**Purpose of Project Work outline**

The Project Work outline should give an overview of the work they intend to pursue for Project Work and present a time schedule of their planned tasks or milestone events.

The proposal submitted by the student will be evaluated by the institute. The evaluation would typically include the following issues.

1. Problem definition, clarity of the proposed work by the student and the proposed outcome of the work

2. Quality of work to qualify as Project Work

2. Justification for **16 weeks of work,** which is the assigned duration for Project Work

3. Proposed action plan for carrying out the work.

Once prepared and submitted it serves as the specification document for carrying out the work. If the outline is prepared with care and in detail with sufficient inputs, it will become a plan document and will aid the student to complete the tasks effectively within the stipulated duration.

The students are requested to prepare the outline keeping this in mind and submit it in the format prescribed in the “guidelines for Project Work outline”, which is presented below in this document.

Once the outline is prepared the students may start working on the Project Work, without waiting for any approval by the institute. Modifications, if any, are required to be made. The Project Work feedback will be provided by the Institute within a period of two weeks.

Title of Dissertation

**3D Object Shape Recognition and Motion tracking for Robotic pick and place application**

DISSERTATION

Submitted in partial fulfillment of the requirements of the

Degree: MTech in Artificial Intelligence and Machine Learning

By

Sai Nikhil Abinas Mohanty

2022AA05245

Under the supervision of

Arvind Raju, Principal Engineer, System SW Architecture, Intel

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE

Pilani (Rajasthan) INDIA

June, 2024

**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**

**SECOND SEMESTER 2023-24**

DSECLZG628T **/ AIMLCZG628T DISSERTATION**

Dissertation Title :\_\_ **3D Object Shape Recognition and Motion tracking for Robotic pick and place application** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name of Supervisor :\_\_\_Arvind Raju\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name of Student : Sai Nikhil Abinas Mohanty\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ID No. of Student :\_\_\_\_\_2022AA05245\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Courses Relevant for the Project & Corresponding Semester : 1. Video Analytics , Sem 3

2. Computer Vision, Sem 3

3. Deep Neural Network, Sem 2

4. MLOps, Sem 3

## Abstract

(Contents of the abstract is to be given here)

##### Abstract (in about 500 words)

**Key Words:**

Image Processing, YOLOv5, Object shape recognition, Motion Tracking, Motion Direction, MLOPs

In modern manufacturing and logistics, automation plays a critical role in enhancing efficiency, accuracy, and speed. One of the key components of automation is the ability of robotic systems to handle and manipulate objects of various shapes and sizes. However, traditional robotic arms often struggle with identifying and picking different type of objects that are moving on a conveyor belt, especially when these objects vary in shape and orientation. This challenge necessitates the integration of advanced computer vision techniques to empower robotic arms with the ability to dynamically identify and pick moving objects.

The dissertation would provide a comprehensive study and implementation on leveraging computer vision, video analytics techniques to enable a robotic arm to pick up various shapes of moving objects on a conveyor system. The project will focus on using depth camera as an input and will develop an image pre-processing and feature extraction algorithm for feature extraction and image modification best suitable for our use case.

The project will use Deep Neural Network model (YOLOv5) for 3D object shape recognition and motion tracking to predict shape and location of the object. The meta data such as location and shape will be published to a ROS environment for robotic system consumption.

To make this implementation production ready, the project will also use some of MLOPs techniques during development of model such as quantization, model packaging, containerization of solution, model meta data store. Different model performance metrics will be used to evaluate the solution.

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**

**II SEMESTER 23-24**

DSECLZG628T **/ AIMLCZG628T DISSERTATION**

**Dissertation Outline**

**BITS ID No.\_2022AA05245\_\_Name of Student:\_ SAI NIKHIL ABINAS MOHANTY\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name of Supervisor:** \_Arvind Raju\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Designation of Supervisor**:\_\_Principal Engineer\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Qualification and Experience: \_**BE, CSE , Experience: 25+ years\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**\_\_\_\_\_**

**Official E- mail ID of Supervisor:\_** raju.arvind@intel.com\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Topic of Dissertation**: **3D Object Shape Recognition and Motion tracking for Robotic pick and place application** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(Signature of Student) (Signature of Supervisor)

Date:------------ Date:--------------

The following pages give basic guidelines regarding the Project Work requirement and the outline preparation.

