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Floor Cleaning Robot with Vision

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Abstract - *The main objective behind this paper is to develop a robot to perform the act floor cleaning in domestic areas. Nowadays robot plays a vital role in our day to day life activities thus reducing human labour and human error. Robots can be manually controlled or can be automatic based on the requirement. The purpose of this robot is to roam around and provide video information from the given environment and send that obtained information to the user. In this project, one can control the robot with the help of a laptop and also can get the live streaming of video. This paper introduces design and implementation of a Floor Cleaning Robot with Vision based on Wi-Fi. The movement directions of the robot are controlled by a GUI designed using visual studio development environment.*

Key Words: GUI, Floor Cleaning, Robot, Video Stream, Vision.

1. INTRODUCTION

Technology has brought a dynamic and tremendous change in robotics and automation field which ranges in all kinds of areas. Surveillance is the process of Systematic ongoing collection, collation, and analysis of data and the timely dissemination of information to those who need to know so that action can be taken. Thus surveillance is mainly required in the areas such as border areas, public places, offices and in industries. It is mainly used for monitoring activities. The act of surveillance can be performed both indoor as well as in outdoor areas by humans or with the help of embedded systems such as robots and other automation devices. A robot is nothing but an automatic electronic machine that is capable of performing programmed activities thus replacing human work, providing highly accurate results and easily overcoming the limitations of human beings. Thus replacing humans in the cleaning fields is one of the great advancement in robotics. With the aim developing a robot which will be able to perform the initial goals, i.e. an autonomous cleaning and be able to navigate through a room or a house with the minimum human assistance, this Floor Cleaning Robot with

2. Proposed System

In this work, we have designed robot for cleaning environments. Proposed design is being operated in dual modes. In one of the modes, the robot is fully autonomous. In manual mode, the live stream after being processed by Raspberry Pi 3 controller and actuators (4 DC encoder motors) is viewed by the authorized person. The robot can also be used by controlling it manually from laptop with a Graphical User Interface (GUI) in Visual Studio (Python language) via Wi-Fi connectivity.

By accessing Log File based on the input of the object present the client navigates the robot in the surrounding, these movements are stored in log file. Further if there is a need to move the robot in the same path as before in the same area, the robot can follow the path stored in log file and save client's time by working autonomously.

3. Components Required

The hardware and software requirements for the Floor Cleaning Robot with Vision are as follows:

3.1 Hardware Specifications:

1. Raspberry Pi 3 model B
2. L298 Motor Driver (Stepper for both forward and reverse direction)
3. Wi-Fi Hotspot to connect remotely to Raspberry pi.
4. 12 volt batteries
5. DC motors
6. Camera

3.2 Software Specifications:

1. Python
2. Nodejs Express framework
3. Vnc viewer
4. Mobaxterm
5. Vs code Editor

4. Algorithm

4.1 Haar Cascade Algorithm

Haar Cascade is a machine learning object detection algorithm used to identify objects in an image or video and based on the concept of features proposed by Paul Viola and Michael Jones in their paper "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001.

It is a machine learning based approach where a cascade function is trained from a lot of positive and negative images. It is then used to detect objects in other images.

The algorithm has four stages:

1. Haar Feature Selection
2. Creating Integral Images
3. Adaboost Training
4. Cascading Classifiers

It is well known for being able to detect faces and body parts in an image, but can be trained to identify almost any object.

