SERB Sponsored Research Internships (VRITIKA):

Title of Research Theme: Real-Time Object Recognition using Artificial Intelligence Techniques on NAO Humanoid Robot

Research Summary:

The research theme focuses on real-time object recognition based on NAO humanoid robot. Improving the perceptive abilities of humanoid robot has always been an emerging research topic. The breakthrough of computer vision technology represented by object recognition provides a broader idea for this purpose. In this research theme, in order to make the NAO robot detect objects faster, we proposed three objectives for real-time object recognition on the NAO humanoid robot. In the industrial field, the anthropomorphism of grasping of robots is the trend of future development. However, the basic vision technology adopted by the grasping robot at this stage has problems such as inaccurate positioning and low recognition efficiency. Based on this practical problem, in order to achieve more accurate positioning and recognition of objects, an object detection method for grasping based on improved YOLOv5 is proposed in the **first objective** of the research theme. To aid humans in everyday tasks, robots need to know which objects exist in the scene, where they are, and how to grasp and manipulate them in different situations. Therefore, object recognition and grasping are two key functionalities for such robots. Most state-of-the-art approaches treat object recognition and grasping as two separate problems, even though both use visual input. Furthermore, the knowledge of the robot is fixed after the training phase. In such cases, if the robot encounters new object categories, it must be retrained to incorporate the new information without catastrophic interference. In order to resolve this problem, a deep learning architecture with augmented memory capacities to handle object recognition and grasping simultaneously is proposed in the **second objective**. Object recognition and localization technology based on robot vision play an important role in robot motion, obstacle avoidance, object

grabbing and multi-robot cooperation. The object recognition and localization algorithm provided by the inbuilt process of NAO humanoid robot is not robust to different light conditions. It often causes misjudgment or low accuracy. As a result, the **third objective** of the research theme is to develop an effective algorithm for object recognition and localization algorithm based on NAO humanoid robot. In order to perform the experiment in real time, we have the NAO humanoid robot (NAO V6.0) in department of computer science and engineering, NIT Rourkela. This robot has been shown in Fig. 1.

Research Objectives:

1) Object detection for grasping based on improved YOLOv5 for the NAO humanoid robot
2) Simultaneous multi-view object recognition and grasping for the NAO robot using deep learning algorithms.
3) Exploring novel localization algorithm and object recognition by NAO humanoid Robot.

Proposed Methodology:

- In the first objective, object recognition for grasping based on improved YOLOv5 will be proposed. The robot object detection platform will be designed, and the different types of object image data will be gathered. The Eye-In-Hand calibration method will be used to obtain the relative three-dimensional pose of the object. Afterwards, the network pruning method will be used to optimize the YOLOv5 model from the two dimensions of network depth and network width. So, a lightweight improvement of the network object detection method based on an improved YOLOv5 will be made. This means that the NAO robot can position and recognize objects more accurately.
- In the second objective, simultaneous multi-view object recognition and grasping by the NAO robot is proposed using deep learning algorithm. The approach will take multi-views of an object as input and jointly estimate pixel-wise grasp configuration as well as a deep scale and rotation invariant representation as output. The obtained

representation will then be used for object recognition through a meta-active learning technique. It will demonstrate the ability of the proposed approach to grasp never-seen-before objects and to rapidly learn new object categories using very few examples on-site in both simulation and real-world settings.

- The third objective focuses on proposing an object detection and localization algorithm based on NAO Robot. The NAO robot can use the vision system to get the spatial coordinates of the object. Even under different illumination conditions and RGB space can well retain the color characteristics of the image and succeed in image segmentation. On this basis, the Hough circle detection will be used. The accuracy of object recognition is further improved by combining the shape information and contour features of the object. Through the new monocular vision location algorithm, we will transform the image coordinates and three-dimensional spatial coordinates. Then, the linear error compensation algorithm will be applied to improve the positioning success rate and accuracy.

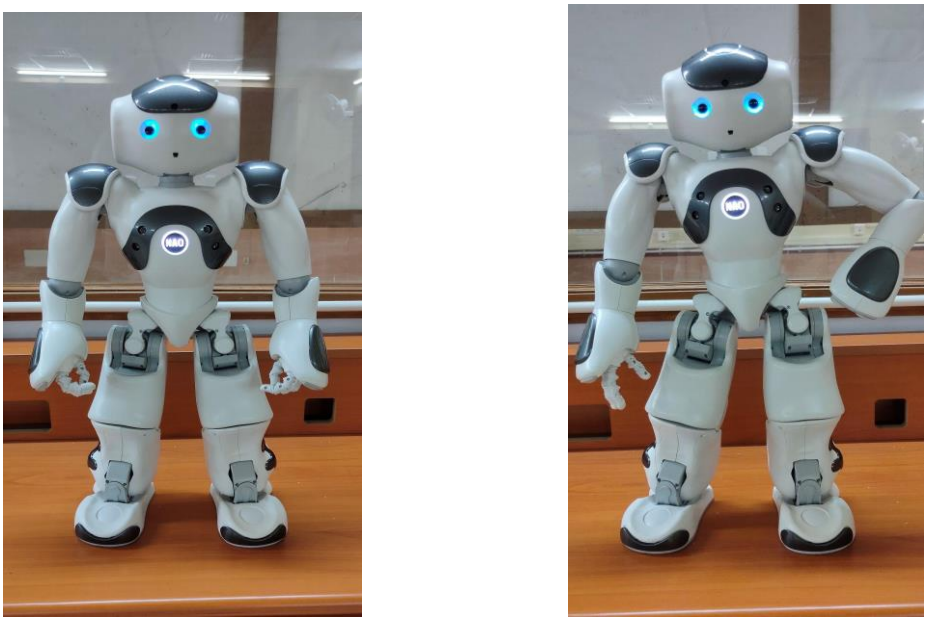

Fig 1: NAO Humanoid Robot

Plan of Research Work:

List of Research Interns	Nature of Work	Research Objectives	Timelines to complete the work with contribution details for each month	
			May 15-June 14, 2023	June 14- 13 July 2023
Research Intern1	Analytical and Experimental	Object recognition for grasping based on improved YOLOv5 for the NAO humanoid robot	Object recognition	Object grasping
Research Intern 2	Analytical and Experimental	Simultaneous multi-view object recognition and grasping for the NAO robot	Multi-view object recognition	Simultaneous grasping
Research Intern 3	Analytical and Experimental	Object detection and localization algorithm based on NAO Robot	Object detection	Object localization