**Guidelines for Project Work outline document preparation**

The student should prepare a detailed **outline** of the Project Work in consultation with his/her Supervisor. Current literature (journals, books etc.) may be reviewed to support your work.

**Project Work Title**

Title should reflect the work that is to be carried out and should not be a very general in nature.

**Discussion on the chosen topic**

This section should include:

1. The purpose of the work and expected outcome of the work

2. Literature review done in connection with the work, if applicable

3. Brief discussion on the existing process and its limitations

4. Justification for selecting a particular methodology for completing the tasks

5. Brief discussion on the Project Work methodology

6. Benefits derivable from the work

7. Any other details in support of the work

**Detailed plan of work**

In this section you are required to break down the Project Work into identifiable activities and give duration for each of these sub tasks, thus justifying for 16 weeks of work.

**Format for the outline document to be submitted is presented in the following pages that has to be strictly followed.**

**Please note that: Outline document has to be uploaded on the viva portal.**

1. **Broad Area of Work**

The project focuses on solving a robotics arm pick and place problem by leveraging computer vision. Automation in Manufacturing and Logistics through Advanced Computer Vision and Machine Learning Techniques.

* Computer Vision Techniques
* Image Pre-processing and Feature Extraction
* Deep Learning for Object Recognition
* MLOps Techniques

1. **Objectives**

The objectives of my project are as follows:

* To pre-process the input image for making the frame suitable for analytics and to extract features.
* To use Deep Learning algorithms for **Object Detection and Shape Recognition**
* Motion Detection, Estimation using motion tracking and prediction algorithms.
* Publish the orientation and estimation data to a ROS environment for Robotic system consumption.
* Prepare the solution for production ready by using MLOPs.

# 3. **Scope of Work**

Scope of this dissertation is to design and develop –

* Implement image pre-processing Algorithm.
* Selection and implementation of object detection and shape recognition algorithm.
* Development of Motion Tracking Algorithm
* Implementation of predictive models to estimate object trajectories.
* Publish the prediction data to ROS environment for Robotics arm to consume.
* Containerize the solution using docker.

**4. Detailed Plan of Work (Sample)** (for 16 weeks)

The plan of work should have tangible weekly or fortnightly milestones and deliverables, which can be measured to assess the adherence to the plan and therefore the rate of progress in the work. The plan of work can be specified in the table given below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Serial Number of Task/Phases | **Tasks or subtasks to be done** (be precise and specific) | **Start Date-End Date** | Planned duration in weeks | Specific Deliverable in terms of the project |
| 01 | Design of Solution | 08/06/2024-17/06/2024 | 1 Week | Work flow and block diagram design |
| 02 | Data Collection, EDA | 18/06 – 21/06 | < 1 Week | Data Collection, insights, analysis of data |
| 03 | Image Pre-processing Algorithm Development | 22/06- 06/07 | 2 Week | Feature Extraction, Feature Engineering, model development |
| 04 | Object Shape Recognition Algorithm Development | 07/07- 21/07 | 2 Week | Model development, model evaluation |
| 05 | Development of predictive model for motion tracking | 22/07 – 05/08 | 2 Week | Model development, model evaluation |
| 06 | Publisher code for prediction data such as coordinates to ROS environment | 06/08 – 14/08 | 1 Week | Publisher code, preparation of ROS Env |
| 07 | MLOPs: Dockerfile creation for the solution, model meta data store into influxdb | 15/08- 30/08 | 2 Week | Containerization, DataStore implementation |
| 08 | Testing of the Solution | 31/08 – 07/08 | 1 Week | Use Case Testing, model testing |
| 09 | Final Report preparation, Documentation for Solution | 08/08 – 15/08 | 1 Week | README, User Guide, Final Report |

# Literature References

The following are referred journals from the preliminary literature review.

1. *Semantic Web Technologies --*

**Supervisor’s Rating of the Technical Quality of this Dissertation Outline**

EXCELLENT / GOOD / FAIR/ POOR (Please specify): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Supervisor’s suggestions and remarks about the outline (if applicable).**

Date\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Signature of Supervisor)

Name of the supervisor:

Email Id of Supervisor

Mob # of supervisor: