PC-based Human Machine Interface Control for Packaging System in Pharmaceutical Factory

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Abstract - Moving from trend to tradition, more and more manufacturers are adding human machine interface (HMI) to their manufacturing process. A good HMI will increase the productivity of the operator and machine, increase uptime and assist in providing consistent product quality. In this system, HMI is developed to monitor the whole process and control the functions of process. The system is designed and constructed to control and monitor drug bottle packaging operation in the pharmaceutical factory. PC is interfaced with hardware module using serial interfacing circuit. The monitoring and running conditions are shown by motors and sensors on the screen of computer using a group of program as Visual Basic.Net and Mikro C. The robotic arm used as packager is constructed using aluminum and the gripper is made by plastic. The control circuit is consisted of PIC, DC motors, motor drivers, LDR and limit switches. It is also used own programs using VB.NET instead of off-the-shelf software. The software is designed of the real time monitoring for packaging process and included signal sensing, supervisory control using PIC, data acquisition and visualization programs. This research is studied to develop automation manufacturing technology in Myanmar industries and implement the software package to control the operations.

Keywords – HMI, Visual Basic.Net, Mikro C and PIC

I. INTRODUCTION

The term Human Machine Interface (HMI) can be defined as a system that provides a window into the operation of a single machine or simple network of multiple machines in a common control system. The HMI is software and hardware that allows human operators to monitor the state of a process under control, modify control settings to change the control objective, and manually override automatic control operations. There are some processes such as testing, filling, weighing, packaging, etc in the pharmaceutical factories. Among them, packaging is an important process in drug production.

Research is focused on human-machine interface and considers integration with robot packaging system to streamline the drug production process in the pharmaceutical industries. PC-based human machine interface (HMI) for robot systems allows the user to control the robot system, view production data, correct machine malfunctions and view manuals. This user-friendly interface minimizes system complexity and operator training. Robot packaging system is studied to perform drug bottle packing in the pharmaceutical factory. The robot arm is flexible with 90°
swiveling range that allow it for free positioning of bottles within working area. Moreover it is connected to drug production processes and worked together with filling and capping machines on the same conveyor.

II. SYSTEM OVERVIEW

The robot packaging system is provided to perform drug bottle packaging in the pharmaceutical factory. PIC 16F887 microcontroller is used as the brain of the system because it can provide serial communication interface and incorporate all of the peripheral I/O facilities that are needed [8],[9]. The firmware program is implemented by Mikro C programming language. Personal computer (PC) is used as human machine interface (HMI) and provides a series of screens or windows for monitoring and control of the devices. The entire process is overseen by the operator via computer. Graphical display screens are developed by Visual Basic and serial interfacing circuit (RS232 protocol and MAX232 voltage level converter) is used to connect computer and controller [4].

The design, implementation and displaying of packaging process for the monitoring and control system is provided by Visual Basic.Net programming language. DC motors are used to control the motions of the system. The robot arm motion can be adjustable according to the drug production line. It moves with a speed of up to 20 picks per minute in the palletizing line. The speed of the robot arm can accelerate of up to 90g in the vertical range of 30cm and a horizontal range within a circle of 65cm on diameter. It can accelerate of up to 90g in experimental environment. It moves with a speed of up to 20 picks per minute in the palletizing line. The speed of the robot arm motion can be adjustable according to the drug production line.

In constructing the drug bottle packaging system, three DC motors are used for the robot arm and one is for the conveyor. There is a DC motor at the base, which allows for circular movement of the whole structure; another at the shoulder which allows for upward and downward movement of the arm; while the last DC motor at the gripper allows for the picking of objects.

![Figure 2. Block Diagram of Control System for Packaging System](image_url)
IV. PROCESS OPERATION

In this robot packaging application, PIC 16F887 microcontroller, four DC motors, L298N and SG3525 motor drivers, position sensors and electrical technologies are used to perform the packaging sequences. For operator control on the robot work cell, PC-based human machine interface is created.

The operation and monitoring of the system is handled and enhanced by utilizing the microcontroller. PIC16F887 microcontroller is used to control and process the entire device in the system. Microcontroller sends sensor data for PC to analyze and display. PC sends commands to control the robot. Communication between PC and microcontroller circuit is connected by serial communication circuit. In complete circuit diagram of packaging process, there will be power supply unit, serial interfacing between PC and PIC, microcontroller control system to supervise, sensor inputs to PIC and control processes from the hardware. Light-Dependent Resistor (LDR) and limit switches are sensors of the robot. LDR is used to detect whether the drug bottle is present or not at pick-up location. Two limit switches are assembled at gripper and four are for palletizing. For robot motion, three DC motors are...
utilized which each is for robot base, arm and gripper. For conveyor, one DC motor is also used. DC motor control is performed by L298N motor driver and SG3525 pulse width modulator. When the position sensor that detects the bottle at the end of the conveyor receives the signal, robot arm moves from the normal position to the assigned place in order to pick the drug bottle and places on the conveyor to the carton.

