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RESEARCH ARTICLE

Automation of industrial machinerie

C. Mohan Raj, M. Sundaram and M. Anand

Abstract

In past two decades, the automation of industrial machines is proliferating. The fourth industrial revolution (Industry 4.0) also focuses on industrial automation and artificial intelligence. As every technology has its ebb and flow, industrial automation also has huge scope in future and its own limitations. One of the major issues is in troubleshooting the virtually controlled machine. The biscuit-making and baking machines are controlled using PLC I/O and HMI. The errors are rectified by taking feedback from the machine's component connections and supply connections. This helps us troubleshoot the faults occurring in the connections and components used.

Keywords: Programmable logic controller, Human-machine interface, Variable-frequency drive, Internet of things, Virtual machines, Arduino.

Introduction

Most of the work in today's world is done by machines rather than by humans. The use of automatic machines is one of the most inevitable in today's modern world. Automatic machines are used everywhere, from making a small pin to performing surgery. Even though the machines work accurately, they also have minor drawbacks. Since most of the machines used in factories are imported, production is affected whenever there is any problem with them. During its disoperation, the one who has manufactured has been expected. But depends on OEM (Original Equipment Manufacturer) suppliers always is a tedious task. In order to overcome these difficulties, virtual control method is developed. In this method, it is possible to detect and correct the defect of the machine while you are in the company that manufactures the machine.

If a machine breaks down, by connecting the faulted machine to the Internet, it is possible to detect the defects and operation of the machine. The engineer does not need to go to the factory where the machine is located to fix this. Therefore, the down time and operating cost of the machine is reduced. This could be implemented by interfacing the machine with IOT. Virtual environment is designed for each I/O Module of PLC. The machine I/O can be monitored and controlled by the machine developer through this virtual environment (Mellado & Núñez, 2022; Shi *et al*., 2020; Varga *et al*., 2020).

PLC is the heart of any machine that runs (or) controls it, based on the program done. PLC and its I/O Modules and SFM Modules are connected to the Virtual environment through IOT. The virtual environment is specially designed for monitoring and controlling I/O Module of the PLC (Prasath *et al*., 2019; Sossenheimer *et al*., 2021). Virtual environment is developed by java or a specialized web designing tool. This environment access the PLC I/O details using Port Programming. Special login will be created for OEM (The one who manufactured/Programmed the machine).

The machine can be controlled/Monitored from anywhere by using this developed Virtual environment with proper login. The OEM or the PLC programmer can operate those connected modules from anywhere.

The OEM can develop a virtual environment for each product or machine using VB com.net. The programmer can run/stop/control from the developer virtual environment and mainly troubleshoot the machine. PLC is used for automating the machinery and interfacing of virtual environment (Gharte, 2016).

Methodology

The Block diagram in Figure 1 shows the virtual control of Industrial machineries using IOT. Here the OEM can access

Department of EEE, PSG College of Technology, Coimbatore, Tamil Nadu, India

***Corresponding Author:** C. Mohan Raj, Department of EEE, PSG College of Technology, Coimbatore, Tamil Nadu, India, E-Mail: c.mohanrajme@gmail.com

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Figure 1: Block diagram of Virtual control of industrial machineries for smart manufacturers

the customer site through the virtual environment with proper approval from the customer site. OEM or Programmer can monitor/controls the operation of the Machines from anywhere.

Hardware Components Used

In this paper, automated biscuit making and baking machine is developed. The following are the hardware components used**,**

VFD Power and Control Circuit

VFD or variable speed or frequency, is used to govern the speed of a conveyor via the frequency. VFD controls the speed and is maintained at desired value.

It is supposed to provide essential records of now no longer unusual place VFD terms VFD operation and VFD benefits (Thamrin and Ismail, 2011).

The basic control and power side circuit concept diagram of VFD is shown in Figure 2**.**

Pole changing way, stator electrical pressure control and cycles per seconds control are the possible ways to control

Table 1: Hardware details

S. No	Hardware detail	Specification
1	PLC (Programmable Logic Controller)	FX5U
2	GOT (Graphic Operation Terminal)	GS – Series(GS2107) 14" GOT Display
3	Variable Frequency Drive	0.5 kW, 3Φ Drive A800Series
4	Relay Board	230V/5A/Coil Voltage24VDC
5	Magnetic Vibrator with controller	230V Coil voltage/50Hz vibration frequency
6	Load cell	Resistive type– 10kg
7	Proximity Sensor	24V DC, PNP Type
8	iOT Controller	ATMEGA Based board

