthilkumar1981@gmail.com, mitvenkatesh@gmail.com, sivakriya16@gmail.com, kamalinee05s@gmail.com and balakabilanmt2018@gmail.com*

<sup>1,2,3</sup> School of Mechanical Engineering, Sathyabama Institute of Science and Technology, Chennai-119, India.

<sup>4,5</sup> UG Student, Department of Mechatronics Engineering, Sathyabama Institute of Science and Technology, Chennai-119, India.

### Abstract:

In the recent past usage of BOT's have been growing a lot to solve multiple complicated real-world problems. Particularly robots are used widely in domains like automatic assembly of machinery, vehicle manufacturing, aerospace domains, health-care etc. In Oil and gas industry pipelines are used to transport necessary items and the pipes used for transportation are of varied diameter and can also transport hazardous gases to be used in an industry. These pipes need to be maintained proper in-order to reduce the operating cost. Multiple ways are available to clean these pipes and the key techniques used are temperature based, chemical solution based, tools such a plunger. Continuous use of these techniques erodes the inner layer of pipes and reduces its life time or even cause leakages which costs more to fix it. In many countries pipes used in sewages and industries are cleaned manually to remove any clog or scales developed inside, without using any equipment. Solution based on robotic automation is an alternative for effective maintenance of these pipes. Robotic equipment to be used in cleaning sewage pipeline needs more maturity and are not on-par with the growth seen in other areas. Existing bots cannot be used where the pipes are of varied diameter and design. Our study is to present a robot to be used in sewage pipes with varying diameter along with a working proof of our concept. Hardware and software components used in our POC are discussed in detailed along with the experiments that were conducted.

**Keywords:** Cleaning Robot; Oil and Gas Pipes; Blockage; Sewage; Ultrasonic sensors

### 1. Main text

Pipes are used as one of the essential things both in industries and for domestic use to distribute oils, waters or gases or any fluidic substances from source to target ranging from few meters to few thousand kilometres. Pipes need to be maintained and cleaned at regular intervals to improve the operational efficiency. Inadequate cleaning leads to clogging of pipes and reduce the rate at which the materials are transported. In general external elements that create clogging are usually filtered and removed by adding appropriate filters in the pipe. Clogging and blockages doesn't happen due to these external elements but it grows gradually due to the gases and chemicals in inner layer of pipe. After certain period of time thickness of clogs in pipes increases and the capacity of pipe reduces, limiting free flow of substances in pipe. Inner layer in the pipe also contaminates the material transported in the pipe (Water or other fluids), this might even lead to busting due to toxic gases and chemical reactions.

#### 1.1 Structure of pipe Cleaning methodologies

In general blockages in pipes can be broadly categorised into three groups A) Robotic / Mechanical treatment, B) Hydraulic treatment, C) Chemical Treatment.

#### Robotic/Mechanical Treatment:

Mechanical treatment uses DC motor powered balls and shafts to cut the deposits and this can be further categorized into three groups namely