With the help of Mikro C compiler, the code for PIC 16F887A is written. The code is written in the PIC microcontroller memory as per requirement and it is transferred to the PC with the help of the USART communication. The process flow chart is shown in Figure 5.

In this system, the window configuration for the packaging operation is controlled and monitored from PC and Visual Basic programming language is used to interface between PC and hardware device via serial communication. The window application in Microsoft Visual studio was selected for the GUI due to its ability to easily support input/output operations via serial port (RS232). It uses 9600 baud rate, 8-data bits array pattern for data transmission. Personal computer (PC) based display consists of an industrially hardened PC, display and keyboard running a standard commercially available operating system and off-the-shelf software. This paper focuses on the creating HMI application on the Window operating system with the Visual Basic. The system is designed using...
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graphical user interface thus allowing easy access to real time control. The Windows application in Microsoft Visual studio was selected for the GUI due to its ability to easily support Input/output operations via serial port (RS232).

The GUI has been developed for monitoring and controlling robot from remote location. The GUI uses the command buttons to activate the selected port of the microcontroller that controls the robot as output instruction commands. Thus every command button on the GUI represents certain ASCII code from the keyboard. The program waits for another ASCII code to be entered by the mouse. The communication port between the PC and the microcontroller can be interfaced either directly via an RS-232 port or the PC USB port. Since computers today are developed with the USB (Universal Serial Bus) port, the GUI based on Windows platforms is designed to be capable of transferring and receiving data via such ports.

Figure 6. Main Window

The system contains the main window that links other window applications and operation window for the real-time process. When the HMI software developed for the packaging system is applied, the window shown in Figure 6 is seen firstly. By clicking the command button on this window, the corresponding windows will be appeared. This window is linked with operation window, introduction and user guide. For running and stopping condition of the system which is real time process, operation window is designed with start and stop buttons. Simulation is made with the sample components for the real devices by using the figures that are images for devices. User guide is included about how the system uses and what it includes. By pressing the Exit button, we can exit the program.

Figure 7. Operation Window
The whole software of data acquisition, processing and monitoring system is linked each other. The software must run and send appropriate command to the processing module according to the user. After receiving and checking the command, the data acquisition processing module is processed by the received command. If the command is selected to acquire data from sensors used in packaging process, the operation window takes the input signal from sensors, processes and sends the result to the output system. Motors are controlled on the same way. The running conditions of dc motors used to drive for robot’s motions and sensors used to measure the reach of drug bottle are shown by operation window.

The main function of the operation window is to control and monitor the whole process of the system. After pressing the command buttons on VB window, the required signals send to the RS-232 serial port with serial communication. RS-232 also sends the receiving signals from PC to PIC microcontroller via MAX232. Depending on the receiving signals, PIC microcontroller controls the required motions.

In the motor monitoring page shown in Figure 8, the image of motor are included and they are moving like the motor of the process. Each is represented a motor used in the robot motion. It includes four motors – gripper motor, arm motor, base motor and conveyor motor for packaging system. If the input signal of pins assigned for motor get, the operation of motor will show on the VB form. This window is linked with the operation window and the back button is used to go back the operation window.

In the sensor monitoring page shown in Figure 9, the image of sensor are included and they are moving like the sensor of the process. Each is represented a sensor used in the robot motion. It includes four sensors – gripper sensor, arm sensor, base sensor and conveyor sensor for packaging system. If the input signal of pins assigned for sensor get, the operation of sensor will show on the VB form. This window is linked with the operation window and the back button is used to go back the operation window.
The sensor monitoring window screen is indicated in Figure 9. If the input signal of pins assigned for sensors get, the sample components on the above VB form change the colour red to green. There are seven sensors to perform the robot packaging process. The LDR sensor detects the reach of drug bottle and six limit switches restrict the rotation of motors for gripper, robot-arm and base. In this system, window based application forms are developed for the real-time monitoring and control of each operation devices.

VI. CONCLUSION

The packaging system has been developed considering for increased productivity and the delivery of end products of uniform quality. It can be employed in places where precision and accuracy are required. By using HMI, the whole system is controlled with minimum supervision and interaction with human operator. The whole process can be monitored and controlled by the only one operator. So, this system can improve production rate and reduce the human error. As the advantages of the use of robot packaging system in the pharmaceutical industries, faster cycle time, more speed, increased throughput and maximized yield are significant. The important part of the design, HMI, facilitates the engineer works in order to enable monitoring and controlling functions from remote locations.

REFERENCE