ISSN: 0974-6471, Vol. 15, No. (1-2-3) 2022, Pg. 01-08

Oriental Journal of Computer Science and Technology

www.computerscijournal.org

Deployment of ROBOT for HVAC Duct and Disaster Management

PANKAJ BHAMBRI[1]*, MANPREET SINGH[1], INDERJIT SINGH DHANOA[2] and MRITYUNJAY KUMAR[1]

[1]Department of Information Technology, Guru Nanak Dev Engineering College, Ludhiana.
[2]Department of Computer Science and Engineering, Guru Nanak Dev Engineering College, Ludhiana.

Abstract

The SBM Robot is a manually operated robot focused on the Internet of Things and the robot operating system. The system is focused on washing and maintenance. The robot is controlled by an android app that uses the Google Real Time Firebase database to control the robot. HVAC duct is small in size and cleaning and repairing the duct is a very difficult task for humans, but it's easy to robot, robot goes inside the duct, and inspects and cleans the duct. Like similar, ships use fuel, oils, sludge, sewage, water and other fluids stored in tanks.

Article History
Received: 28 August 2022
Accepted: 28 October 2022

Keywords
Internet of Things;
SBM Robot.

Introduction

The SBM (Swachh Bharat Mission) Robot is a robot centred device manually operated internet with a head. The arm used in our robot has a low-cost arm with a good quality acrylic sheet. The word used for a mechanical device is the number of independent parameters that describe its structure called DOF (Degrees of Freedom). Once a robot arm is built, the DOF is known to be connected to roll, yaw, and pitch. The arm has 3 DOF for cleaning and maintenance operations with optimum precision.[1-10]

This Robotics Arm consists of three axes of rotation and three joints. In which one twisting joint and the other two are revolute joint. This arm mounted on chassis and chassis has consisted four wheels. All-wheel is connected with Direct Current (DC) motors. All robotic joints connected with the servo motor. Pi camera used for camera feedback and streaming status of the tank/tube. A multi-gas analyzer is used for detecting the percentage of oxygen and the availability of toxic gases.[11-24] All DC motor, servo motor, multi-gas analyzer, and the pi camera is controlled by Raspberry pi microcontroller. The robot is controlled by the web applications and android applications through the Internet of Things. The Raspberry Pi is connected with Google firebase which is connected to the

CONTACT Pankaj Bhambri pkbhambri@gmail.com Department of Information Technology, Guru Nanak Dev Engineering College, Ludhiana.

Doi: http://dx.doi.org/10.13005/ojcst15.010203.01

android application and web application. Android application sends a command to the raspberry pi and raspberry controls the robot.[25-34].

