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Multi-tasking Robot using Artificial Intelligence

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Abstract – *In modern day world, automation plays vital role in various aspects such as industrial work process, autonomous cars and exploration of complex places. This is extremely useful for enhancing the efficiency of achieving a particular task, at the same time minimizing the human power consumption. So, we have developed a mobile robot which can perform multiple tasks in a work environment using concepts of artificial intelligence. The robot detects various obstacles on its path from a given source to destination and identifies the type of obstacles using YOLO object detection algorithm by training the neural networks. It then avoids the obstacle without hitting with certain distance calculated using ultrasonic sensors. The robot also gives information about ambient conditions of its environment such as levels of temperature and flammable gases such as LPG using temperature and gas sensors respectively.*

Key Words*: *Artificial intelligence, automation, ultrasonic, YOLO, multi-tasking, sensors, non-max suppression, up sampling.

1. INTRODUCTION

Multi-tasking means performing multiple tasks at the same time. In the present time, automation plays a vital role in each and every field such as autonomous vehicles, industrial work process, restaurants, space exploration etc. As an example of multi-tasking, a robot can be used to serve food for customers By detecting, identifying and avoiding the obstacles in its path from kitchen to the customer's table and vice versa. At the same time, it has to sense temperature and also detect if there is any unusual leakage of cooking fuel(LPG).

So, using artificial intelligence concepts, we have developed a mobile robot that can perform multiple tasks in a work environment. The robot detects various obstacles on its way from one source to the destination and recognizes the form of obstacles using the YOLO object detection algorithm by training the neural networks. It then avoids the obstacle with some distance measured using ultrasonic sensors. The robot also gives information about ambient conditions of its environment such as levels of temperature and flammable gases such as LPG using temperature and gas sensors respectively.

2. LITERATURE SURVEY

1. According to Zhihao Chen et.al[1], it implements framework for object identification, localization and monitoring for smart mobility applications such as road traffic and railway climate. An object detection and tracking approach was firstly carried out within two deep learning approaches: You Only Look Once (YOLO) V3 and Single Shot Detector (SSD).

2. Zhong-Qiu Zhao et.al[2], a analysis of deep learning focused on the frameworks for object detection is presented in this paper. Generic object detection architectures are addressed in context with convolution neural network (CNN), along with some modifications and useful tricks to boost detection efficiency.

3. Licheng Jiao et.al [3], This paper highlights the rapid growth of deep learning networks for detection tasks, the efficiency of object detectors that has been greatly enhanced.

4. Yakup Demir2 et.al[4], addresses autonomous driving that involves reliable and accurate detection and identification in real drivable environments of surrounding objects. While numerous algorithms for object detection have been proposed, not all are robust enough to detect and identify occluded or truncated objects. A new hybrid Local Multiple System (LM-CNNSVM) based on Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs) is proposed in this paper due to its powerful extraction capability and robust classification property.

5. Mukesh Tiwari ed.al[5] discusses that the identification and tracking of objects are important research areas due to daily change in object motion and variance in scene size, occlusions, variations in appearance, and changes in ego-motion and illumination. Specifically, selection of features is a vital part of tracking objects.

3. EXISTING SYSTEM

Most of the mobile robots at present are based on object detection using SVM technique. SVM works by mapping data into a high-dimensional feature space such that data points can be classified even if the data cannot be separated linearly. There is a separator between the groups, then the data is translated in such a way that the separator can be drawn as a hyperplane.

But the main downside of the SVM algorithm is that it has many key parameters which need to be set correctly to achieve the best results for any given problem. Parameters which can lead to excellent classification accuracy for problem A will lead to poor classification accuracy for problem B.

4. BLOCK DIAGRAM

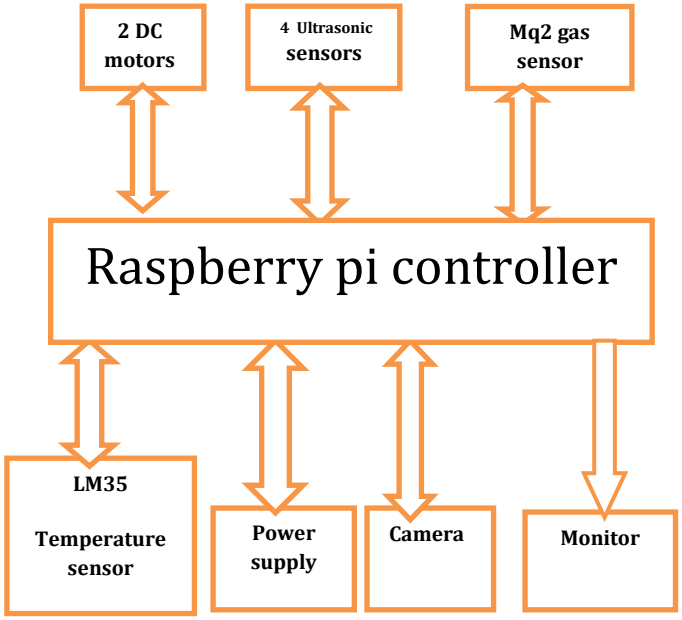

***Fig -1**: Block diagram of the model.*

The robot is controlled using Raspberry Pi controller, which is interfaced with a camera, two DC motors, four ultrasonic sensors, a gas sensor(Mq2), a temperature sensor(LM35). The results are displayed on the console.
***Camera**: It is used to capture the environment of the robot in video mode and send it to the raspberry pi controller.*
***Temperature sensor(LM35):** It is used for measuring ambient temperature.*
***Ultrasonic sensor(HC- SR04)**: Four ultrasonic sensors are used for measuring distance of obstacles from the robot in four directions i.e. Front, Back, Left and Right.*
***Gas Sensor(MQ2):** It is used for measuring levels of gases such as LPG*
***DC Motor:** It is used to control motion of the robot.*

5. WORKING

***Object Detection and Identification using YOLO**:*

YOLO is a custom object detector method which stands for " You Only Look Once". It is originally based on Darknet, a neural network library written in C and CUDA.

The network consists of 3 layers: Residual block, Decision layer and Upsampling layer. Detection happens in three stages or scales. In the image each grid makes three predictions using three anchor boxes. Anchor boxes are predefined boxes with specific heights and widths. Anchor boxes are chosen using K-means clustering. A cell is selected if the center of an object fall in the receptive field of the cell. The output of each cell has four dimensions [x and y coordinates, height and width].These four dimensions are converted into two dimensions for concatenating output of previous layers with present layer output. Predictions are made using following equations:

$$B_x = \sigma(t_x) + c_x \quad \text{------(1)}$$
$$B_y = \sigma(t_y) + c_y \quad \text{------(2)}$$
$$B_w = \rho\, w\, e^{tw} \quad \text{-------(3)}$$
$$B_h = \rho\, h\, e^{th} \quad \text{--------(4)}$$

Where :
B_x and B_y are x and y co-ordinates of center of bounding boxes.
B_w and B_h are width and height of bounding boxes.
t_x and t_y are co- ordinates of predicted center.
c_x and c_y are co- ordinates of grid.
σ is sigmoid function.
ρw and ρh are width and height of anchor boxes.

After the predictions, the outputs are concatenated at various levels. Non-max suppression is used to get rid of multiple detection of same object. Finally it draws the remaining bounding boxes using openCV.

