International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-11 Issue-8, July 2022

Design and Development of Automatic Water Tank Cleaner

Mansi Vazarkar, Pratyasha Kar, Vishal Dhobale, Pratik Ghawate, A.D. Shiralkar

Abstract: ***This system aims to design and develop a prototype of an automatic system for cleaning domestic cylindrical water tanks. The proposed system includes a simple mechanism with centrifugal force. Household water tanks are supposed to provide safe water for cleaning, gardening, cooking, and drinking. The majority of the time water coming into the tank comes with dust and dirt particles. Over time, sludge or sediment may build up, contaminate water and cause illnesses in humans like diarrhea, cholera, amebiasis, typhoid, and gastroenteritis. Tank cleaning is necessary since the mud, dust, and dirt entering through water may settle at the bottom of the tank, leading to the formation of algae, and salt deposits that disturb the quality of water and hamper the flow of water through a pipe. It has been observed that the methods to clean water tanks are manual and a person needs to enter the tank to clean it. Thewater has to be drained out before handed, hence it is a tough and time taking task due to which cleaning of tanks gets postponed. If the tank is overhead, then it creates more problems for cleaning the tank. The benefits of this system are reduced human effort and time, avoiding exposure to chemicals that influence the health of a person entering the water tank for cleaningand reduced wastage of water.***

Keywords: Over Time, Sludge or Sediment May Build Up

I. INTRODUCTION

1.1. Traditional Method

Traditional cleaning methods include a person entering in the tank and scrubbing the base and side of the tank using brushes and scrubs. Then using chemicals and high-pressure jets to complete the process. The water is drained out completely before the above process. As this process is time-consuming, needs a lot of manpower and wastage of water, cleaning of tanks gets postponed now and then, leading to choking up in pipes, dirty base of tanks, turbid water which also hampersflow and quality of water.

1.2. Recent Technologies

Some devices like Sedimclean, KENT - KSL-612 Wet and DryVacuum Cleaner, Hanbaz water tank cleaner universal edition (Vortex Series) cleaning brush are recently replacing human efforts of manual cleaning.

Manuscript received on 06 June 2022 | Revised Manuscript received on 11 June 2022 | Manuscript Accepted on 15 July 2022 | Manuscript published on 30 July 2022.

***** Correspondence Author
Mansi Vazarkar, UG Student, Department of Electrical, AISSMS IOIT, Pune (Maharashtra), India
Pratyasha Kar*, UG Student, Department of Electrical, AISSMS IOIT, Pune (Maharashtra), India
Vishal Dhobale, UG Student, Department of Electrical, AISSMS IOIT, Pune (Maharashtra), India
Pratik Ghawate, UG Student, Department of Electrical, AISSMS IOIT, Pune (Maharashtra), India
Dr. A. D. Shiralkar, Associate Professor, Department of Electrical, AISSMS IOIT, Pune (Maharashtra), India.

These devices are yet again manually operated where the user needs to rotatethe device with the help of a handle and then a water pump is inbuilt to suck out the sedimented dust. Some systems were proposed that will clean the base and side. In these proposed systems, water needs to be drained out pre handed, then a mechanical system is sent into the tank that uses high-pressure jets, brushes, and chemicals. These systems are designed as per the size of tanks and are bulky. Therefore, there is a need of a system that lives at the base of the tank, thus ensuring less water wastage and providing an automatic process of cleaning with zero or less humanintervention.