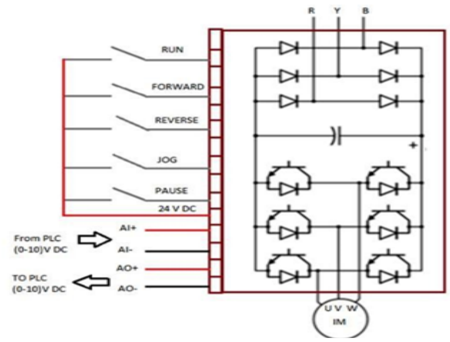

Figure 2: Control and power circuit concept diagram of VFD

the revolution per minute controls of Induction Motor (Pushpalatha *et al*., 2017). One of the popular methods of speed control is Volts/Freq control. The basic control of Volts/Freq control technique is shown in the Figure 3.

An induction motor's velocity is managed by converting each voltage and frequency by VFD. The velocity is numerous from zero rpm to rated rpm motor. The speed of the three-phase rotating transformer or Induction motor is changed by changing the cycles per second or frequency of the VFD and the values are changed within side the HMI AI module of the produces the variable voltage primarily based totally on the velocity set-factor and the conveyor velocity is adjusted (Badoual *et al*., 2016; Raj, 2017).

Design and Implementation of Plc Ladder Logic

The ladder programming is developed using GX-works 2 software programming software. The ladder software for the proposed system is established below list of inputs and output used for monitoring and controlling from virtual environment are listed below collectively with their address

Design and Implimentation of Proposed System

Mechanical setup for Virtual control project is shown in below. Here the real time machine (Biscuit Making Machine) has taken and the same mechanical model is developed. PLC I/O's are monitored and the status of all the inputs and outputs are updated in the virtual environment. The operator can monitor and control the I/O from anywhere through the virtual environment.

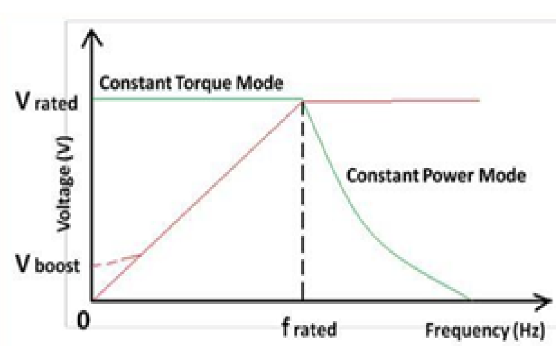

Figure 3: Volts/Freq control concepts

Experimental Results

The experimental outputs of our mechanical and software setups are shown in Figure 4. The conveyor speed is adjusted by the VFD based on the reference frequency set-point and the Tray is placed on the conveyor. The 3Φ induction motor runs conveyor and the motor is controlled by VFD. The status of the VFD inputs and outputs are taken as a feedback by Mod bus protocol refer Table 2. The condition of

