IIOT using HMI local control and remote monitoring

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Abstract— In the IIOT the internet used for monitoring the status of the machineries which is installed nearer to that company .Status of the machineries is sent to the company email address as well as send message to the supervisor mobile via the GSM Modem.HMI is connected to the PLC via the RS-485 cable. HMI is interfaced with the raspberry pi via Optocoupler and PLC. HMI sends signal to PLC via RS-485 cable.PLC operate as per the ladder logic which is uploaded by the WLP Soft software, raspberry pi receives the signal via isolation unit which is sent by the PLC and also connected to the GSM Modem for delivering the message. Raspberry pi is connected to internet via Wi-Fi. It access the SMTP server for to sending the status to the given company mail address. Raspberry pi send the message to mobile by using the AT commands.

By using HMI control the machine locally but status of the machine is send to remote GSM Modem. Internet is used by raspberry pi for sending the status of the machine from the raspberry pi to mail and status of the machine is displayed on sent mail and also sending the message to the supervisor mobile.

Index Terms— GSM (Global System for Mobile communication), HMI (Human Machine Interface), PLC (Programmable Logic Controller), SMTP (Simple Mail Transfer Protocol).

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1 INTRODUCTION

IN IIOT internet is used for monitoring the status of the machineries which is installed nearer to that company. Updating the status of the machineries by sending the mail to the company email address as well as send message to the supervisor mobile via the GSM Modem.

This uses 3 fields industrial control system, Internet of Things and Human machine interface (HMI). These systems help us to find the status of the devices as well as operation of the industry. Now industrial automation becoming important aspect for controlling the manufacturing process as well as monitoring the process. Monitored process lead to improve the company efficiency as well as performance of the company. When HMI operated than HMI sends signal to the PLC. Ladder logic is used in the PLC and HMI screen is uploaded by the appropriate version of the DOP soft. We used RS-485 for long distance communication, in that we used only RX+ pin (1st pin) and RX- pin (6th pin).

2 ABBRVIATIONS

Abbreviation	Expansion
IIOT	Industrial Internet of Things
HMI	Human Machine Interface
PLC	Programmable Logic Controller
SMTP	Simple Mail Transfer Protocol
V & A	Voltage & Ampere

IC	Integrated circuit
GSM	Global System for Mobile communication
SIM	Subscriber Identity Module
USB	Universal Serial Bus
IP	Internet Protocol
LCD	Liquefied Cristal Display
TFT	Thin Filament Transistor
IIOT	Industrial Internet of Things
PC	Personal Computer
NC	No Connection
LED	Light Emitting Diode
IR	Infrared Rays
ASCII	American Standard Code for Information Interchange
CPU	Central Processing Unit
RTU	Remote Terminal Unit
TCP	Transmission Control Protocol
PPM	Parts Per Million
SD card	Secure Digital card
HDMI	High Definition Media Interface
GPIO	General Purpose Input Output
GPRS C	General Packet Radio Services Computing
RFC	Request For Comment
FTP	File Transfer Protocol

IMAP	Internet Message Access Protocol
POP	Post Office Protocol
ARPANET	Advance Research Project Agency Network
TTL	Transistor Transistor Logic
UART	Universal Asynchronous Receiver Transmitter
DOP Soft	Dynamic Operating Program Software
MS	Master Slave
TP	Token Passing
SoC	System on Chip
EEROM	Electrically Erasable Programmable Read Only Memory
SPI	Serial Peripheral Interface
WLP Soft	WEG Ladder Programmer
WEG	Winglins Editing Group
AC	Alternating Current
DC	Direct Current
BJT	Bipolar Junction Transistor
FTDI	Future Technology Devices International
MOSFET	Metal Oxide Semiconductor Field Effect Transistor.

3 HARDWARE REQUIREMENT

Delta DOP- B-series Human Machine Interface

Specifications

1. 4.3-inch (480 x 272 pixels) 65536 colors TFT LCD.
2. 2 sets of COM ports, supports RS-232 / RS-485 / RS-422
3. for data transfer/download: USB, RS-232
4. Complies with the IP65 standard
5. Supports horizontal / vertical display unit.
6. PC editing software, DOP Soft is compatible with operating systems: Windows XP, Windows Vista, and Windows 7.