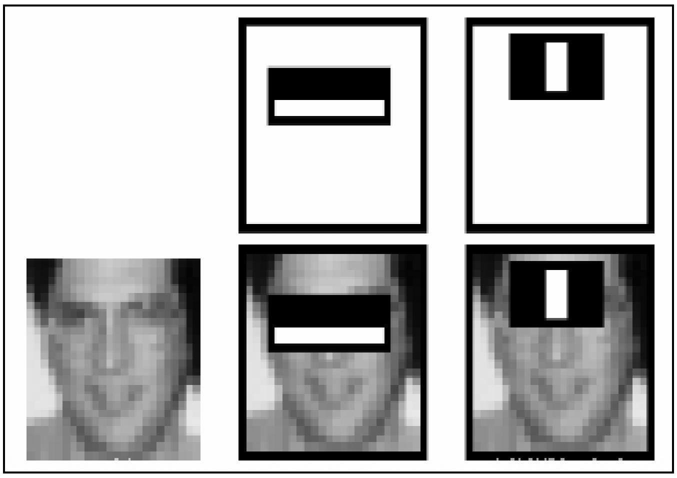
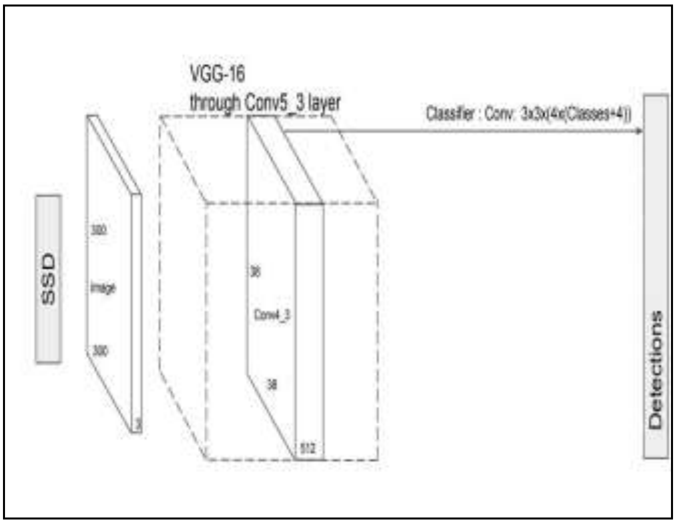


Fig. 4.1 - Object Detected Image

4.2 SSD Algorithm

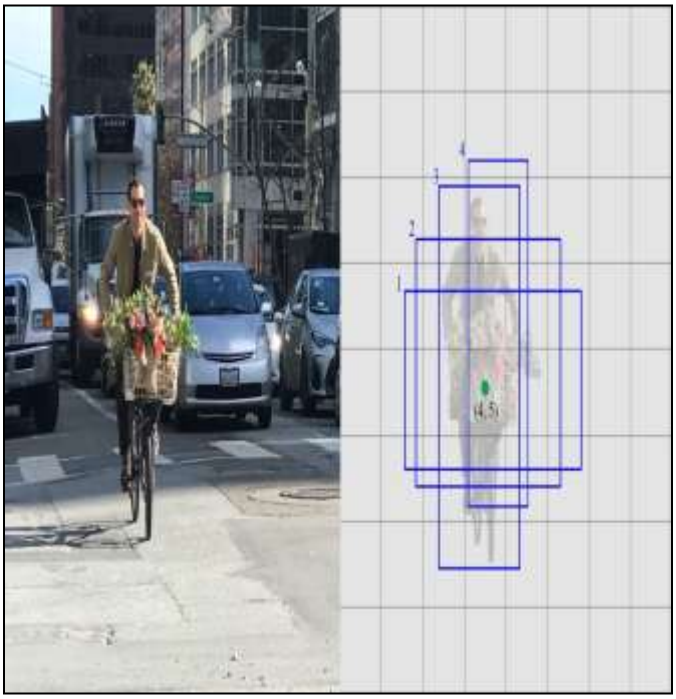
The SSD object detection composes of 2 parts:

1. Extract feature maps, and
2. Apply convolution filters to detect objects.



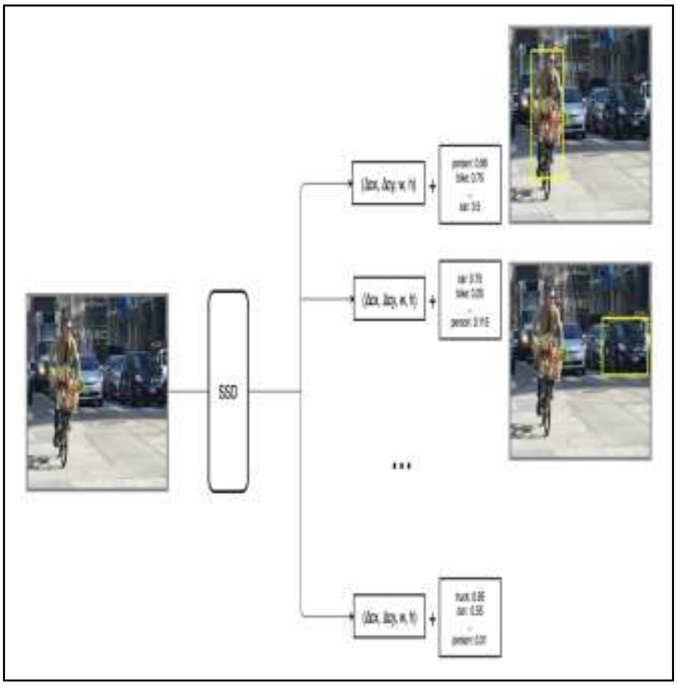
Modified from SSD: Single Shot MultiBox Detector.

