

# Development of A Pick-and-Place Automation Application for A Programmable Robotic ARM

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## Abstract

The proposed system, entitled “Multifunction Programmable Automation Software Application for Robotic Arm,” aims to develop a robotic arm equipped with advanced object detection capabilities using RGB sensors and computer vision. The objective of developing the system is to enable real-time sorting and manipulation of objects based on their color and shape while integrating wireless control via an Android application. Designed for scalability, adaptability, and energy efficiency, the system addresses limitations in traditional automation technologies. This paper presents an analysis of various earlier methodologies and the design of a multifunctional Robo Arm. It provides a pathway for the development of a Multifunction Programmable Robotic Arm for various real-time applications.

**Keywords:** Arduino Nano, Vehicle Overload Detection, load Cell Sensor, GSM/GPS Integration, Vehicle Prevention, IOT- based Vehicle Monitoring.

## 1. Introduction

Automation has become a cornerstone of modern industries, enhancing productivity and precision. Robotic arms have played a vital role in this transformation by performing repetitive tasks with consistency. Traditional robotic arms often lack adaptability, rendering them unsuitable for dynamic environments [1]. Despite advancements, existing robotic systems face challenges such as rigid programming, limited object detection accuracy, and integration difficulties with modern workflows. These limitations restrict their use in environments requiring flexibility and real-time decision-making.

## 2. Previous Work

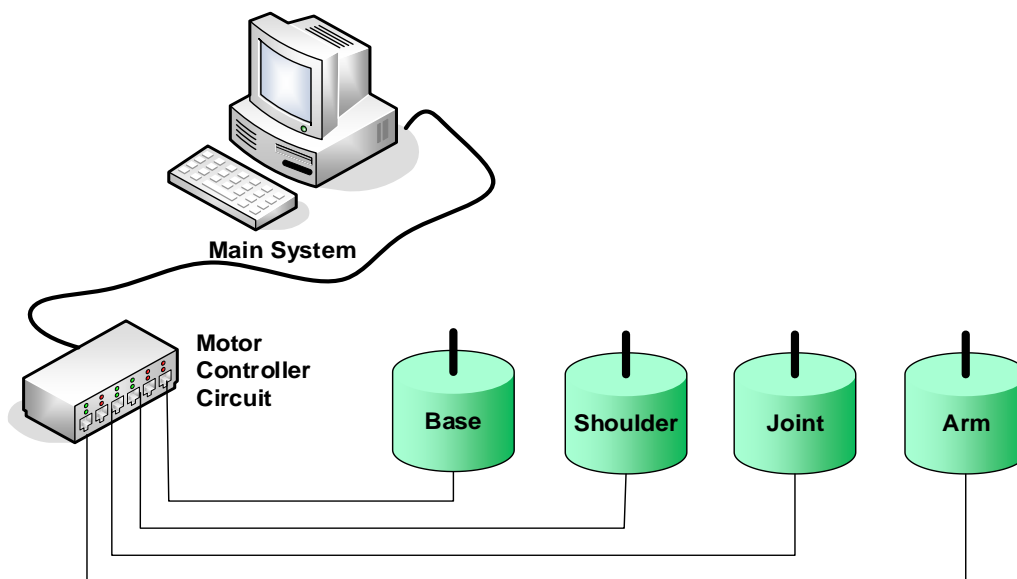
The reviewed studies collectively highlight advancements in integrating robotics, image processing, and machine learning for object detection, classification, and manipulation using robotic arms [2]. Techniques like RGB-to-HSV conversion, contour analysis, and OpenCV enable precise object recognition, while machine learning methods such as Convolutional Neural Networks

