

Vision-Assisted PLC Motor Control with Real-Time Dashboard

Davis Onyeoguzoro

onye6983@vandals.uidaho.edu

Programmable Logic Controller (PLC) Project

Department of Computer Science

Center for Intelligent Industrial Robotics (CIIR)

University of Idaho, Coeur d'Alene, ID, USA

Abstract—This project implements a hybrid automation system that integrates a camera based face recognition with PLC driven motor control and safety mechanisms. A Raspberry Pi performs the identity recognition and communicates securely to the CLICK PLC over Modbus TCP. Once identification and recognition of an authorized user, the system halts the running stepper motors, activates the stack light indicators, and updates the monitoring dashboard in real-time. An emergency stop circuit provides hardware-level safety override. This project demonstrates how machine vision can be combined with traditional automation to enhance safety, authentication, and real-time monitoring in industrial environments.

Index Terms—PLC, Machine Vision, Artificial Intelligence, Automation, Motors, Face Recognition

I. INTRODUCTION

Programmable Logic Controller (PLC) provide deterministic and highly reliable control of industrial machines like motors, which traditionally lack the capability to perform complex tasks like user identification or face recognition on its own.

This project bridges the gap between high-level AI perception and low-level PLC control by developing a Smart Access Control (SAC) system that uses a Raspberry Pi and camera for face recognition, a CLICK PLC for deterministic industrial control, and a dashboard for real-time monitoring. The system identifies authorized individuals using a trained lightweight facial recognition model. When a match is detected, the Raspberry Pi sends a Modbus TCP command to the PLC. The PLC then stops the stepper motor and activates a stack light to indicate the system state. Additionally, an emergency-stop (E-Stop) switch provides hardware-level override that immediately disables machine motion when

pressed. This integration enables the PLC to react intelligently to visual inputs, which is cannot be achieved using PLC logic stand alone.

II. PROBLEM STATEMENT

Traditional PLC-driven systems cannot identify personnel or interpret complex visual information. This limitation introduces several challenges in environments where human presence and machine operation overlap.

- Motors continue running even when specific personnel approach a machine.
- There is no authentication mechanism based on facial recognition.
- Supervisors lack real-time visibility into who is near the equipment.

III. PROJECT OBJECTIVE

The primary objective was to design a real-time vision-assisted PLC control system that integrates perception with deterministic industrial control. The system aims to:

- Identify authorized users using both a Raspberry Pi and camera module.
- Transmit secure Modbus TCP commands to the CLICK PLC.
- Stop the stepper motor immediately upon detection of an authorized face.
- Provide clear visual indication of systems state using the stack light.
- Maintain operator safety using a hard-wired E-STOP that overrides all logic.

- Display and save detected users and system states on a live dashboard for monitoring and debugging.

IV. SYSTEM ARCHITECTURE

The system is divided into four major subsystems:

- Vision
- Control
- Execution
- Monitoring

A. Vision Subsystem (*Raspberry Pi + Camera*)

The camera module continuously captures video frames. These frames are processed by the Raspberry Pi using a python based face recognition model. When a positive match is detected using face landmarks, the Raspberry Pi writes a Modbus TCP coil to the PLC and publishes the detected identity to the dashboard.

B. Control Subsystem (*CLICK PLC*)

The CLICK PLC does the following:

- Reads Modbus coils sent by the Raspberry Pi
- Stops the stepper motor on face match
- Manages the stack light signaling
- Monitors E-Stop input for safety system override.

C. Execution Subsystem (*Field Devices*)

These devices perform mechanical and visual actions in response to the PLC logic. These devices include:

- Stepper motor
- Stack Light
- Rhino Power Supply
- Emergency stop, start

D. Dashboard and Monitoring Subsystem

A web-based dashboard that displays the detected users, systems states, safety indicators, and logs events in real time.

V. SYSTEM REQUIREMENTS

A. Hardware Requirements

1) Core Processing Unit and Vision:

- Raspberry Pi 5
- Camera module

2) Control Hardware:

- CLICK PLC
- Digital I/O for stepper motor and stack light
- 24V Rhino industrial power supply
- Wiring terminals, relays

3) Actuation Hardware:

- Stepper motor
- Limit switches
- Mechanical mount

4) Safety Hardware:

- Emergency Stop switch,
- Stack Light

5) Networking Hardware:

- Ethernet switch for connecting the Programmable Logic Controller (PLC), Raspberry Pi module.
- Cat6 cable

B. Functional Requirements

1) Face Recognition:

- The system captures live video frames
- The Raspberry Pi detects faces and classifies them as authorized or unauthorized
- The system triggers PLC logic based on the input from the Raspberry Pi

2) Communication:

- The Raspberry Pi sends Modbus TCP commands to the CLICK PLC
- The PLC reads designated Modbus coils and registers continuously

3) Motor Control:

- When an authorized face is detected, the PLC immediately stops the stepper motor
- The motor remains disabled until the system returns to false state

4) Stack Light Signaling:

- The PLC sets the stack light to represent the entire system state.
 - Green: Authorized user detected
 - RED: E-STOP or Fault

5) E-STOP Safety:

- Pressing the E-STOP immediately disables all motion outputs.
- The dashboard displays an emergency alert