II. LITERATURE REVIEW

Thonge Suraj D. et al., [1], The water tankcleaner includes two main mechanisms arerack and pinion gear mechanism and reciprocating four-bar linkage mechanism.The rack and pinion arrangement are used to move the whole mechanical system up and down for cleaning the cylindrical tank. Limitations of this system are it can only be used in the cylindrical tank (the device is tank specified) and the system removes the water before the cleaning of the tank, thus causing wastage of water. Rohit R. Dabhade, et al., [2], In this the water tank cleaner was used to clean the water tanks by using rotating brushes. This method was more effective and safer than the conventional methods. This method is capable to clean water tanks within less time and human effort. The limitation of this system is system is bulky, for the feeding system manpower is required and the system removes water before the cleaning of the tank, thus causing wastage of water. Mr. Shubham Samrit, et al., [3], In this theworking of the tank cleaning machine is based on the principle of reciprocating mechanism in which a motor is used for generating the power and transmitting through the pulley. A rack and pinion mechanism are used for providing the reciprocating motion. This mechanism gives the reciprocating and rotational motion to the brushes. The rack and pinion 7 mechanisms are used to provide reciprocating motion. This reciprocating motion is used to translate the vertical sleeve up and down, due to which the inner surface of the water tank is in direct contact with the vertical and horizontal brushes. The machine can be operated on solar energy also. The machine could be fully automated(sensors). P.Prem Kumar, et al., [4], In this the method uses a robot to clean the tank. The robot first moves in the forward direction and the arm will move in up and down as well right and left direction to pump out high-pressure water to the walls of the tank.

In case of heavy scaling inside the tank, chemical agents can be mixed with the cleaning water. When the robot completes the entire cleaning process in the forward direction, it again reaches its default tank centre position. Now, it moves in the reverse direction and performs the same operation. The robot's entire body will be water sealed and all components will be present in the waterproof body. Only, the robotic arm will be exposed outside. Now, as the walls of the water tank are cleaned. The robot moves aroundthe entire tank and cleans the floor of the tank using a rotating scrubber present at the bottom of the tank. There will be dirtywater and sludge remaining at the bottomof the tank. It will be sucked out using the suction pump present inside the robot. Limitations of this system are device is bulky and before placing the robot inside the tank, the tank will be completely drained causing wastage of water. Ramya R, Lokesha H, et al., [5], In this the system is to develop a mechanical system for cleaning water tank. The setup of this project consists of a frame that is usually mounted on the ground rigidly with the help of suitable supports. The whole system is inserted in a retracted position into the water tank. The four-bar linkage is then adjusted according to the water tank diameter in such a way, that brushes at end of the shaft touch the water tank wall. Now the motor is switched ON. The four-bar linkage starts rotating along with the shaft. This causes scrubbing of the inner wall of the water tank by the brush attached to the ends of the linkage. For cleaning the upper portion of the water tank, the whole mechanism is reciprocated along with the guideways with the help of another D.C motor with a rack and pinion mechanism. In this way, the water tank gets cleaned within time. Limitations of this system are more moving parts are involved and the cost of the system is high. Ashwin Chander, et al., [6] In this paper the project is to develop a mechanical system for cleaning water tanks. The method used to clean the tank is water from the tank is first pumped out. Once the tank has been emptied, the cleaning machine is gradually placed inside the tank through the tank opening passage. The machine consists of a scrubbing mechanism positioned towards the face of the tank, which is to be cleaned first. A sprinkler system has been installed in the machine, which sprays pressurized water, simultaneously during the scrubbing of the walls. Thus, the scales and sludge after scrubbing and rinsing with water get collected at the 8 bottoms of the tank. There is a suction mechanism provided at the lower end of the machine, which absorbs all the waste from the floor of the tank to storage placed outside of the tank. The suction mechanism installed absorbs the sediments from the tank floor at a designated pressure. This procedure can be repeated for two to three cycles for complete cleaning of the tank. Limitations of this system are it can only be used for cleaning rectangular tanks, the machine is bulky, the machine is placed after the tank is emptied, causing wastage of water and human supervision is required. Yogesh Kumar S R, et al., [7], In this the water tank cleaning machine is developed for overhead tanks. The machine is attached at the top of the tank. Then the brushes are mounted at the three ends of the shaft through the surface of the tank. After the complete setup, the motor rotates and the brushes rotate at the surface of the tank. The system has been system and cleaning operation also. But the sludge cannot be removed completely thus a suction mechanism is involved at the bottom for complete removal of the sludge from the tank. The machine can be operated on solar energy also. The machine could be fully automated(sensors). Akshay Sawansukha, et al., [8], In this the whole mechanical system is inserted into the tank through a manhole in retract position, this is done manually (Opening diameter of the tank is smaller than the diameter of the tank). After this Lubricant is sprayed throughout the inner wall & bottom of the tank for easy cleaning with help of a pipe that is attached to the submersible water pump. Initially, the base of the system should touch the bottom of the tank. Switch ON the motor. As the motor starts, the main shaft will start rotating in turn the C-type foldable rod also starts rotating. The brushes attached to the edge of the C-type rod will start cleaning the inside wall and bottom of the tank. After the cleaning is done switch off the motor and remove the assembly from the tank. Then with the help of a suction pump, they take out all the dirty water present in the tank. After that, a spray an antibacterial solution which is effective in purifying water against all microorganisms, including bacteria, bacterial spores, fungi, viruses, etc. In such a way the tank gets easily cleaned by using this automated cleaning system. The system could be more compact and lighter in weight. Improvement in the design to improve the efficiency.