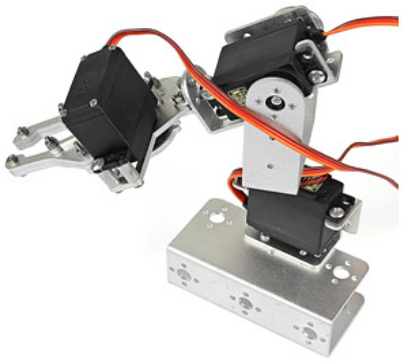

Fig.1: Robot Architecture

Project Category

Robots are an technological and research facility that incorporates Mechanical Engineering, Electrical Engineering, Computer Science, Information Technology and is still in the evolving sector as it has developed in the past 10 years and is near to the point of departure. It's an ever-expanding field, and in the past, many paths have been opened. The robot pledge is simple to describe, but complicated to comprehend. A robot is a smart agent or agent that can perform tasks automatically or in a directory, usually with remote control. It is usually an electronic machine that is controlled by computers and electronic systems when operating a robot. Robots promise to move and convert objects as easily as a computer system converts data. But the gray area remains wide when it comes to research awareness in the field of robotics and automation. Sooner or later, robotics and automation can be seen in any area of human life. Advances in development will carry the day of robotics through. They will quickly switch anywhere from the tools to the clothing and even our own heads. In view of the increasing need for automation, machine vision should become a pioneering technology of the future. Industrial automation and robotics are in high demand in the market because they have a strong effect on the development of the business. Simple and advanced mechanical robots are used for precise and reliable research in these industries. The use of sensors has allowed the ability of industrial robots to be increased. Vision sensors are used to provide visual information to help control robots. The robot controller uses the knowledge derived from the target and the simulation software to guide the robot arm to reach, retain and steer the target. A photo is worth more than 10,000 characters. Image processing has been the most popular and most efficient new technology. Machine vision is expected to be a pioneer in future technology. Computer vision provides power to perceive and control any entity around it. The two main goals of automation of the production cycle of the automotive sector are to maintain efficiency and rising unit costs. The focus is on the technical details and location of the selected robots. In order to upgrade and repair the component, it is necessary to ensure the consistency of the goods and to ensure a smooth and reliable processing pace that allows the development of the full performance. Color is also the most popular attribute that distinguishes between items, sorting, viewing, and monitoring.[35-37]

Objectives

Major set of objectives are as below

- To Construct the IoT (Internet of Things) based mini robot
- To Deploy the robot for HVAC (Heating, Ventilation and Air-Conditioning) duct and disaster management
- To Deploy the robot for ships tanks

Need of the Project

Effective solution of this problem is critical to avoid

- Time delays in inspecting, cleaning and repairing tanks/duct
- Accidents which still occur inside the tanks on board ships.
- Manpower cost.

Existing System

At the moment, the problem is being solved by letting air into the tanks and having people wear protective gear. But the ambience in the tanks is still not good enough and continues to put people's health at risk. Before trying to make admittance for tank cleaning, the following steps are taken

- The fluids in the tank should indeed be taken out as soon as possible and completely before going into the tank.

- Ventilate the tank thoroughly or use forced ventilation to make it safe for people to enter.
- Before getting to the person, the surroundings of the tank is inspected for the amount of oxygen and any poisonous gases. This needs to be done from a distance, if this is not possible, the person who goes into the tank must dress up a breathing device to test the air quality.
- Various rates and compartments of the tank are checked for the amount of oxygen and the presence of poisonous gases. A multi-gas analyzer shall be used and an evaluation shall be carried out by an individual who is qualified and has experience of the usage of these devices. When the tank has been made secure for man to join, staff reaches the tank and carries out washing, testing, maintenance, etc. Living inside such tight areas is dangerous, given all health measures.

Proposed System

You can solve the problem by making a device like a robot with the succeeding attachments.

- A gas analyzer to check how much oxygen is in the air and if there are any toxic gases;
- A camera to look inside the tank and look for problems.
- A cleaning attachment.
- Fix the joints.
- Tools for Checking Quality

The robot should be able to work reliably on a ship & be able to go inside the tanks & reach every part of them. It should be able to be programmed to move horizontally, vertically, change speed, move in a single or multiple stages at any length & angle range, etc. It should be small enough to fit on a ship and light enough to carry. The way it's fixed should match how things are done on the ship.

Unique Features of the System

The system reduces the accident of cleaning and inspection of ships tanks and HVAC duct, and it also reduce the manpower cost.