DOP-B Series

Figure 1: HMI screen of the DOP B-series

The various touch screens with multiple dimensions and colors of the DOP-B Series Human Machine Interface available

in the market. Fast and convenient control functions for industrial automation machines which are offered by the HMI. In addition to Delta Windows-based and user-friendly DOP Soft Screen Editor and Programming Software configures the whole DOP B- Series. Users can quickly edit images and graphs and easily configure suitable communication protocol in the DOP Soft. Applications can be created, edited, downloaded and uploaded [6].

When receiving the software upgrade technical announcement. User can download the upgrade software program, Patch_DOPB_yyyymmdd at Delta's official website. The upgrade software program includes the enhanced function and firmware. The user needs to confirm if the software destination directory is the default setting before installing the upgrade software program, i.e. C:\Program Files\Delta Industrial Automation\Screen Editor 1.01.10. Please ensure the destination directory is the default setting or the user could not perform the upgrade successfully.

I used only Button, Indicator and Prestored message for display the name of the name of the project or name of the company. And Button for controlling the LED which is connected to the Raspberry pi 3 board. Operation is indicated by the indicator.

PLC (Programmable Logic Controller)

DVP series PLCs for industrial automation applications, Delta has been devoted to delivering more innovative products that satisfy customers' needs and meet the requirements of a wide variety of applications. Broad range of controllers and modules which all feature high performance which is in Delta PLCs offer a, multiple functions and efficient program editing tools. In addition to the user-friendly programming software and faster execution speed, we also provide complete industry-focused solutions, motion control solutions, and industrial field bus solutions with Delta's new PLC series. Integration of the PLCs with industrial automation products to deliver total solutions for various field applications [5].

Figure 2: HMI screen of the DVP 14SS-series

Specifications

• Digital modules (output/input/mix):8, 16, 32, 64 I/O.

- Analog modules (output/input/mix):6 channel, 2 channel, 8 channel inputs (14-bit) / output (12-bit).
- Load cell modules: with 24 bits resolution with 2.5ms response rate of the independent dual-channel high speed high accuracy load cell module.
- Temperature measurement modules: conversion time 200ms/channel, overall accuracy0.6%, resolution 16bits, RTD inputs: Pt100 / Pt1000 3850 PPM/°C (DIN 43760 JIS C1604-1989) / Ni100 / Ni1000 / LG-Ni1000 / Cu100 / Cu50, thermocouple inputs: K, J, R, S, T type.
- Network modules: Ethernet, Device Net, PROFIBUS-DP, CANopen, RS-485, RS-422, BACnet MS/TP (Master Slave / Token Passing).
- Remote I/O communication modules: Device Net, PROFI-BUS, Ethernet (MODBUS TCP), RS-485 (MODBUS AS-CII/RTU).

Raspberry Pi

The capacity of previous models of the raspberry pi is 6 times lesser processing capacity than that of raspberry Pi 3. This third generation Raspberry Pi has an upgraded Broadcom BCM2837 processor, a powerful 64-bit ARM Cortex-A53 based quad-core processor that runs at 1.2 GHz. All of these improvements lead to a 50-60% increase in performance in 32-bit mode when compared to the Pi 2 and nearly a 10-fold increase over the original Raspberry Pi [8].
Specifications

- Chip: Broadcom BCM2837
- Core architecture: ARM Cortex-A53 Quad-core
- CPU: 1.2 GHz
- GPU:
- Dual core Video Core IV® Multimedia Co-Processor
- Provides1080p30 H.264 high-profile decode and OpenGL ES 2.0, hardware-accelerated Open VG, and Capable of 1 gigapixel/s, 1.5 gigatexel/s or 24 GFLOPS (Giga floating point operation per second) with texture filtering
- Memory: 1 Gb (900 MHz)
- Networking: 10/100 Ethernet, 2.4 GHz 802.11n wireless
- Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy
- Storage: Micro
- Operating system: Raspbian Operating System (Linux operating system type OS).
- Dimensions: 85 x 56 x 17 mm
- Power: micro-USB socket 5 V, 2.5 A
- Connectors:
  Ethernet: 10/100 Base T Ethernet socket
  Video output: HDMI®
  3.5 mm analog audio/video jack
  USB: 4 x USB 2.0
  GPIO connector:
- 40-pin 2.54 mm (100 mil) expansion header: +3.3 V, +5 V and GND supply lines as well as 2 x 20 strip providing 27 GPIO pins.