III. MAIN COMPONENTS

The components used in the system are mentioned in Table No.-1:

Table No.- 1. Component Specification

Component	Specification	Manufacturer	Function
Submersible Motor	1 phase 0.3KW/0.5HP, 2800rpm 220V,4-5A, 50Hz	Sharp King -Mini OpenWell	To generate centrifugal force when the water level goes above the level sensor.
Starter	1 phase 0.5HP		
Water Level Sensor	DC-5V, =< 20A Analog Sensor	Water Level Depth Detection Sensor Module	Ensures the turn-off of the motor if the water level is low.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Arduino Uno	Atmega 328 DC-5V(o/p voltage), DC-7-12V(i/p voltage) DC-20mA(I/O pins) 16MHz	Arduino	Controller of the system. Used to interface all the components and sensors.
Bluetooth	2.4GHz ISM band 3.3 - 6V Supply current:30mA	HC-05	Interfacing medium between mobile application and system.
2 CHANNEL 12V RELAY MODULE	10A 250VAC 10A 30VDC 10A 125VAC 10A 28VDC	Hong Wel-JQC3F-12VDC-C	Used for converting ac-dc. As controlling required DC 12V signal.
Turbidity Sensor	Operating Voltage: 5V DC Operating Current: 40mA (MAX) Analog output: 0-4.5V pH Measuring Range 0-14ph	Turbidity sensor SKU: SEN0189	Used for measuring the degree of sludge deposited at the base of the water tank. This value is displayed on the mobile application.
Adapter	Input: 100-240V AC Output: 12V - 2A	PE AC/DC Adapter	For powering Arduino and relay on 12V signal.
Water Pump	1 phase power Rating: 0.014 kW Power Supply: 220 Motor Power: 0.02 HP,45 Lpm	Circle 14w Submersible pump: Varun Cooltech (INDIA) Pvt. Ltd.	For generating vacuum suction to suck the turbid water.
Timer Module	3.3V	DS3231	Used for counting sedimentation time, motor-on time, and pump-on time.
Water filter candle			Used to purify the sludge water coming out from the pump.
RGB Lights	DC12V, Operation temperature: -20-50°C, Water-proof rating: IP20, LED lighting angle: 120°	RGB Lights ILED	Used for a display to the user. Changes in lights show the ongoing process.