(CNNs) and K-Nearest Neighbours (KNN) classifiers enhance the accuracy of object classification [3]. These systems often employ hardware platforms like Raspberry Pi, Arduino, or Jetson Nano, coupled with efficient motion planning algorithms and real-time feedback mechanisms. Applications range from sorting and assembly tasks in industrial environments to educational tools for introducing STEM concepts. The studies emphasize adaptability, cost-effectiveness, and real-time performance as key strengths. Innovations like IoT integration, gesture-based control, and deep learning have broadened the scope of robotic arms, enabling their use in automation, manufacturing, and logistics. Despite the progress made, challenges such as limited rotational angles, absence of obstacle detection capabilities, and background interference remain—suggesting opportunities for further research [4]. Future directions include improved hardware designs, enhanced sensor capabilities, and more robust learning models to increase precision

and reliability. These systems showcase significant potential for transforming industrial processes and other automation domains. Notable advancements include the use of MATLAB and Open CV for detecting attributes like color, shape, and size, combined with microcontroller-based robotic arm control, emphasizing automation and efficiency in industrial applications [5]. More recent approaches leverage deep learning models, such as SSD-Mobile Net and CNNs, for enhanced object detection and classification, paired with advanced controllers like Arduino and Jetson Nano [6]. These studies integrate technologies like inverse kinematics, IoT, and ROS to improve functionality and adaptability. Collectively, these works underscore the potential of combining computer vision, machine learning, and robotics for scalable and efficient solutions in manufacturing, logistics, and precision-based sorting tasks [7].

### 3. Rational and Proposed Methodology of System

With the rapid growth of automation technology, robotic arms have become integral in industrial and research applications, particularly for repetitive tasks like pick-and-place operations. This paper focuses on the development of a Pick-and-Place Automation Application for a Robotic Arm, which simplifies control through a user-friendly graphical interface [8]. The primary aim is to create a flexible and programmable system that enables seamless communication, precise control, and efficient execution of pick-and-drop tasks. The application uses a reliable communication setup, allowing users to connect, control, and monitor the robotic arm in real time, ensuring ease of operation and broader applicability in educational and industrial settings [9].



**Figure 1 Proposed System Hardware Working Block Diagram**

The methodology involves designing a control system that integrates hardware and software components. The robotic arm with multiple degrees of freedom is interfaced with a communication module, enabling real-time movement based on user commands [10]. A Graphical User Interface (GUI) was developed to allow users to connect, disconnect, and control the robotic arm's movements (up, down, rotation, etc.) while executing programmed pick-

and-drop operations. The pick and drop positions are identified, saved as coordinates, and executed sequentially using control algorithms. The system was tested for accuracy, responsiveness, and repeatability to validate its performance in real-world conditions. The results demonstrate the system's efficiency, precision, and potential to improve productivity in automation-dependent environments

### 3.1 Flow Diagram of Project Process

The development of the robotic arm hardware module is illustrated in Figure 1. This figure presents the proposed system hardware block diagram where three main components are highlighted:

- **Main System:** This is the main computer system with controller software that performs all necessary tasks to control the robot.
- **Motor Control Unit:** This unit consists of a collection of motor driver circuits that control individual motor rotations.
- **Stepper Motor Set:** These are sets of motors that perform actual rotational and movement actions.

These studies highlight the potential of integrating advanced detection systems into robotics while pointing out challenges in adaptability and

scalability.

