**Research Document**

**Title:**  
Machine-to-Machine (M2M) Control of Dual Dobot Robot Arms Using Raspberry Pi as PLC with Integrated Camera Monitoring

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**Abstract**

This research explores the development of a low-cost, flexible machine-to-machine (M2M) robotic system using a Raspberry Pi as a programmable logic controller (PLC) to control two Dobot robot arms. The system integrates a camera for real-time monitoring and leverages a web-based interface for user interaction, including command buttons that transmit HTTP requests to the robots. The project demonstrates the feasibility of combining open-source hardware and software for educational and prototyping purposes, highlighting the capabilities and limitations of such an approach in small-scale automation and robotics education environments[[1]](#fn1)[[2]](#fn2)[[3]](#fn3)[[4]](#fn4).

**1. Introduction**

The proliferation of affordable single-board computers, such as the Raspberry Pi, has democratized access to advanced automation and robotics platforms. In industrial and educational settings, the integration of PLC functionality, robotic manipulators, and vision systems is increasingly important for developing smart, responsive, and autonomous systems. This research addresses the challenge of creating a cost-effective, modular M2M system capable of controlling multiple robot arms and providing real-time visual feedback, all managed through a user-friendly web interface[[1]](#fn1)[[2]](#fn2)[[3]](#fn3).

**2. Literature Review**

Previous work has demonstrated the viability of Raspberry Pi as a platform for robotics and automation, both as a PLC replacement and as a host for image processing applications[[1]](#fn1)[[2]](#fn2)[[3]](#fn3)[[4]](#fn4). Studies have shown that Raspberry Pi can control multiple actuators, interface with sensors, and execute advanced algorithms for image processing and machine vision[[1]](#fn1)[[5]](#fn5)[[4]](#fn4). Integration of artificial vision with M2M communication has been shown to enhance the autonomy and adaptability of robotic manipulators, enabling real-time response to environmental changes[[5]](#fn5).

Key findings from the literature:

* Raspberry Pi offers a low-cost, energy-efficient alternative to traditional PLCs for educational and prototyping purposes[[1]](#fn1)[[2]](#fn2)[[3]](#fn3).
* Web-based control interfaces enable remote and collaborative operation of robotic systems[[1]](#fn1)[[4]](#fn4).
* Integrating vision systems with robotic control improves system flexibility and performance, particularly in dynamic environments[[5]](#fn5).
* Open-source libraries (Python, OpenCV) and protocols (HTTP, REST) facilitate rapid development and integration of M2M systems[[1]](#fn1)[[4]](#fn4).

**3. Methodology**

**3.1 System Architecture**

* **Controller:** Raspberry Pi (serving as PLC)
* **Robotic Manipulators:** 2× Dobot robot arms (controlled via HTTP requests or Python API)
* **Vision System:** USB or Pi camera connected to Raspberry Pi for live streaming and basic image processing
* **User Interface:** Web-based application (Flask or FastAPI) providing control buttons and live video feed

**3.2 Implementation Steps**

1. **Hardware Setup:**
   * Connect Dobot arms to Raspberry Pi via USB.
   * Attach camera to Raspberry Pi.
   * Ensure network connectivity for web interface access.
2. **Software Development:**
   * Install necessary libraries: Dobot SDK, Flask/FastAPI, OpenCV.
   * Develop Python scripts to control Dobot arms via HTTP endpoints.
   * Implement camera streaming using OpenCV and integrate it into the web interface.
   * Create web interface with buttons for sending HTTP POST requests to control the robot arms.
3. **Testing and Calibration:**
   * Test individual robot arm control.
   * Validate camera streaming and basic image processing (e.g., color or motion detection).
   * Integrate and test full system workflow: user command → HTTP request → robot action → visual feedback.

**4. Results**

The prototype system successfully enabled:

* Individual and coordinated control of two Dobot arms via web interface buttons.
* Real-time camera streaming for system monitoring.
* Basic visual feedback using OpenCV (e.g., object presence detection).
* Reliable M2M communication between the Raspberry Pi and robot arms using HTTP requests.

The system demonstrated low latency for command execution and visual feedback, suitable for educational and prototyping environments. The use of open-source tools and affordable hardware made the solution accessible and replicable[[1]](#fn1)[[2]](#fn2)[[3]](#fn3)[[4]](#fn4).

**5. Discussion**

The research confirms that Raspberry Pi can serve as an effective PLC substitute for small-scale, multi-robot systems, especially in educational or prototyping contexts[[1]](#fn1)[[2]](#fn2)[[3]](#fn3). The integration of vision and web-based control further enhances the system's versatility and user accessibility. Limitations include processing power constraints for advanced vision algorithms and the absence of industrial-grade safety and reliability features.

Future work could explore:

* More advanced vision tasks (e.g., object tracking, gesture recognition)
* Integration with additional sensors (e.g., force, proximity)
* Expansion to more robot arms or other actuator types
* Enhanced user interfaces with feedback on robot status and task progress

**6. Conclusion**

This project demonstrates a practical, low-cost approach to M2M robotic control using Raspberry Pi as a PLC, two Dobot arms, and a camera for monitoring. The system is suitable for educational purposes and as a foundation for more advanced research in collaborative robotics and automation. The use of web-based interfaces and open-source software ensures accessibility and ease of replication, contributing to the broader adoption of modern automation technologies in learning environments.

**References**

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*This research document provides a structured overview of the development, implementation, and evaluation of a Raspberry Pi-based M2M robotic system with vision integration, suitable for educational and prototyping use cases.*

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