IV. METHODOLOGY AND WORKING PRINCIPLE

The suggested system lives at the base of the circular tank. This system will work on the principle of Centrifugal force and the Sedimentation process. A level sensor is attached to the tank, and as soon as the water level goes above a limit of 3/4th to the submersible motor height, this sensor becomes active high, and starts the submersible motor through a 12V 2 channel relay module with 10A 250VAC 10A 30V DC, generating a circular motion in the water, called centrifugal force. After 5 minutes of the submersible motor start (considered as per test results), the submersible motor turns off and the sedimentation process begins, where the heavy dust and dirt particles (Grain density >= 1.49g/cm3) settle down. This starts sedimentation and the time will be counted with the help of the DS-3231 timer module. After the particles are settled down the water pump turns on, this will vacuum out water and dust from the base of the tank. A mobile application is designed for a better user interface that allows the user to turn on the submersible motor or water pump manually. For more efficient cleaning, a turbidity sensor is integrated into the system which will continuously monitor and display the values. Now, if the sensor value goes above a certain value as per water quality, the user gets a warning on the application. The whole of these sensors is controlled through ATMEGA 328 - ARDUINO UNO. The user interface is obtained through the BLUETOOTH HC-05 module, which communicates between the application and the system. During sedimentation time, the water pump and submersible motor cannot be turned on, as the particles need to be settled down. The submersible motor and water pump cannot be turned on simultaneously. An RGB is connected as an indicator for user display i.e change in colors shows the ongoing process. The block diagram is shown in figure no. 1.

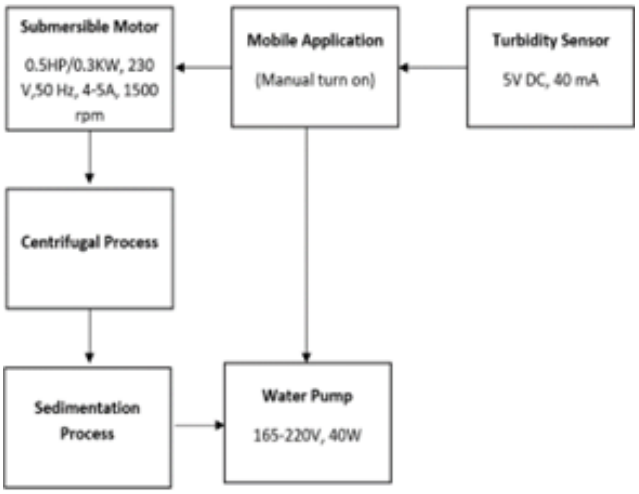

Figure No.-1. Methodology

V. HARDWARE ASPECT

The submersible motor operates at 1 phase, 0.3KW/0.5 HP, 230V,4-5A. A direct online starter is provided to start the submersible motor. The phase which is connected to a NO of 12V 2 channel relay module and neutral of the starter is connected to mains.COM of 12V 2 channel relay module is supplied to phase of mains making a phase connection. The same connection is kept for the water pump. The relay module helps switching ac signal to dc which is then sent to ATMEGA 328. Arduino Uno is interfaced with LEVEL SENSOR, TURBIDITY SENSOR via analog pins; DS 3231 timer module, 2 channel 12 V RELAY MODULE, RGB light via digital pins, and HC-05 Bluetooth module via Receiver and transmitter pins.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

The circuit integration is shown in figure no. 2. A mobile application is created using MIT APP Inventor, which allows manual turn on submersible motor and water pump, and values are received continuously from turbidity sensor. This app is connecting to the circuit part via Bluetooth HC-05 Module.