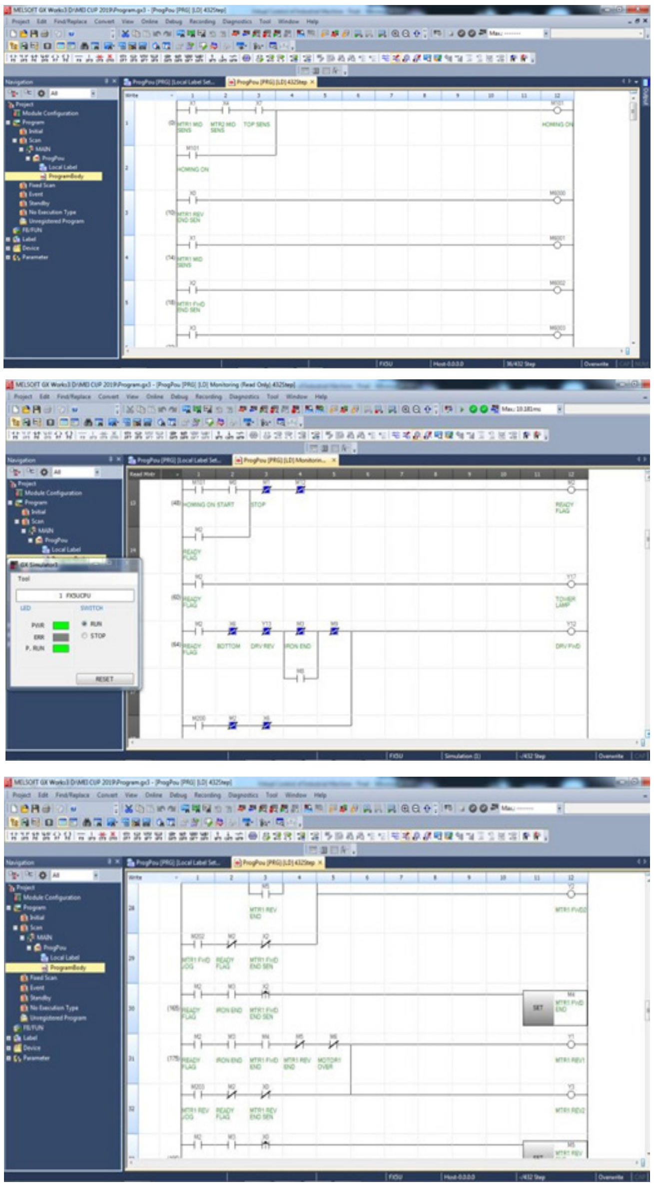

Figure 4: PLC ladder logic for machine automation

Figure 5: Biscuit making machine with IoT setup

Table 2: List of inputs and outputs used

S. No	Name of the I/O	Address
1	Motor 1 REV Sensor	X0
2	Motor 1 MID Sensor	X1
3	Motor 1 FWD Sensor	X2
4	Motor 2 FWD Sensor	X3
5	Motor 2 REV Sensor	X4
6	Bottom Sensor	X5
7	Top Sensor	X6
8	Mtr 1 fwd1	Y0
9	Mtr 1 rev1	Y1
10	Mtr 1 fwd2	Y2
11	Mtr 1 rev2	Y3
12	Mtr 2 rwd1	Y4
13	Mtr 2 rev1	Y5
14	Mtr 2 fwd2	Y6
15	Mtr 2 rev2	Y7
16	Pack mtr fwd	Y10
17	Pack mtr rev	Y11
18	Drv fwd	Y12
19	Drv rev	Y13
20	Bottom blower	Y14
21	Steam valve	Y15
22	Pack blower	Y16
23	Tower lamp	Y17

Figure 6: Conveyor system of proposed machine

Figure 7: Wiring of Control Panel of Proposed machine

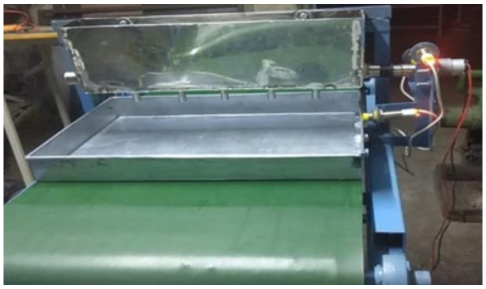

Figure 8: Conveyor setup

Figure 9: Biscuit packing process setup

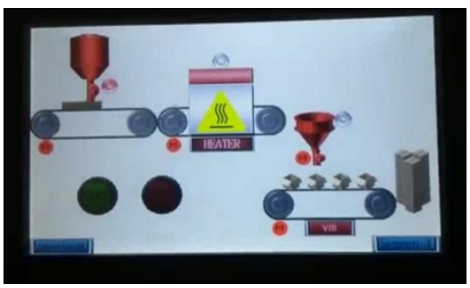

Figure 10: Virtual control environment

the Induction motor (stator current and temperature) is also monitored in the virtual environment (Basile and Ferrara, 2020). When the tray reaches the appropriate position in the conveyor, the proximity sensor senses the tray and the PLC stops the conveyor operation. Biscuit making process will be executed and the conveyor enters into run mode once the process is over. The Figure 5 shows the topology used in Biscuit making machine with IoT setup, figure 6 showing the Conveyor system of proposed machine, figure 7 showing the wiring of Control Panel of Proposed machine and figure 8 shows Conveyor setup. Next to Biscuit making section is packing section refer Figure 9. Here packed quantity values are entered in the HMI and the magnetic vibrator vibrates until the required level is reached (Thürer *et al*., 2022). Load cell measures the actual weight of the product and it is given to PLC Analog Input Module. In addition to that the status of I/O is simultaneously uploaded in the virtual environment refer Figure 10 (Sossenheimer *et al*., 2021).

Conclusion

The virtual control of Industrial machines is achieved by interfacing the PLC with virtual environment created in the cloud. The details of the PLC I/O are fed back to the virtual environment and the status was controlled from a remote location. The behavior of the machine was tested with standard input and Output commands given from iOT-Cloud.

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