- Display connector: A clock lane and Display Serial Interface (DSI) 15-way flat cable connector with 2 data lines.
- Memory card slot: Micro SD
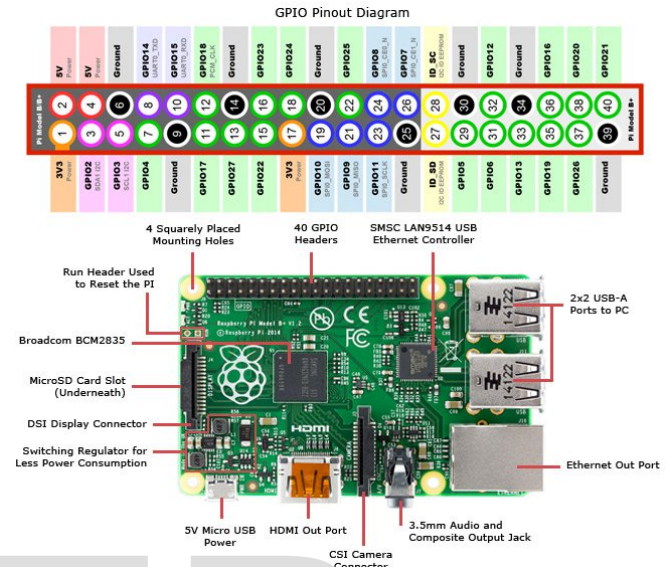- Camera Serial Interface (CSI)

Figure 3: Raspberry pi board on bottom and pin diagram on top

GPIO

The Raspberry Pi feature is the row of GPIO (general-purpose input/output) pins along the top edge of the board. A 40-pin GPIO pins is found on all current Raspberry Pi boards (unpopulated on Pi Zero and Pi Zero W). Prior to the Pi 1 Model B+ (2014) boards contains a shorter 26-pin header. Any of the GPIO pins can be designated (in software) as an input or output pin and used for a wide range of application.

Voltages

Two 5V pins and two 3.3V pins are present on the board, as well as a number of ground pins (0V), which are unconfigurable. The remaining pins are all general purpose 3.3V pins, meaning outputs are set to 3.3V and inputs are 3.3V-tolerant.

Outputs
A GPIO pin designated as an output pin can be set to high (3.3V) or low (0V).

Inputs
A GPIO pin designated as an input pin can be read as high (3.3V) or low (0V). GPIO pins are made easier with the use of internal pull-up or pull-down resistors. GPIO2 and GPIO3 Pins have fixed pull-up resistors, but for other pins this can be

configured in software. GPIO pins can be used with variety of alternative functions.

- PWM (pulse-width modulation)
- Software PWM available on all pins
- GPIO12, GPIO13, GPIO18, GPIO19 on these pins Hardware PWM are available
- SPI
- SPI0: MOSI (GPIO10), MISO (GPIO9), CE0 (GPIO8), CE1 (GPIO7),SCLK (GPIO11)
- SPI1: MOSI (GPIO20), MISO (GPIO19), SCLK (GPIO21), CE0 (GPIO18), CE1 (GPIO17), CE2 (GPIO16)
- I2C (integrated circuit interconnection)
- Clock (GPIO3),Data (GPIO2)
- EEPROM Clock (GPIO1),EEPROM Data: (GPIO0)
- Serial:RX (GPIO15)-receiving,TX (GPIO14)-transmission

Programming with GPIO

The GPIO pins are controlled by using a number of programming languages and tools. See the following guides to get started:

- GPIO with Scratch 1.4
- GPIO with Scratch 2
- GPIO with Python
- GPIO with standard kernel interface via libgpiod uses C/C++
- GPIO with 3rd party library pigeon uses C/C++
- GPIO with Processing 3

GSM Modem (Global System for Mobile communication)

Working of SIM900A Modem with any GSM network operator acts like a mobile phone when SIM card is inserted with its own unique phone number.SIM900A GSM/GPRS modem is plug and play modem with RS232 serial communication supported. Merits of using this modem will be that its RS232 port can be used to communicate and develop embedded applications [7].