System Design and Fabrication

The SBM robot is indeed a type of portable robot with an arm that works like a human arm and can usually be programmed. The hand can be the whole device or it can be a component of a larger robot. The links of this kind of manipulator are linked by joints that let them move either in a circular motion or in a linear motion. The way the manipulator works can be thought of as a kinematic chain. The last part of the manipulator's kinematic chain is called the "end effector," and it looks like an eye. We used three servo motors while building the arm since our construction enables mobility across all three dimensions. There is a servo motor at the foundation that enables the circular movement of the whole structure; the other two at the shoulder and elbow to enable the upward and downward movement of the limb. The serial arm is a three-degree device of independence. Three DOF regulates the location of the arm in the Cartesian vacuum, one for the direction of the wrist and one additional servo for the actuation of the final effector. The robot characteristics in the control Interface or teaching pendant are the foundation rotating, the arm, the elbow, the wrist rotate and the end effector. The foundation of the robotic arm is made of iron, while the ties are made of aluminium clips and iron. The serial manipulator uses 1 x frame, 1 x arm, 1 x elbow and 1 x handle. Servo motors operate as actuators for different joints. Such engines have a 180-degree rotation in the clockwise direction. The engines are powered by the raspberry pi microcontroller board upon receipt of commands from the host machine via Universal Serial Bus (USB) cable.

Connectivity

Raspberry Pi is linked to the Internet through Local Area Network (LAN) and Personal Computer (PC) which are connected to the Internet by LAN or Wi-Fi. Raspberry Pi is directly attached to the robot arm and RJ45port is connected to the LAN network, enabling the user to track and power over the Internet by entering the domain.

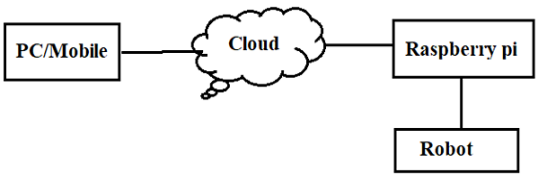

Fig. 2: Block Diagram of Connectivity

Information about the two-way contact is sent to the computer, and when the web page is used, python code is run on the domain controller as it continues to follow the route, so that the impacts can be shown on the server side. This method would be based on an algorithm that was made to get rid of the entity. Pi sends the signal to the robot that tell it how to move, which lets the head move. Simple Robotic Cognitive Automation (RCA) Exit can also be used to show the value of Pi. Raspberry Pi store information in a database, and the data it collects can be used to move the robot arm precisely. Applications which are built with both hardware & software features are linked to make a stable device. Figure 2 is the Block Network Circuit.

Methodology

Today, people want robots with high precision, high output, & no mistakes. Robots are better at doing precise or repetitive work. For a robot, a sensor and camera is basic decency for machine-like image analysis to detect and recognize an object as well as its characteristics, which helps it do a task that needs to be done. Using a camera & image computation in raspberry pi, a robotic arm can choose an object based on its colour, such as Red, Green, or Blue. The primary objective of the project is to create a robot that can pick up a certain object and put it in a different section based on its colour. Raspberry Pi has been used in a lot of different and useful ways in robotic systems. Raspberry Pi doesn't have any of the usual motor coordination peripheral devices built in, and it costs very little. The Python code for making a mechanical arm with image analysis and a local webpage with a slider to change the position of a servo motor has been written. For industrial purposes, the robot can help separate and sort objects by colour.