SSD uses **VGG16** to extract feature maps. Then it detects objects using the **Conv4_3** layer. For illustration, we draw the Conv4_3 to be 8 ×8 spatially (it should be 38 ×38). For each cell (also called location), it makes 4 object predictions.



Left: the original image. Right: 4 predictions at each cell.

Each prediction composes of a boundary box and 21 scores for each class (one extra class for no object), and we pick the highest score as the class for the bounded object. Conv4_3 makes a total of 38 ×38 ×4 predictions: four predictions per cell regardless of the depth of the feature maps. As expected, many predictions contain no object. SSD reserves a class "0" to indicate it has no objects.

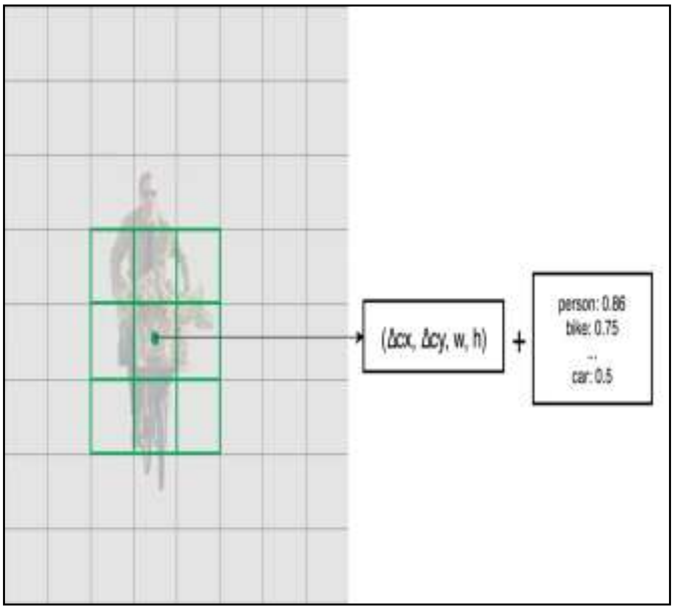


Each prediction includes a boundary box and 21 scores for 21 classes (one class for no object).

Making multiple predictions containing boundary boxes and confidence scores is called multibox.

Convolutional predictors for object detection

SSD does not use a delegated region proposal network. Instead, it resolves to a very simple method. It computes both the location and class scores using **small convolution filters**. After extracting the feature maps, SSD applies 3 ×3 convolution filters for each cell to make predictions. (These filters compute the results just like the regular CNN filters.) Each filter outputs 25 channels: 21 scores for each class plus one boundary box.



Apply a 3x3 convolution filter to make a prediction for the location and the class.

For example, in Conv4_3, we apply four 3 ×3 filters to map 512 input channels to 25 output channels.

$$(38\times38\times512)\xrightarrow{(4\times3\times3\times512\times(21+4))}(38\times38\times4\times(21+4))$$

5. Implementation Plan

5.1 Use case Diagram

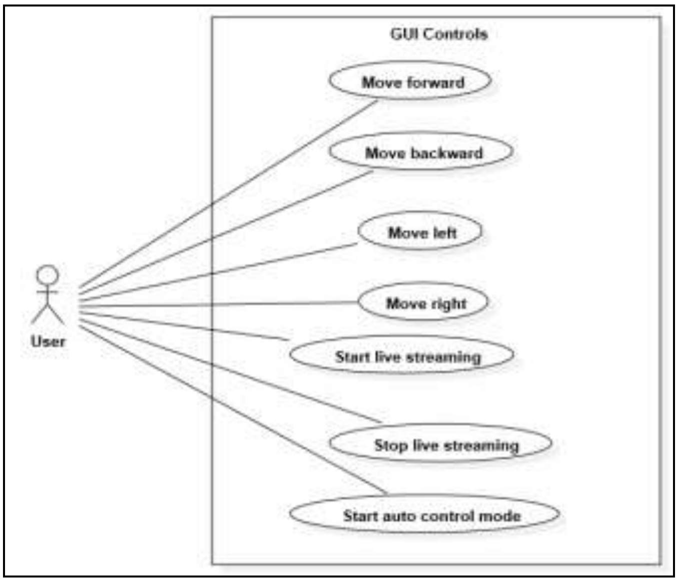


Fig. 5.1 - Use case Diagram

5.2 Block Diagram

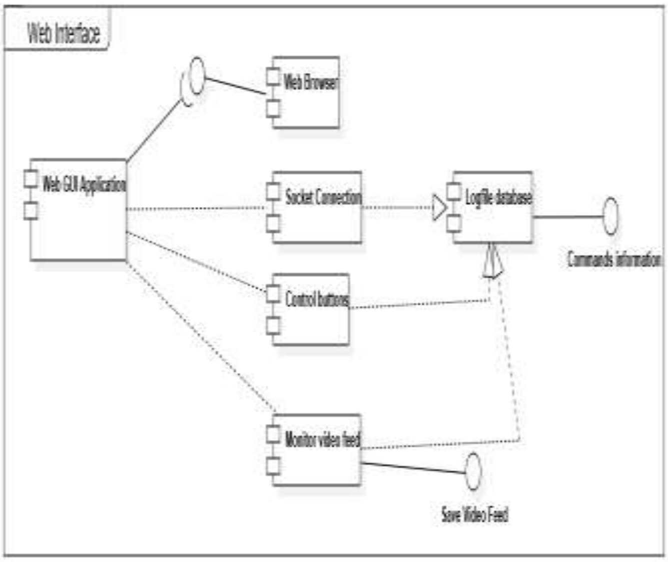


Fig. 5.2 - Block Diagram

6. Methodology

6.1 Activity Diagram

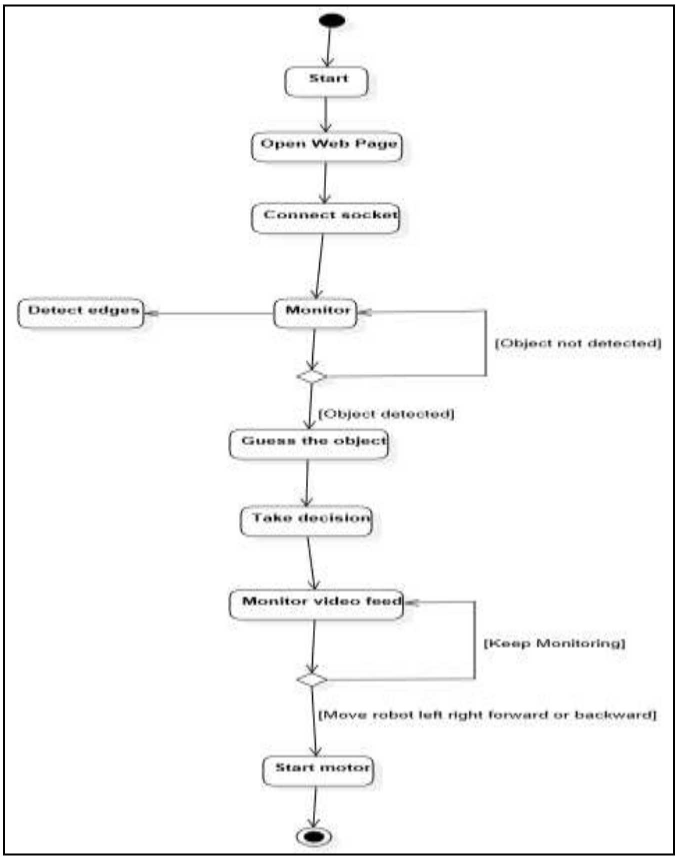


Fig. 6.1 - Activity Diagram

7. Result

It automatically moves to the designated area for cleaning and surveillance. The proposed robot can be remotely operated through the GUI. The robot detects the objects using the Haar Cascade Algorithm and SSD Algorithm. The robot has a GUI designed by which the commands are given to perform the necessary actions. The robot complies with the necessary building regulation requirements. Operation of the robot is efficient (e.g. cost efficient, energy efficient, manpower). Minimal human intervention is involved in carrying out its work. The robot has minimal noise disturbance to the public when in operation. The proposed robot has object recognition technology. This proposed solution is easy to operate and is able to effectively scrub the floors and provide reports accordingly.

8. Conclusion

Automation plays the major role in our daily life, since automation reduces the labour work, time and cost etc. Many automation processes in industry, hospitals and offices can be done with the help of robotics. Automating cleaning operation is one of the important process which is needed to be concentrated. This project enlightens about the advancement in cleaning. Ingenious floor cleaner robot with vision operates in two modes according to the user's wish. This mopping operation can be selected by a switch in automatic mode and in human control mode it is done through the application. This robot efficiently cleans the area.

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