Dissertation Proposal Form

PDE4439

Please fill out this form with the details for your project ideas. Refer to the appendix for clarification regarding the various terms.

Once finalized, you will also have to consider the ethical guidelines for the project. Typically, if your evaluation strategy involves human participants, you will be required to get prior ethical approval. Based on your understanding of the project and discussions with supervisor, please select the declaration that applies to you regarding ethical approval.

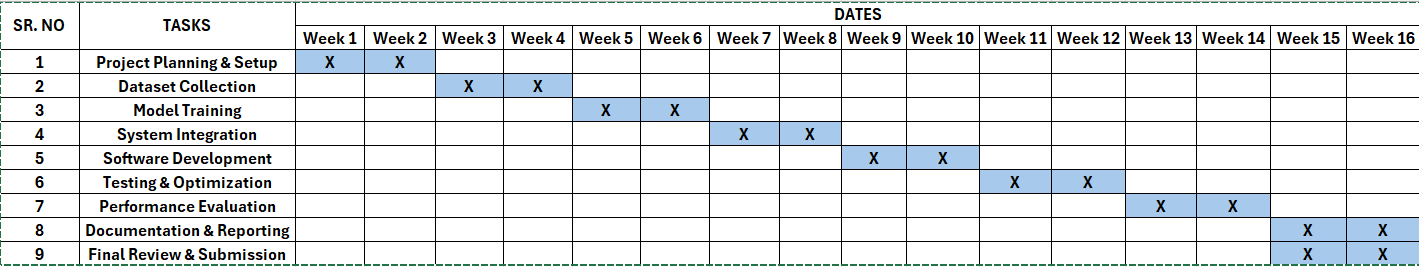
## Student Details:

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| MISIS Number | M00909391 |

