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PATH NAVIGATION AND OBJECT DETECTION USING CONVOLUTIONAL NEURAL NETWORK AND HAAR CASCADE FOR MOBILE ROBOT

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ABSTRACT

Autonomous mobile robot is a kind of vehicle that is capable of sensing its environment and navigating without human input. This paper demonstrates the development and implementation of a trajectory tracking control system based on computer vision for autonomous mobile robot. Neuromorphic computing is a propitious solution for reducing the hardware or size of mobile embedded systems. Convolutional neural networks are used here for path control of the quadruped robot. The quadruped robot detects the objects through the camera and visual data processing is performed via python and Open CV (Open Source Computer Vision) library. The microcontroller used in the robot is the Raspberry Pi (for actual real time processing and actuation of commands) which is used to control the L298 driver and Raspberry Pi camera. L298 driver is used to operate the Dc motor. This autonomous mobile robot is the prototype to the self -driving cars which is the growing technology of existing scenario

Keywords: *Convolutional Neural Network, OpenCV, Raspberry Pi, Pi camera, Object Detection, Autonomous Mobile Robot*

I. INTRODUCTION

Autonomous mobile robot, as inconceivable and far-fetched as it may sound, is one of the greatest technological revolution of near future. Potential of this technology is predicted that will adequately change transportation as we know it today. Autonomous mobile robot will speed up people and conveyance transportation as well as increase the security by reducing the human error.

Mobile Robots in the industrial sector are quickly evolving from powerful, stationary machines into sophisticated, mobile platforms to address a broader range of automation needs. Autonomous mobile robots (AMRs) differ from automated guided vehicles (AGVs) by their degree of autonomy. AMRs are far more independent than AGVs. AMRs will be an important part of lean operations in a wide range of industrial settings once they are widely deployed, as they are built to address specific challenges in typical industrial environments.

ANN provides high speed data processing capability of learning. The use of ANN in robotics for its kinematics, dynamics, and path planning and motion control has changed the definition of the robot.

As per Webster a Robot is: "An automatic device that performs functions normally ascribed to humans or a machine in the form of a human".

Using an ANN technique, adequate human like decision making quality can be built in a robot. This requires the analysis of environment to resolve complexity of motion and ensured that the robot is mechanically characterized to perform motion, with required degree of freedom. Then electronic has to support the motor used, hence to control the motion.

Mobile robot motion planning and path planning is one of the most apparent field of application of ANN. If a robot encounters an obstacle, the arm attempts to avoid the obstacle. One application of robotics is Simultaneous localization and Mapping (SLAM) which is the computation problem of constructing or updating a mapof an unknown environment while simultaneously keeping track of agent's location Within it. Image processing can

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ensure robot obstacle avoidance and path planning in a two dimensional work space of the robot. Robotic tunnel inspection is also one of the best application of mobile robots. In military also, mobile robots are also designed for the applications from transport to search & rescue and attack. Talking about self-driving cars, At present, many vehicles on the road are considered to be semi-autonomous due to safety features like assisted parking and braking systems, and a few have the capability to drive, steer, brake, and park themselves. Autonomous vehicle technology relies on GPS capabilities as well as advanced sensing systems that can detect lane boundaries, signs, signals and unexpected obstacles. While the technology isn't yet perfect, it's expected to become more widespread as it improves, with some predicting that up to half of the automobiles rolling off of assembly lines worldwide will be autonomous by 2025. Dozens of states already have legislation on the books concerning the use of autonomous vehicles in preparation for when this technology is commonplace.

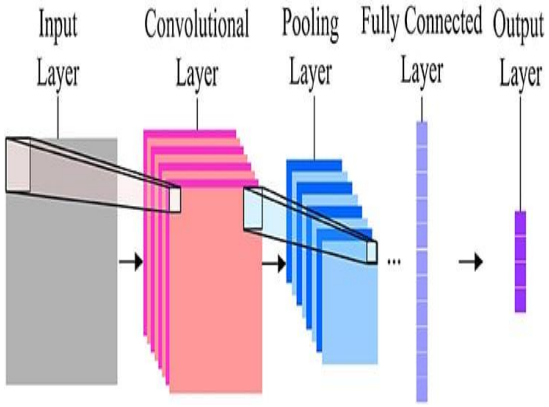
II. METHOD & MATERIAL

Convolution Neural Network: Convolutional Neutral Networks is used for image recognition and image classification tasks. A CNN accepts array of pixels values as input to the network.The hidden layer consists of several different layers which carry out feature extraction.

There is a fully connected layer that recognizes the object in the image. There are four layers in CNN. These are **Convolution layer, ReLU layer, Pooling layer and Fully Connected Layer**.