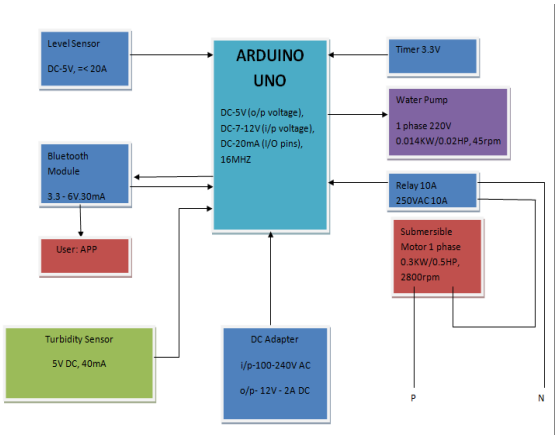

Figure No. 2. Pin Diagram of Circuit

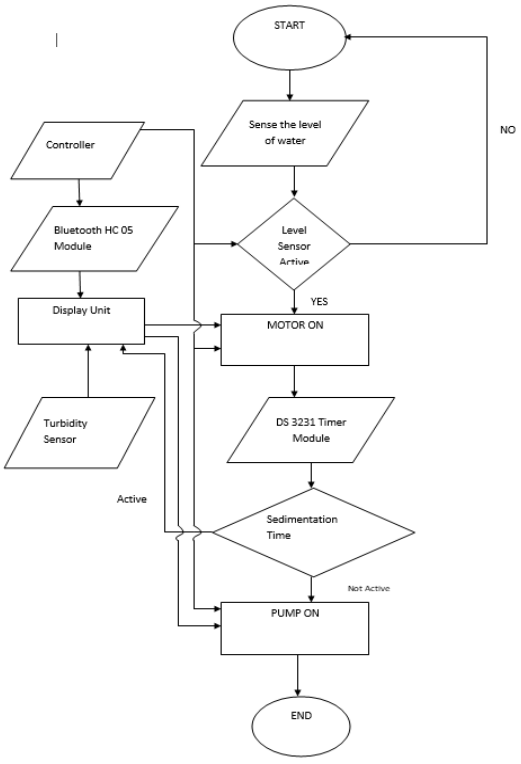

Figure No.-3. Flow Chart

VI. SOFTWARE ASPECT

A mobile application is designed with the help of the MIT APP Inventor for a better user interface. The flow chart is shown in figure no. 3. It displays:

1. Bluetooth status
2. Button to turn on the Motor and pump.
3. Sedimentation status
4. Turbidity value

One of the results on MIT APP Inventor are shown in figure no. 4.

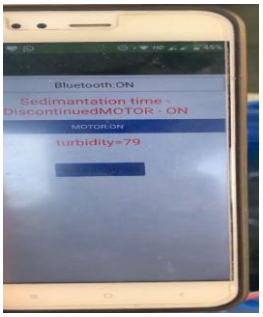

Figure No.- 4 Mobile Application

VII. RESULT AND CALCULATION

i. The mechanism was tested on a 200 ℓ water tank and the observations are:
   a. Height of submersible motor = 25cm
   b. Minimum water level that should be available to start the submersible motor is greater than $3/4^{th}$ to the height of the submersible motor.
   c. $P = 2 \pi N T / 60$
ii. P (Pressure) = 0.3KW
iii. I (Current) = 4-5 A
iv. N (Speed) = 1500 rpm
v. T (Torque) = 1.91 N-m
vi. T = F*r
vii. d (Diameter of submersible motor) = 18cm
viii. r (Radius of submersible motor) = 9cm = 0.09m
ix. F (Centrifugal Force) = 21.22 N
x. Range of sludge density that the system could clean is less than equal to 1.49 g/cm^3.
xi. As per the test, the submersible motor should be turned on for 5 minutes.
xii. Sedimentation time takes place in 4 hours.
xiii. The pump is turned on for 3 minutes, as in this time it takes out the water with dust and dirt.
xiv. Total time for the process is 4 hours 7 minutes.
xv. The tank can be placed in the center or side of the circular tank.
xvi. The pump is placed according to where the dust is settled down.
xvii. More accurate result is obtained when a wiper-like structure is attached to pump so that more surface area is obtained for suction.

The experimental set up is shown in figure no. 5 and 6.

Figure No.- 5 Setup of system

Retrieval Number: 100.1/ijitee.H91310711822
DOI: 10.35940/ijitee.H9131.0711822
Journal Website: www.ijitee.org

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

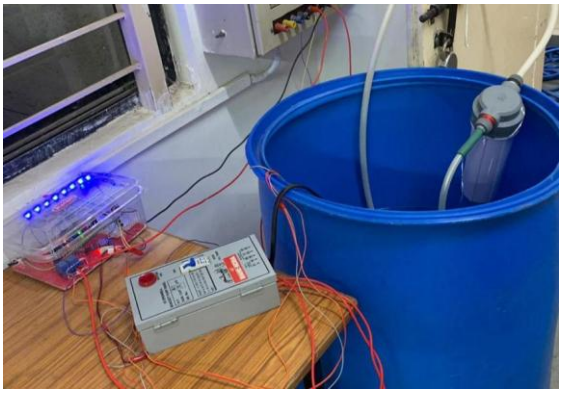

Figure No.- 6. Setup of system

VIII. ADVANTAGES

Following are the advantages of this system:

a) No or Zero usage of chemicals, or detergents that may hamper water quality.
b) Zero water drainage due to use of a candle.
c) Less human intervention due to automated processes.
d) Submersible motor and water pump cannot be turned on simultaneously. Also, during sedimentation time both the other devices cannot be switched on.
e) Turbidity sensor provides real-time clarity of the water.
f) Application provides manual turn-on of submersible motor and water pump.