Virtual Design of Robotic Arm

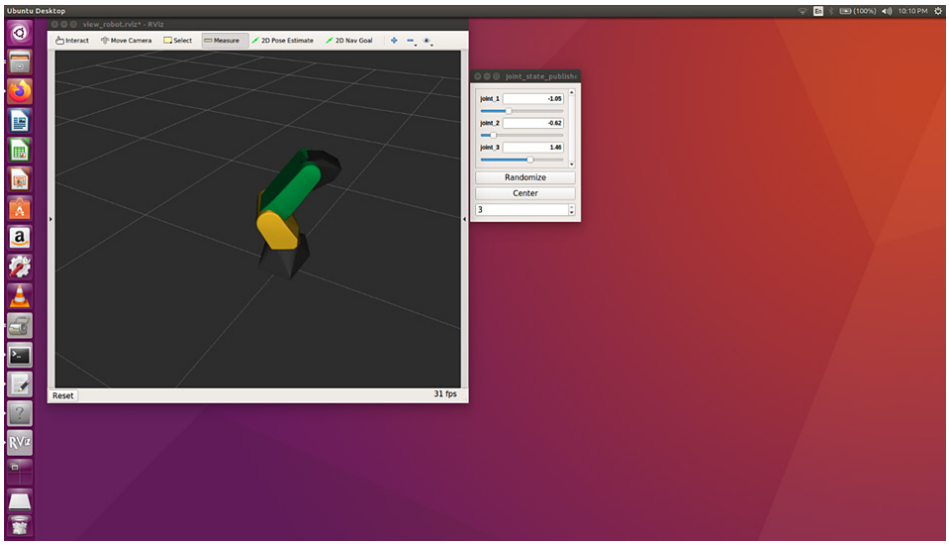

Fig. 3: Robot Arm in RViz

Robotic arm is created virtually in RViz using URDF file which are written in XML. It contains URDF macro and URDF xacro macro. Arm has 3 DOF which is tested using python program through ROS. Arm has 3 joint which is controlled by joint_state_publisher.

Transformation Tree of Robot

Transformation tree of a robot is defined as robot design description which component is used in robot design. In this case robot use slam technology using slam_gmapping for map creation and location finding in inspection process. It also contains laser and sensor which give information about the area as like unwanted objects and gases (percentage of oxygen and availability of the toxic gases).

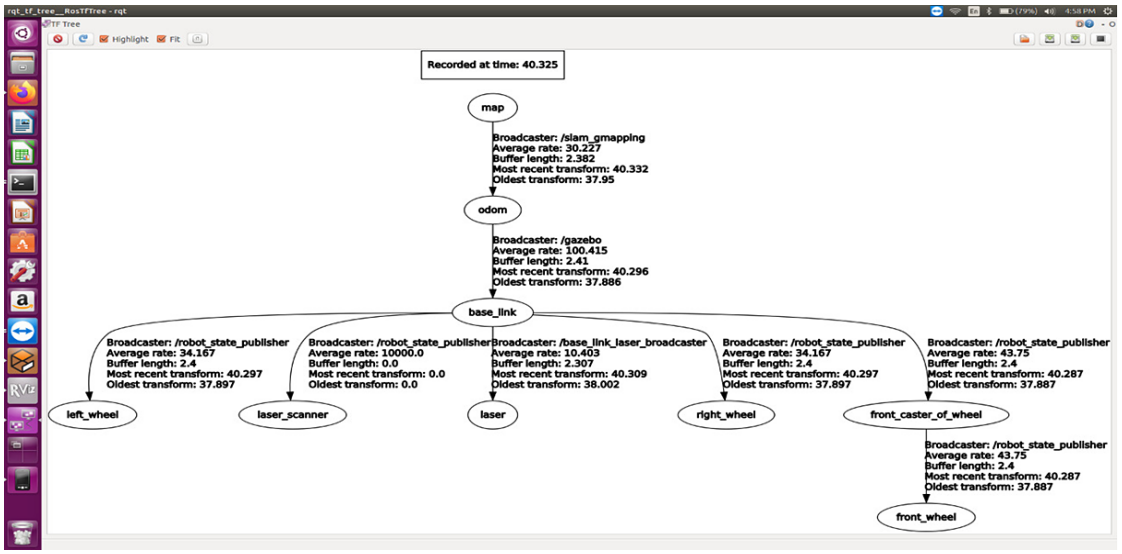

Fig. 4: Transformation Tree of the Robot

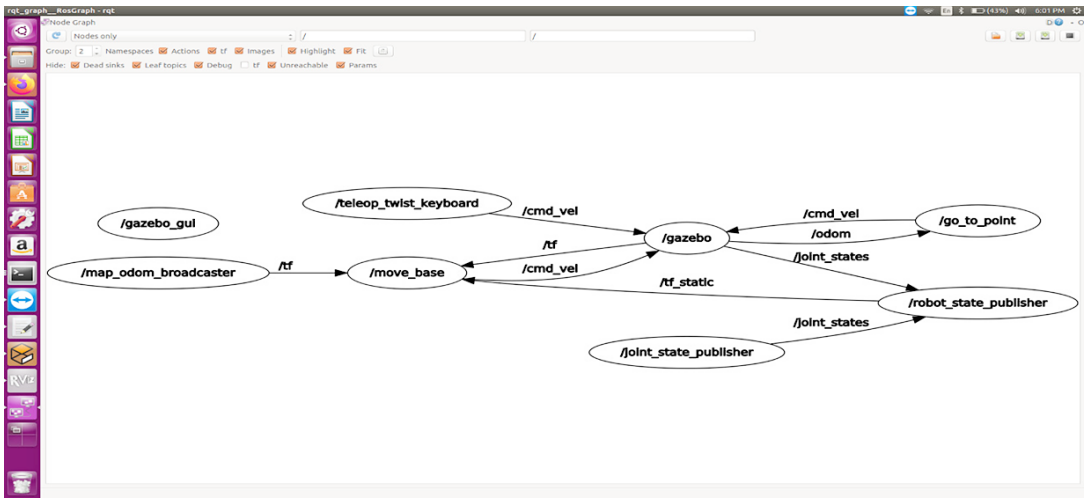

Fig. 5: rqt_graph of the system

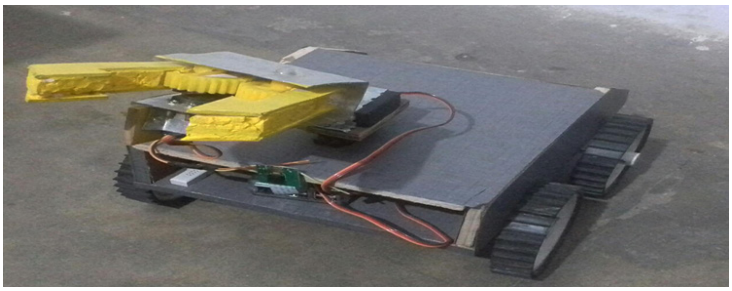

Fig. 6: SBM Robot

rqt_graph of the system

rqt_graph creates a dynamic graph of what's going on in the system. Oval represents ROS node and arrow represents ROS topic of the system. In this graph all publisher and subscriber are shown, and also shown which ROS node is subscribe/publish which node through which topic.

SBM Robot

SBM robot has a wheel and an arm and these equipments are displayed in Figure 6. Arm has a gripper which holds the repairing tools to perform various tasks in the HVAC duct and Ships. Robot front end has contains a camera which is give live camera feedback and also take picture of the location.

Conclusion

After five times translocation and replication from two forms of links (LAN and WAN), Raspberry Pi effectively regulates the robot neck. This implies that the use of Raspberry Pi is recommended to monitor and control robot's arm via website. With this method, the results of the test outcome will be applied on a wider scale in manufacturing equipment for other considerations, the weight and density of the items to be moved, the reliability of the position of the robot arm, and the style of contacts that occurred. In the upcoming work, this result will be established and restudied in order to have it applied in large scale implementation including the solution to the time delay due to the relation forms. All and all, the benefit of this program is that it will assist people in finding such items for example hazardous chemical compounds or artefacts quickly, rapidly, and effectively.

Future Scope

The robot is the most growing technology in future because of industry 4.0 revolution and the COVID19 effect. Due to COVID19 effect maximum work are done via remotely. So, conclusion of that the work which is not done via a remote location is done by the robot which is communicated through the internet of thing. So, Future scopes of the project are

- Used in disaster condition
- Inspection of bore-well and repairing of bore-well
- Inspection and repairing of large fuel tanks
- Used is military operations
- Used in inspection of patient condition of corona patient in isolation centre without direct contact of patients

Acknowledgment

Nil

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Conflict of Interest

The authors do not have any conflict of interest.

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