Figure 4: GSM Modem

Applications like SMS (Short Message Service) Control, data transfer, remote control and logging can be developed. SIM900 modem supports features like voice call, GPRS, SMS, and Data/Fax etc. SIM900A modem uses AT commands to work with supported features .Note that to be connected to a cellular network; the modem requires a SIM card provided by a network provider.

Power Requirement

This board requires external power supply of ~12V (Power is taken from the 12 V Adapters) and can draw up to ~2A of current at its peak.

Figure 5: 12V adapter for GSM   Modem

Indicators:
It has two LED indicators as,

ON: It shows that the Modem is getting powered and is switched on.
NET: This network LED blinks when the modem is communicating with the radio network.

Network LED

When powering up the modem, network LED blink every second and after network registration it will start to blink after every 3 seconds. The modem is registered with the network was shown in these. To test modem, connect modem serially with the PC and send "AT" through serial terminal. If "OK" response is received from the modem, then it means all is well.

Frequency of 850/900/1800/1900MHz at which GSM/GPRS Modem works on a and which can be used not only to access the Internet, but also for oral communication (when it is connected to a small loud speaker and a microphone) and for SMSs. Externally, it looks like a big package with L-shaped contacts on four sides with size of 0.94 inches x 0.94 inches x 0.12 inches so that they can be soldered both on the bottom and at the side.

Internally, data communication (through an integrated

TCP/IP stack), phone communication and (through an UART and a TTL serial interface) the communication with the circuit which is interfaced with it, these is controlled by AMR926EJ-S processor. The processor controls the SIM card operation (3 or 1.8 V) which needs to be attached to the outer wall of the module. In addition, the GSM900 device integrated with an analog interface, an A/D converter (analog to digital converter), an RTC (real time clock), an SPI bus (Serial Peripheral Interface), an Integrated Circuit interconnection-I2C, and a PWM module (Pulse Width Modulation).

The radio section is GSM phase 2/2+ compatible for either class 4 (2 W) at 850/ 900 MHz or class 1 (1 W) at 1800/1900 MHz Communicating all the data relative to the SMS and during TCP/IP sessions in GPRS, the data-rate is determined by GPRS class 10: max. 85,6 kbps, and receiving the circuit commands coming from the PIC governing the remote control that can be either AT-enhanced or AT standard Sitcom type controlled by TTL serial interface. The module is supplied with continuous energy with the voltage between 3.4 and 4.5 V and absorbs a maximum of 0.8 A during transmission.

AT commands are used to control the modems where AT stands for Attention. From Hayes commands which were used by the Hayes smart modems these commands were derived. Every the dial up modems as well as wireless modem, require an AT command to interact with a computer machine.

Usage

The AT commands can be used with GSM/GPRS MODEMs to access these services and information:
- SMS
- MMS
- Fax
- Data over mobile network as well as Voice link
- Information and configuration concerning SIM card and the MODEM.

Types of AT Command:

There are 4 basic types of AT commands:
Test: The test command is used to check the compatibility of a command by a modem.
AT=?

Read: Read command is used for extracting the modem settings required for operations.
SYNTAX: AT?

Set: This command is used to make changes into modem settings needs for the operation.
SYNTAX: AT=value1, value2, …, valueN

Execution: This command is used to execute the said operation.

SYNTAX: AT=parameter1, parameter2, …, parameter
Most Commonly Used AT Commands.

The following are 7 most commonly used AT commands:
1. AT: Used to check the interaction between the module and the computer. The module can connect correctly to the port than it relay with OK, else wise it comes back with a result code ERROR.

2. +CMGF: Used to setup the SMS mode. By adding 1 or 0 with the command PDU or text mode can be selected. The text mode is easy to operate but it only allows a few limited features of SMS. Whereas the PDU (protocol data unit) mode allows a more detailed access to the service.

SYNTAX: AT+CMGF=<mode>

3. +CMGS: sending SMS to a particular phone number done by using CMGS command
SYNTAX: AT+CMGS= serial number of message which is to be send.