## Project Details:

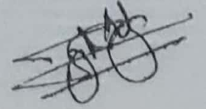
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| Proposed Title | Sorting of different types of batteries using Epson VT6 and Yolo V8 |
| Keywords | Epson VT6 robot, YOLOv8, battery differentiation, deep learning, robotic arm, electromagnet gripper, Non-Maximum Suppression |
| Problem Definition  (Maximum 500 words) | The disposal and recycling of batteries pose significant environmental challenges due to the hazardous materials they contain. Current manual sorting processes are labour-intensive, error-prone, and inefficient. This project aims to address these issues by automating the sorting process using an Epson VT6 robot equipped with the YOLOv8 object detection model and an electromagnetic gripper. The integration of advanced robotic and deep learning technologies can significantly enhance the accuracy, efficiency, and sustainability of battery sorting in industrial and recycling settings. |
| Research Question(s) | 1. How effective is the YOLOv8 model in accurately identifying and categorizing AA, D, and 9V batteries in real-time? 2. What are the efficiency gains in battery sorting when using a robotic arm with an electromagnetic gripper compared to manual sorting methods? 3. How can the integration of robotic technology and deep learning contribute to more sustainable battery recycling practices? |
| Background Review  (Maximum 500 words) | Battery recycling is critical to mitigate the environmental impact of hazardous waste. Traditional methods of sorting batteries are labour-intensive and prone to human error. Automation in industrial processes has shown promise in enhancing efficiency and accuracy. The YOLO (You Only Look Once) model, particularly its latest iteration, YOLOv8, has demonstrated state-of-the-art performance in object detection tasks, making it a suitable candidate for this application. Integrating an electromagnetic gripper with a robotic arm like the Epson VT6 can further streamline the sorting process by securely and efficiently handling different types of batteries. This project builds on existing research in robotics and deep learning, aiming to apply these advancements to the practical challenge of battery sorting. |
| Aims | * To develop an automated system for sorting AA, D, and 9V batteries using an Epson VT6 robot and YOLOv8. * To enhance the efficiency and accuracy of battery sorting processes in industrial and recycling settings. * To contribute to sustainable battery management practices through advanced technology. |
| Objectives  (Bullet points) | * Program the Epson VT6 robot to recognize and classify AA, D, and 9V batteries using the YOLOv8 model. * Integrate an electromagnetic gripper with the robotic arm for efficient battery handling. * Test and evaluate the performance of the automated sorting system in a controlled environment. * Analyse the improvements in sorting efficiency and accuracy compared to manual methods. * Document the findings and provide recommendations for industrial application. |
| Brief Methodology  (Include Gantt chart) | 1. **System Design**: Develop the integration plan for the Epson VT6 robot, YOLOv8, and the electromagnetic gripper. 2. **Model Training**: Train the YOLOv8 model with a dataset of images of AA, D, and 9V batteries. 3. **Implementation**: Program the robotic arm to use the trained model for real-time battery identification and sorting. 4. **Testing**: Conduct experiments to assess the performance of the system in various conditions. 5. **Evaluation**: Analyse the results to determine the efficiency and accuracy of the sorting process. |
| Evaluation Strategy | 1. Dataset and Model Training  Dataset Collection and Annotation: Collect and accurately label images of AA, D, and 9V batteries.  Model Training: Train YOLOv8 on the annotated dataset, using data augmentation to improve robustness.  Performance Metrics: Evaluate precision, recall, F1 score, and mean average precision (mAP).  2. Robotic System Performance:  Sorting Accuracy: Measure the robotic arm's accuracy in identifying and sorting batteries.  Sorting Speed: Assess and compare the speed of automated sorting to manual methods.  Handling Efficiency: Evaluate the electromagnetic gripper's performance in securely handling batteries.  3. Comparative Analysis:  Manual vs. Automated Sorting: Compare sorting accuracy, speed, and consistency between manual and automated methods.  Error Analysis: Identify and analyse misclassifications to improve system reliability.  4. Sustainability Impact:  Environmental Benefits: Assess the reduction in waste and improvement in recycling rates.  Resource Efficiency: Evaluate energy consumption and operational efficiency of the robotic system. |
| Ethical Declaration  (i) or (ii)  (Refer below) | 1. As I will be the user controlling Epson VT 6.   I will not have inputs from different people.  **This project does not involve human participants or sensitive data.** The focus is on the technological development and environmental impact, ensuring adherence to ethical guidelines for non-human research. |
| Deliverables  (Bullet points) | * Detailed system design documentation * Trained YOLOv8 model for battery classification * Programmed Epson VT6 robot with integrated electromagnetic gripper * Performance evaluation report * Final project report with recommendations for industrial application |
| Resources Needed | * Epson VT6 robot * Electromagnetic gripper * Computer with GPU for model training * Dataset of battery images * YOLOv8 software * Lab space for testing and experiments |
| References | 1. [1] Abdulkareem Alasli, Levent Çetin, Nail Akçura, Aytaç Kahveci, Fatih Cemal Can, and Özgür Tamer. Electromagnet design for untethered actuation system mounted on robotic manipulator. Sensors and Actuators A: Physical, 285:550–565, 2019. 2. [2] Venkata Siva Bathula, Venkannababu Mendi, Sekhar Chinthamreddy, Arigela Pa van Kumar, and B Chandra Bose. Pick and place operation by collaborating electromagnetic and pneumatic gripper robots. Materials Today: Proceedings, 2023. 3. [3] Hamidreza Karbasi, Adam Sanderson, Alireza Sharifi, and Cristian Pop. Robotic sorting of used button cell batteries: Utilizing deep learning. In 2018 IEEE Conference on Technologies for Sustainability (SusTech), pages 1–6, 2018. 4. [4] Philip Keller, Johannes Mangler, Nicolas Hügel, Marvin Grosse Besselmann, Arne Rönnau, and Rüdiger Dillmann. Robotic sorting of batteries using visual few-shot learning and fusion with depth data. In 2023 3rd International Conference on Elec trical, Computer, Communications and Mechatronics Engineering (ICECCME), pages 1–7, 2023. 5. [5] Maxence Leveziel, Guillaume J Laurent, Wissem Haouas, Michael Gauthier, and Redwan Dahmouche. A 4-dof parallel robot with a built-in gripper for waste sorting. IEEE Robotics and Automation Letters, 7(4):9834–9841, 2022. 6. [6] Venkata Siva Bathula, Venkannababu Mendi, Sekhar Chinthamreddy, Arigela Pavan Kumar, and B. Chandra Bose. Pick and place operation by collaborating electromagnetic and pneumatic gripper robots. Materials Today: Proceedings, 2023. 7. [7] Gang Wang, Yanfei Chen, Pei An, Hanyu Hong, Jinghu Hu, and Tiange Huang. Uav-yolov8: A small-object-detection model based on improved yolov8 for uav aerial photography scenarios. Sensors, 23(16), 2023. 8. [8] Dustin Weigl and David Young. Impact of automated battery sorting for min eral recovery from lithium-ion battery recycling in the united states. Resources, Conservation and Recycling. 9. [9] Tianyong Wu and Youkou Dong. Yolo-se: Improved yolov8 for remote sensing object detection and recognition. Applied Sciences, 13(24), 2023. [10] Yongjing Zhou, Weigang Zhu, Yonghua He, and Yonggang Li. Yolov8-based spatial target part recognition. In 2023 IEEE 3rd International Conference on Information Technology, Big Data and Artificial Intelligence (ICIBA), volume 3, pages 1684–1687, 2023. |

