**Swachh Robot: An Autonomous Robot for Cleaning Tasks**

The ‘Swachh Bot’ is the project developed in order to technically contribute towards the “Swachh Bharat Mission”. In most of the situations collection and disposal of waste materials is done manually. This being a laborious and monotonous task becomes time consuming and inefficient when done manually. The project aims to build an autonomous robot that could perform these tasks in an efficient manner. The robot will make use of advanced computer vision and machine learning tasks to perform these tasks.



PID controllers and

Wi-Fi communication

Control instructions

Computer vison and

Machine learning algorithms

Camera video stream

An overall architecture of the robot is shown in the figure above. The robot is mounted with a mobile phone which streams the video over a Wi-Fi network to a computer. The Wi-Fi network can be established either from the computers or mobile phones. The computer implements the object recognition algorithms and sends the control instructions to the robot over the same Wi-Fi network. The robot is equipped with a nodeMCU which contains a microcontroller and ESP8266 Wi-Fi module. The PID controllers required for accurate robot motion is implemented on the microcontroller.

The architecture described above has many advantages compared to the use of onboard processors. Real-time processing of many of the object recognition algorithms requires expensive hardware. However, they can be implemented on computers. Another advantage being reusability. The robots developed are quite inexpensive except for the mobile phone and computer. However, the mobile phone and computer can be used for various other tasks when not being used with the robot. The architecture also facilitates creation of swarm of robots to perform the tasks collectively and collaboratively. The communication, control and coordination is difficult if every robot has onboard computers and performing its tasks independently.

Scale Invariant Feature Transform(SIFT), Speeded Up Robust Features(SURF), Local Binary Patterns(LBP) classifier, Viola-Jones Framework with Haar like features have been implemented and tested for object detection and recognition. Viola-Jones Framework with Haar like Features was found to provide best results. The algorithms are implemented using OpenCV in Python.

**Applications**

The robot basically performs object recognition and pick-and-place tasks and could be used in a wide variety of scenarios. Some of them are listed below-

* The robot could be employed by governmental organizations to clean surroundings and open grounds after events such as large public gatherings.
* It could be used to collect wastes from house-to-house. The waste bags would be labelled with stickers and the robot would collect the waste bags accordingly.
* It could be used in public places such as gardens to collect the waste materials.
* It could be used in industries for cleaning purposes.

The robot would be customizable and could be used in many situations other than cleaning which involves object detection and pick-and-place.

Some applications are-

* Industries to collect and move different parts/ objects from one place to another.
* In the warehouses, for collecting and placing objects.
* As personalized assistants to move around things in offices, hospitals etc.