4. ATD: Make call to a particular number done by using ATD
SYNTAX: ATD;(Enter)

5. ATA: Used to answer the incoming calls. The calls are denoted by a message 'RING' and 'CLIP' for incoming number which is displayed which duplicated for every ring of the call. After call gets ended a message saying 'NO CARRIER' is displayed.
SYNTAX: ATA(Enter)

6. +CMGW: Message is stored in the SIM by using +CMGW. Where the message can be entered after the execution of the command, the '>' sign appears in the next line.
SYNTAX: AT+CMGW=" Phone number"> Message to be stored

7. ATH: This command is utilized to disconnect a remote user with the GSM module.
SYNTAX: ATH (Enter)
This AT commands were used in my Industrial Internet of Things for sending the message

Jio hotspot

Jio hotspot device allows N number of users and mobile devices to access Jio's 4G high-speed internet connectivity and create a personal Wi-Fi hotspot. The Jio hotspot device can connect a minimum of 1 device (User) + 1 USB connection, with some models having the ability to support many more connections.

Optocoupler

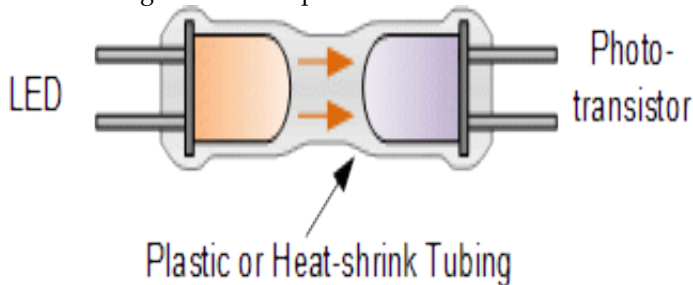Optocoupler device to separate the two electrical circuits by means of a light sensitive optical interface.

Figure 6: Internal diagram of the Optocoupler

Transformers provides isolation between the primary input voltage and the secondary output voltage obtained using magnetic coupling and this is achieved using the magnetic flux circulating within their laminated iron core [1].

Figure 7: External view of the Optocoupler

But we can also provide electrical isolation between high voltage side and low voltage side using just light by using a very commonly used electronic component called an Optocoupler.The basic modeling of an Optocoupler or Opto-isolator consists of a light source LED that produces infra-red light and a semiconductor photo-sensitive device photo transistor that is used to detect the emitted infra-red beam.

Both the light source as well as photo-sensitive device is enclosed in a light-tight body or package with metal legs for the electrical connections as shown in the above figure. Opto-isolator consists of a light source and a photo sensitive receiver with the basic operation of an Optocoupler being very simple to understand.

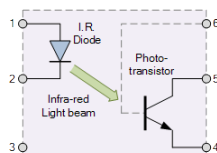### Phototransistor Optocoupler

Figure 8: Optocoupler internal circuit diagram

Assume a photo-transistor device as shown in the above figure. Current from the source signal passes via the input LED which emits infra-red light whose intensity is proportional to the electrical signal. This emitted light falls upon the base of the photo-transistor, it leads to switch-ON and conduction is similar way as normal bipolar transistor [2].

The base connection of the photo-transistor can be left open (not connected) for maximum sensitivity to the LEDs infra-red light energy or connected to ground via the suitable external high value resistor ,to control the switching sensitivity high value of resistor is connected for making it more stable and resistant to false triggering by external electrical noise or voltage transients.When the current flowing through the LED is interrupted, the infra-red emitted light is in OFF state, causing the photo-transistor to increase conducting. Current switching in the output circuit was done by photo-transistor.

The spectral response of the LED and The photo-sensitive device are the same which is being separated by a transparent medium such as glass, plastic or air. Since there is no direct electrical contact between the input and output of an Opto-coupler, electrical isolation up to 10kV is achieved. Generally Optocoupler is of four types which available, each one having an infra-red LED source but with different photo-sensitive devices are used in it.

Table 1: IC 4N35 Optocoupler pin description

Pin	Pin Description	Connections
1	Anode	The input voltage is connected to the IR LED to ON it.
2	Cathode	This connects to ground or return.
3	NC	This terminal remains unconnected.
4	Emitter	The emitter gets connected to ground.
5	Collector	The collector terminal is connected to the output devices.
6	Base	This remains unconnected.