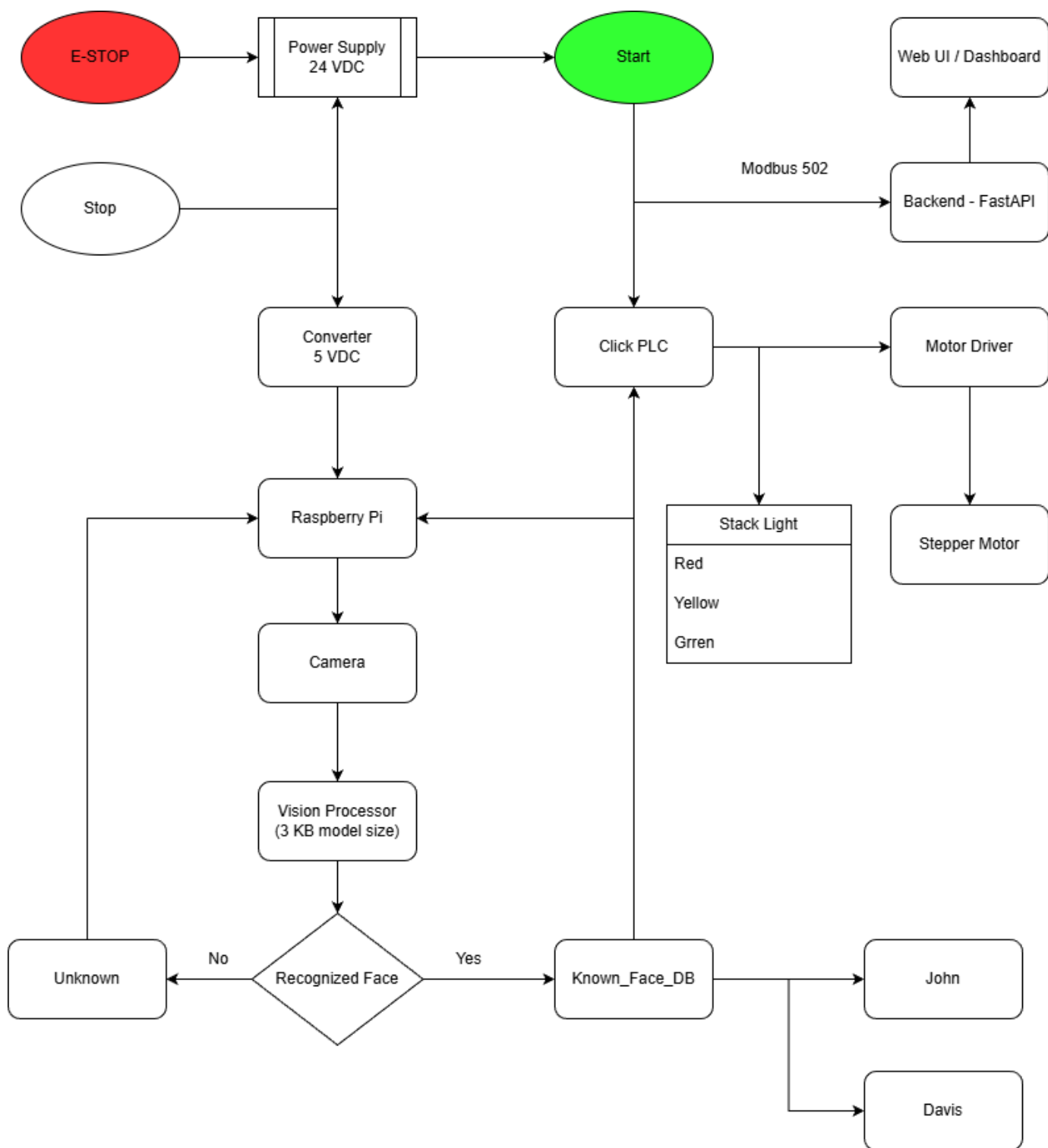


Fig. 1. Smart Access Control (SAC) System Architecture Integrating Vision, PLC, and Safety Subsystems.

6) *Dashboard Monitoring:*

- The dashboard displays the detected users identity and logs all data to database with timestamps.
- The dashboard monitors motor state, stack light state, and safety status.

C. *Non-Functional Requirements*

1) *Reliability Requirements:*

- The E-STOP must override all other operations regardless of the state of the software.
- The PLC must fail safe if communication with the Raspberry Pi is lost

2) *Security Requirements:*

- Only authorized identities can trigger access
- Modbus TCP communication is restricted to specific IP addresses using an access control list, and predefined firewall rules.

VI. SYSTEM OPERATION

The systems begins in ready state, and waits for the user input either from the dashboard or by pushing the start button, which sends the message to the PLC and triggers the stack light green. As a person approaches, the Raspberry Pi processes the camera feed and determines identity.

VII. CONCLUSION

This project demonstrates an effective integration of modern machine vision and traditional industrial automation. The system successfully merges the perception capabilities of the Raspberry Pi with the deterministic safety and reliability of the CLICK PLC. The architecture enhances authentication, safety, and real-time monitoring, forming a strong base for future industrial smart systems.

[Link to Video Demo 1](#)

[Link to Video Demo 2](#)

[GitHub](#)