GRANTT CHART



Sir my Grantt Chart might change as I have my previous Dataset images, I will try to use that. In case it doesn’t work then I must make new dataset.

In my previous coursework I was sorting batteries one by one. But as Judhi sir suggested robot should sort the batteries kept all together in Live camera time.

Signature:

Date: 30th May 2024

## Ethical Approval Guidelines

## Declaration A

1. I have established that my study does not require additional human participation.
2. I agree to re-apply for approval if the nature or goals of my project change.

## Declaration B

Project goals involve human participation:

1. My study involves human participation through:
   * Observation
   * Questioning
2. Participants will be selected without coercion.
3. I will obtain written informed consent from each participant.
4. I have arrangements in place for the protection of personal data.
5. I agree to re-apply for approval if the nature or goals of my project change.

**To be completed by the supervisor:**

Supervisor Name:

Is the proposal acceptable? (YES/NO):

If not, please provide feedback:

Signature:

Date:

## Appendix: Explanation of Typical Terms Used in Research Proposals

* **Title:** Write a title which briefly describes the research problem and your approach to it.
* **Keywords:** To give a clear and concise description of the scope and nature of the report, such as the main variables to be considered.
* **Problem definition:** Correctly defining the problem is the crucial first step in the research process. If the research problem is defined incorrectly, the research objectives will also be wrong. Problems must be stated in terms of underlying causes – they must be structured in a way in which they can lead to a solution. It is critical that the statement be useful for development and evaluation of potential solutions.
* **Research Question:** Indicate what you want to know most and first out of your research. These are typically written in a ‘question’ format, for example, ‘Does a robotic exoskeleton provide an efficient solution to physical rehabilitation of the upper arm for stroke patients?’ Multiple research questions should be put in a list. Questions should not be answered by a simple YES or NO, they must generate a discussion.
* **Background Review:** Explain the technical/discipline area you will be working in, the problem area that you will be addressing in your research, and where you would locate your intended work in relation to previous researchers or existing solutions.
* **Aims:** They represent the changes you hope to achieve as a result of your work.
* **Objectives:** These are the activities you undertake and the methods you propose to bring these changes about. They should be in a bulleted list, and more specific than the aims. In fact, this list should be a way of breaking down the aims into more achievable tasks. Anywhere between 4 – 7 objectives are usually considered appropriate for a project of this scale.
* **Methodology:** A brief description of the steps to be followed to achieve the objectives that have been set out. This section should describe the development plan.
* **Gantt chart:** A Gantt chart is a horizontal bar chart used in project management to visually represent a project plan over time.
* **Evaluation Strategy:** Methods and techniques used in evaluating the project. There are two basic approaches, quantitative and qualitative. Quantitative involves the generation of data, through experiments or simulation, in quantitative form, which can then be analysed. Qualitative is concerned with subjective assessment of opinions, behaviour, impressions via, for example, interviews.
* **Deliverables:** Defining your intended outcomes (be as specific as possible). It is part of good project planning. Deliverables are linked to your aims.
* **Resource Needed:** Information on the hardware, software, and research resources you will be using during your research. Be specific – Give the name of any software and hardware, rather than stating something generic.