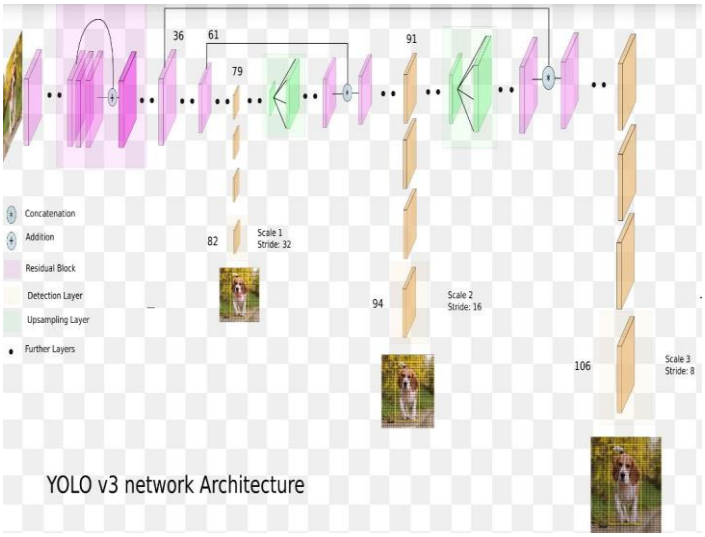

***Fig -2** : YOLO V3 network architecture*

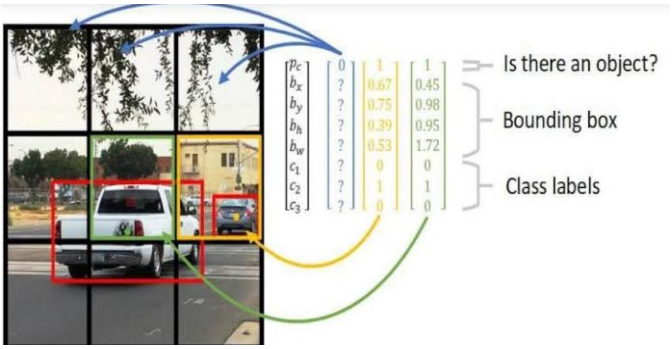

Fig -3.

1. *Finding distance of obstacle from robot is done using four ultrasonic sensors.*
2. *Measuring gas and temperature levels using gas and temperature sensor respectively.*
3. *Controlling motion of robot using results of object detection and distance calculation.*

6. APPLICATIONS

1. *Self-driving cars :- automobile companies such as tesla, BMW have designed driverless self-driving cars and these cars primarily use object detection and obstacle avoidance techniques. Hence, the developed model can be incorporated to build self-driving cars*

2. *Industrial process automation:- various tasks performed by humans in industries such as assembly and dispatching can be performed by these multitasking robots in order to achieve higher efficiency and to reduce human power employed.*

3. *Exploration of complex places:- in some highly compact places with very less space for humans to explore, these robots can be used for exploration as they are relatively small in size compared to humans.*

4. *Exploration of dangerous and harmful places: - places with dangerous ambient conditions such as gas storage units in factories can be explored and report if there is any dis-functioning of units such as leakage of harmful gases. This is extremely useful as manual detection by human is life threatening.*

5. *Restaurants:- mobile robots can be trained to identify customers and food items to serve customers.*

6. *Space exploration:- With fine tuning and future exploration it can also be used in space exploration which includes exploring the types of matter present in other planets.*

7. ADVANTAGES

1. *Compared to object detection using hardcoding, this artificial intelligence based object detection which involves deep-learning is more efficient in wide range of applications.*

2. *Budget friendly :- as most of the task is achieved using software and hardware components used are low in cost this entire project is budget friendly and affordable.*

3. *This automation process can be blended with manual control such as semi- autonomous driving vehicles to avoid road accidents.*

4. *Eco-friendly as it does not involve the use of any harmful materials.*

5. *It is possible to train the robot with custom data sets.*

8. LIMITATIONS

1. *Use of packages in object detection algorithms, which might need regular upgradation.*
2. *Can be expensive when incorporated into other higher level projects such as self driving cars.*
3. *processing time is slightly higher compared to conventional systems.*
4. *It needs use of high resolution camera in critical applications which might be high in cost.*

9. RESULT

***Fig-4**: The object is detected as "bus" in real time simulation*

***Fig-5:** The object is detected as "car" in real time simulation*

10. CONCLUSION

The developed model detects and identifies the objects using YOLO algorithm, which gives distance of obstacles from it using ultrasonic sensors and at the same time gives information regarding the ambient conditions such as levels of temperature and flammable gases such as LPG using temperature and gas sensors respectively. It is the use of deep learning based object detection algorithm YOLO, which increases the efficiency of the system compared to other systems which use conventional image processing (SVM approach). This developed model can be successfully used in industrial process automation, exploration of complex places and developing self-driving cars as per the set goals. Not only, it is efficient but it also reduces human intervention and is does not create pollution.

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