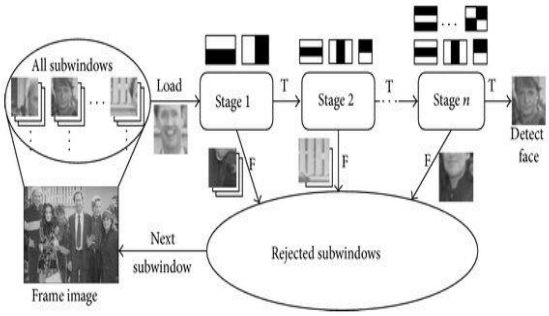
The **Convolution layer**uses a filter matrix over the array of image pixels and perform convolution operation to obtain a convolved feature map. The next layer is the **ReLU layer**which introduces non-linearity to the network. It sets all negative pixels to zero and performs element wise operation. The original image is scanned in multiple Convolution and ReLU layers for locating hidden features and patterns in the image. The output is a **Rectified Feature Map.**

The third layer is known as **pooling layer.** It reduces the dimensionality of the feature map. The output is a **Pooled Feature Map.** Pooling layer uses different filters to identify different parts of the image likeedges, corners, body etc. The pooled feature map is then converted into a **long continuous linear vector.** This process is called **Flattening.** This flattened matrix goes through a fully connected layer to classify the images.



Haar Cascades:
A Haar Cascade is basically a classifier which is used to detect the object for which it has been trained for, from the source. The Haar Cascade is obtained by superimposing the positive image over a set of negative images. The training is generally done on server and on various stages. Better results are obtained by using high quality images and increasing the amount of stages for which the classifier is trained. Some predefined haar cascades are also available.

Path Navigation:



In our project, for path navigation, a Raspberry pi (model 3 B+), attached with a pi camera module is used to collect input data.The processing unit handles multiple tasks: receiving data from raspberry pi, neural network training and prediction(steering). A multithread TCP server program runs on the computer to receive streamed image frames from the raspberry pi. Image frames are converted to gray scale and are decoded into numpy arrays.The functionality the autonomous mobile robot is mainly based on computer vision and convolution neural networks. One advantage of using neural network is that once the network is trained, it only needs to load trained parameters afterwards, thus the prediction can be very fast. Only lower half of the input images is used for training and prediction purposes. There are 38,400 (320x120) nodes in the input layer and 32 nodes in the hidden layer. The number of nodes in the hidden layer is chosen fairly arbitrary. There are four nodes in the output layer where each node corresponds to the steering control instructions: left, right, forward and reverse respectively. In the training data collection process, first each frame is cropped and converted to numpy array. Then the trained image is paired with trained

Label(human input). Finally, all paired image data and labels are saved into npz file. The neural network is trained in OpenCV using back propagation method. Once training is done, weights are saved into xml file. To generate predictions, the same neural network is constructed and loaded with the trained xml file.

Stop Sign Detection:

In our model for stop sign detection collection of positive samples which are target images(stop sign images) and negative samples other than target images (human images) carry out. Then Pre-processing of positive and negative samples and superimposition of Pre-processed images is performed with the help of OpenCVlibrary. Pre- processing contain gray scale conversation, image resizing etc. Resized dimensions for positive and negative samples are 50x50 and 100x100 respectively. After processing, training of data carried out on server. Opencv_createsamples command is used to create vector file of superimposed data and Opencv_traincascade command is used to train the mobile robot. Training time of the model depends on system, generally it takes 1 or 2 days. . xml file is created after trained the data.

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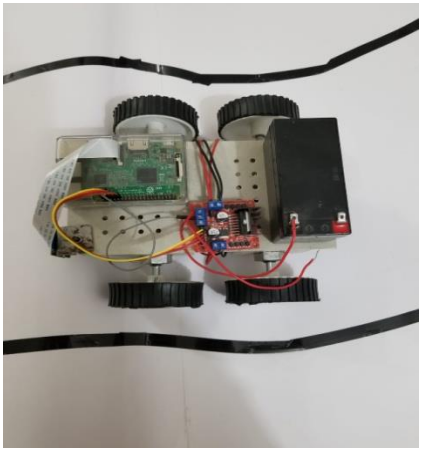
III. CONCLUSION

The designed autonomous mobile robot is capable of moving autonomously in the surroundings for which it is trained. It touch the track and make decision to go straight, forward, reverse, left, right and also able to stop when stop sign is detected. With the use convolution neural network, self-decision making by mobile robot is performed.



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REFERENCES

1. *M. Nielsen. "Neural Networks and Deep Learning." in 2017*
2. *J. Wu. "Introduction to Convolutional Neural Networks", in 2016*
3. *A. Karpathy. "Convolutional Neural Networks for Visual Recognition." in 2016.*
4. *B. Jia, M. Zhu, W. Feng. "Obstacle detection in single images with deep neural networks", in 2015.*
5. *SouhailGuennouni, Ali Ahaitouf, AnassMansouri. "Object detection using OpenCV on an embedded platform." in 2014.*
6. *Zheng Wang Auto RC Car GitHub.*