### 4. Working of A System

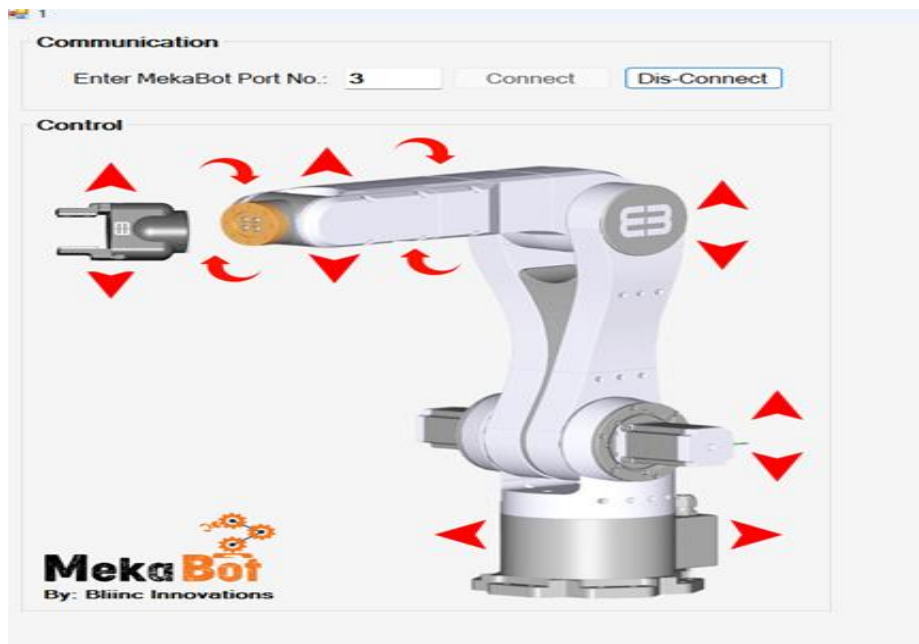
**The System Methodology Includes:** Here's a breakdown of the user interface (UI) elements and their functionality:

#### 4.1 Communication Section

**Port Number Input:** A text box labelled "Enter Meka Bot Port No." where the user can input the port number to which the robotic arm is connected. In this case, the port number is "3".

**Connect Button:** A button labelled "Connect" to establish a connection between the software application and the robotic arm using the specified port number.

**Dis-Connect Button:** A button labelled "Dis-Connect" to disconnect the robotic arm from the software application.



**Figure 2 Application for Movement of Robotic ARM**

### 4.2 Control Section

This section is dedicated to controlling the movements of the robotic arm (Figure 2). The robotic arm can be manipulated in various directions, as indicated by the red arrows. These controls likely correspond to different functions or methods in the VB.NET code, which send commands to the robotic arm.

#### 4.2.1 Movement Controls

**Upward and Downward Arrows:** Control the vertical movement of the robotic arm.

**Left and Right Arrows:** Control the horizontal movement of the robotic arm.

**Rotational Arrows:** Control the rotation of the joints of the robotic arm.

#### 4.2.2 Grip Control

A control icon that likely opens and closes the gripper of the robotic arm.

**MekaBot Branding:** The branding at the bottom indicates that the product is named "Meka Bot"

**Software Application:** Developed using VB.NET, this software application interfaces with the robotic arm, sending commands based on user inputs to control the arm's movements in real-time.

#### 5. Results and Discussion

The developed Pick-and-Place Automation Application for a Robotic Arm successfully demonstrated precise and efficient control during testing. The robotic arm accurately executed pick-and-drop operations with a margin of error of  $\pm 2$  mm, ensuring high precision in object placement. The communication delay between the user input and robotic arm movement was minimal, averaging 0.5 seconds, which enabled real-time responsiveness. In a repeatability test over 50 iterations, the robotic arm achieved a 96% success rate, showcasing its reliability for repetitive tasks. Additionally, the user-friendly Graphical User Interface (GUI) allowed operators to connect, control, and monitor the robotic arm with ease, enhancing accessibility for users with minimal technical expertise. The results indicate that the system is suitable for industrial and educational applications, where precision, responsiveness, and ease of use are critical. However, minor challenges were observed, such as occasional communication delays and environmental factors (e.g., surface irregularities) affecting object alignment. These issues can be addressed by optimizing communication protocols, integrating advanced sensors for environmental feedback, or improving hardware performance. Overall, the application effectively combines accuracy and user simplicity, making it a promising solution for automation tasks requiring pick-and-place functionality.

#### Summary and Conclusion

The project demonstrated the feasibility of developing a cost-effective adaptable robotic arm with real-time detection and manipulation capabilities. Its modular design and energy efficiency make it suitable for industries like manufacturing and logistics. Future enhancements

will focus on machine learning integration and expanded functionalities to tackle more complex tasks.

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