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Pick and Place Robot Arm
Self Evaluation Report

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Abstract

This feasibility report outlines the development of a robotic arm system designed for the precise assembly of H-Bridge components in industrial applications. The project integrates principles from mechanics, control systems, materials science, and manufacturing processes, applying mathematical concepts and hands-on skills acquired during the engineering course. The robotic arm system exhibits potential applicability in Sri Lanka, addressing industrial automation needs, particularly in electronics manufacturing. Cost considerations further contribute to the project's feasibility. The report concludes with recommendations for detailed design specifications, technical feasibility, and safety considerations to ensure a comprehensive and viable solution.

Contents

1 Applying Engineering Principles

1.1 Mechanics

The project focuses on applying kinematics and dynamics principles to design robotic arms. Considerations include workspace optimization, payload capacity, velocity requirements, and accuracy specifications.

1.2 Control Systems

Feedback control mechanisms are implemented for precise positioning and orientation of the robotic arms.

Figure 1: Stepper with Feedback

1.3 Materials Science

Material selection involves choosing lightweight, durable, and cost-effective materials for robotic arms, taking into consideration the operational environment and longevity. Additionally, a suitable hard object needs to be selected for placing the combined washer, rivet, transistor, and heat sink during the filleting process.

1.4 Manufacturing Processes

As this is a prototype-level application, some existing parts will be utilized in the manufacturing process. For the remaining components, a cost-effective manufacturing process needs to be implemented.

2 Applying Mathematics and Science

2.1 Calculus

Calculus is applied to calculate forces, and moments, enabling precise movement and positioning of the robotic arms during the assembly process.

2.2 Linear Algebra

The robotic system is modeled using matrices and transformations, facilitating a comprehensive understanding of its behavior.

2.3 Physics

Principles of mechanics, statics, and dynamics are utilized to ensure the robotic arms function optimally and safely.

2.4 Electronics

Understanding electronic components and their thermal requirements is crucial for overall system design. Additionally, the H-bridge system used to drive the motor is typically covered in electronics studies.

2.5 Probability and Statistics

Probability and statistics are employed for analyzing and optimizing the performance of the robotic arm system, including reliability and error analysis.

3 Applying Hands-on Skills Learnt in University

3.1 Programming

Skills in coding for robot control, motion planning, and communication are essential for the successful operation of the robotic arm system.

3.2 Mechanical Design

Creating detailed CAD models and drawings is part of the mechanical design process, contributing to the overall efficiency of the system.

3.3 Fabrication

Hands-on skills in building and assembling the robotic arms using learned tools and techniques are essential for project success.

3.4 PCB Design

PCB design is an essential aspect of creating an industrial-level system. Since preexisting microcontrollers cannot be used, the controlling and other circuits need to be designed using Altium or OrCAD.

3.5 Soldering

Soldering is a critical skill in electronics, used to create reliable connections between components on a PCB. Proper temperature control, solder composition, and flux application are key considerations.

Figure 2: Soldering Station

3.6 Testing and Calibration

Tuning the system for accuracy and reliability requires thorough testing and calibration processes.

4 Applicability in Sri Lanka

4.1 Industrial Automation

The project has the potential to be adapted for various industrial tasks in Sri Lanka, promoting automation and improving overall efficiency.

4.2 Electronics Manufacturing

The robotic arm system can significantly benefit electronic component assembly in Sri Lankan industries.

4.3 Skills Development

The project contributes to skills development in robotics, automation, and mechatronics, aligning with the technological sector's growth in Sri Lanka.

5 Cost Considerations

Item	Quantity	Price (LKR)
Motor Driver	1	300.00
Stepper Motors (NEMA 23)	2	7,200.00
Linear Rails	2	4,500.00
Square Linear Rail Slider Block	2	6,400.00
PCB Printing & Shipping	1	3,000.00
Clamp 3D Printing	1	1,500.00
Enclosure 3D Printing	1	4,000.00
Nuts and Bolts	As Required	1,000.00
SG90 9G Micro Motor	1	425.00
Couplers	As Required	1,000.00
Stands for Components (3D Printing)	3	1,000.00
Stand for Final Assembly	1	1,500.00
OLED Display	1	940.00
Buttons and Switches	As Required	1,000.00
Robot Arm Parts (3D Printing)	As Required	2,500.00
Belts & Cog Wheels	As Required	2,000.00
Total		38,265.00

Table 1: Project Estimated Cost Summary

The above table provides an itemized breakdown of the anticipated project costs. The total estimated budget for the project, as proposed by the team, is LKR 40,000.00. This proposed budget includes the costs associated with various components, printing, and assembly. This is a preliminary projection, and actual expenses may vary during the course of the project.

6 Achieving learning outcomes of the course

6.1 Identify a Suitable Design Model for a Given Problem

In the process of designing the robotic arm system, we apply engineering principles, considering the specific requirements of assembling H-Bridge components. The chosen design model ensures efficiency, precision, and compatibility with industrial applications.

6.2 Design Testable PCBs Complying with Industry Standards

The project involves the integration of electronic components, including transistors, onto a PCB (Printed Circuit Board). The PCB design follows industry standards, enabling efficient testing and integration into the overall robotic arm system.

6.3 Explain Testing Methodologies Used in Electronic Manufacturing

Throughout the development, we implement rigorous testing methodologies to validate the functionality and reliability of the robotic arm system. This includes testing the electronic components, control algorithms, and the overall system to ensure it meets specified standards.

6.4 Design Product Enclosures Complying with Industry Standards

Considerations for the design of the robotic arm system extend to the enclosure, ensuring it complies with industry standards. This includes considerations for safety, durability, and environmental factors.

6.5 Prepare Proper Documentation for Electronic Design

6.5.1 Design Specifications

Detailed design specifications outline the parameters, dimensions, and functionality of the robotic arm system, serving as a reference for understanding the intended design and its requirements.

6.5.2 Testing Procedures

A thorough testing procedures document guides the verification and validation processes, providing step-by-step instructions for conducting tests on different components and the overall system.

6.5.3 Assembly Instructions

Detailed instructions for the assembly process, guiding the assembly of robotic arms, integration of electronic components, and ensuring the correct configuration of the entire system.

6.5.4 User Manual

The user manual provides a comprehensive guide on operating the robotic arm system, covering startup procedures, safety precautions, and step-by-step instructions for common tasks.

6.5.5 Troubleshooting Guide

A troubleshooting guide assists users and maintenance personnel in resolving common issues, including a list of potential problems, their possible causes, and recommended solutions.

6.5.6 Maintenance Instructions

For long-term functionality and reliability, a maintenance instruction document outlines routine maintenance tasks, recommended schedules, and procedures for addressing wear and tear.

6.5.7 Safety Guidelines

To ensure the safety of users and maintenance personnel, a set of safety guidelines documents potential hazards, safety procedures, and emergency protocols for the robotic arm system.

6.6 Apply the Knowledge Gained to a Commercial Design Project Resulting in a Working Prototype

The culmination of the project is the development of a working prototype of the robotic arm system. This not only showcases the practical application of knowledge gained but also serves as a testament to the successful implementation of engineering principles in a real-world scenario.