IX. LIMITATIONS

Following are the limitation of the system:

a) Sidewall of the tank cannot be cleaned.
b) Light-weightedted particles i.e. less than 1.49 g/cm^3 cannot be settled
c) Unexpected interruptions due to Interruption in light, Particles getting stuck in machinery.

X. CONCLUSION

1. The system available in the market has a human dependency; therefore, the proposed system has the advantage of reduced human intervention.
2. Proposed system is provided with a mobile application, which allows the user to turn on the submersible motor/water pump according to necessity.
3. As discussed, we can place the system anywhere in the water tank and the size of blades can be increased if the same specification of system components is utilized for large size tanks. For large tanks, higher rating submersible motor and pump can be used.
4. A regular process of cleaning the tank is obtained, since this process is automatic and cleans the tank at regular intervals, as compared to other manual methods.
5. Use of candle ensured zero wastage of water, as the water is sent back to the tank.

FUTURE SCOPE

The system could be moved underwater & integrated with light, a camera to the system would make the system more users friendly & more accurate since the person gets a real-time view of the tank. In the future, a connection of a Wi-Fi module could be provided so that the user will get a better interface & the device could be operated from a far distance.

REFERENCES

1. Thonge Suraj D., Shelke Prasad K., Wakte Vaibhav B., Thonge SharadA. ,Prof. Shinde R.S, "Automatic Water Tank Cleaning Machine", Published in International Journal of Engineering and Advanced Technology, Vol. 04 Issue 02, February 2017.
2. Rohit R. Dabhade, Shubham V. Lasankute, Sanket P. Wankhade, Shubham G. Darokar, Prof.Vikramsingh R. Parihar, "Automatic Overhead Water Tank Cleaning System: A Review and an Approach", Published in International Journal of Advanced Engineering Research and Science, Vol. 5 Issue 10, January 2018. [CrossRef]
3. Mr. Shubham Samrit, Mr.Divyarajsingh Mandale,Mr. Ankit Rokade, Mr.Paresh Choudhary, Mr.Faisal Khan, Mr.Abhijeet Kongre, Mr.Harshaldalvi, MrSaurabh Zade, Prof. M.S.Giripunje, "Fabrication of Water Tank Cleaning Machine", Published in International Journal of Innovations in Engineering and Science, Vol. 3, 2018.
4. P.Prem Kumar, W.Deotus, S.Kathir, T.Prasad, Dr.K.Karthikeyan, "Autonomous Water Tank Cleaning Robot for Indian Household", Published in International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 7 Issue 3, March 2018, DOI:10.15662/IJAREEIE.2018.0703017.
5. Ramya R, Lokesha H, Nitheesha T S, Yashwant C M4, Vitthal R,, "Water Tank Cleaner", Published in Journal of Emerging Technologies and Innovative Research, Vol. 6 Issue 5, May 2019.
6. Ashwin Chander, G. Siddharth, E. Krishna Kanth, Kevein Shadrack, P. Vetrivezhan, "Design and Fabrication of Water Tank Cleaning Machine", Published in International Journal of Innovative Technology and Exploring Engineering, Vol. 8 Issue 9, July 2019. [CrossRef]
7. Yogesh Kumar S R, Naveen Kumar, GowthamNaik,Venkatesh A, Hanumantharaya R, "Fabrication of Water Tank Cleaning Machine", Published in International Journal of Scientific & Engineering Research, Volume 11 Issue 6, June 2020.
8. Akshay Sawansukha, Aniket Humane, Himanshu Bhute, Prajwal fating, PriyalBobhate, Sandip Raghorte, Dr. V.G Arajpure, "Intelligent Based Design And Development of Overhead Water Tank Cleaning Machine", Published in Journal of 9 Emerging Technologies and Innovative Research, Vol. 8 Issue 6, June 2021.

AUTHORS PROFILE

Dr. Ashpana Shiralkar, BE ELECTRICAL, ME Control System, PhD is an Associate Professor at AISSMS INSTITUTE OF INFORMATION TECHNOLOGY, Pune. I'm currently designated as Head of Department of Electrical Engineering at AISSMS INSTITUTE OF INFORMATION TECHNOLOGY. I have pursued my under-graduation from Shivaji University, Kolhapur, and post-graduation from Savitribai Phule Pune University. I have 19 years of teaching experience and 1 year of research experience. I have published Eleven in International Journal & Two in National Journal. I have presented two of my papers at National conferences and one at an international conference. I have guided a total of 5 MTech students. I am an active member of the IEEE Pune Section.

Mansi Vazarkar, Electric Engineering final year student from AISSMS INSTITUTE OF INFORMATION TECHNOLOGY, Savitribai Phule University, Pune. A person who is persistent, flexible, and dedicated to work. I am holding the position of Technical Secretary of IE(I) students' chapter, AISSMS Institute Of Information Technology, Pune for the years 2021- 2022. My topic of interest is the automotive and power electronics domain. I am a design-oriented problem solver. I have done courses in C, Arduino IDE, MATLAB-SIMULINK, and A-CAD. Recently, our team has won 2nd consolation prize in a regional level project competition organized by DTE and 3rd prize in Anusandhan Research Fest 2k22 organised by IEEE, G.H Raisoni Institute of Management.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Pratyasha Kar, Electric Engineering final year student from AISSMS INSTITUTE OF INFORMATION TECHNOLOGY, Savitribai Phule University, Pune. A person who is persistent, flexible, creative, a team player, and dedicated to work. I am holding the position of Technical Joint Secretary of IE(I) students' chapter, AISSMS Institute Of Information Technology, Pune for the years 2021-2022. My topic of interest is electrical machines and control systems. I am a design-oriented problem solver. I have done courses in C, Arduino IDE, C++, Python, embedded systems, digital marketing, and blockchain. Recently, our team has won 2nd consolation prize in a regional level project competition organized by DTE and 3rd prize in Anusandhan Research Fest 2k22 organised by IEEE, G.H Raisoni Institute of Management.

Vishal Dhobale, B.E final year student of Electrical engineering, from AISSMS INSTITUTE OF INFORMATION TECHNOLOGY, Savitribai Phule University, Pune. I'm a practically oriented student, a Hard worker, honest and dedicated to my work. I have a positive attitude toward learning and I gain knowledge very quickly. I have completed an eight-day training on six Sigma Green Belt. I'm a design-oriented problem solver. I have done the course in Python programming. Recently I have placed in Wipro Pvt.Lmt. Also, recently my team has won 2nd consolation prize in a regional level project competition organized by DTE and 3rd prize in Anusandhan Research Fest 2k22 organized by IEEE, G.H Raisoni Institute of Management.

Pratik Ghawate, B.E final year student of Electrical engineering, from AISSMS INSTITUTE OF INFORMATION TECHNOLOGY, Savitribai Phule University, Pune. Currently, I am a Sales Analyst intern at Elringklinger. I possess unyielding expertise in business development, general management, and critical thinking. I have done courses in C, C++, Python, SQL, and Google data analytics. Recently I have been admitted to the University of Southern California for a master's in Engineering Management. Furthermore, I am known as a proactive and innovative leader who thrives under pressure; equipped with presentation, analytical, management, and problem-solving skills. Recently my team has won 2nd consolation prize in a Regional level project competition organized by DTE and 3rd prize in Anusandhan Research Fest 2k22 organized by IEEE, G.H Raisoni Institute of Management.