Battery eliminator

An electrical source battery eliminator device which is equivalent of battery, which then converts the AC source to a suitable a battery eliminator eliminates the needs for batteries but may remove the advantage of portability. A battery eliminator device is also effective in replacing obsolete battery designs. Using two battery eliminator of 12V variable DC with one is of 1A and another is of 0.5A.
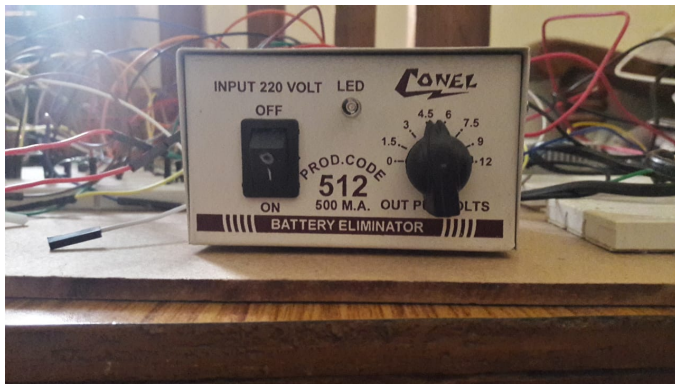
Figure 9: Variable battery eliminator

The size and shape of a PP9v battery, originally intended to replace the battery in portable radios in the 1960s. A solar panel for a portable appliance may also be considered a battery eliminator. Battery eliminator does not contain any power storage components [4].

Switched Mode Power Supply

A switched-mode power supply is an electronic power supply that incorporates a semi-conductor device such as BJT for to convert electrical power efficiently. An SMPS transfer's power from a DC or AC source (often mains power) to DC loads, such as a HMI, SMPS has converting current and voltage characteristics. Other than linear power supply, the pass transistor of a switching-mode supply continually switches between full-on, low-dissipation and full-off states, and spends very little time in the high dissipation transitions; wastage energy is minimized by this [3].

Dissipation of power is nil in a hypothetical ideal switched-mode power supply. Varying the ratio of on-to-off time (also known as duty cycles) achieves the Voltage regulation. Continuously dissipating power in the pass transistor in a linear power supply regulates the output voltage. This higher power conversion efficiency is an important in a switched-mode power supply. Switched-mode power supplies may also be substantially lighter and smaller than a linear supply due to the smaller transformer size and weight. Its rating is 24V 1A.

Replacements of linear regulators with the switching regulator when switching regulator has higher efficiency, smaller size or lighter weight is required. They are more complicated and their switching currents can cause electrical noise problems if not carefully suppressed it may cause poor power factor.

A linear regulator provides the desired output voltage by wasting high power in the form of ohmic losses .A linear regulator regulates either output voltage or current by dissipating the excess electric power in the form of heat.

The AC input is fed to the AC to DC converter SMPS, here AC is converted into DC by rectification process using a rectifier and filter. Unregulated DC voltage is fed to the large-filter capacitor or PFC (Power Factor Correction) circuits for correction or controlling of power factor. The low power factor due to the rectifier draws short current pulses having significantly high-frequency energy.
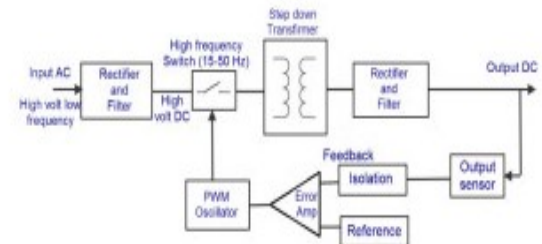

Figure 10: AC to DC converter SMPS

It is similar to the above DC to DC converter (Fixed DC to variable DC), but instead of direct DC power supply, here AC input is used. So, the combination of the rectifier and filter, shown in the above block diagram is used for converting the AC into DC and switching is done by using a power MOSFET amplifier for achievement of very high gain. The switching frequency is chosen such that it must be kept inaudible to normal human beings (mostly above 20 KHz) and the PWM oscillator utilized by the feedback for controlling the switching action.

RS-485

1st and 6th pins are used in the HMI communication, this connector type is also referred to as a DB9 connector. Usually a male port in a computer's serial COM port (DTE-Data Terminal Equipment) is as shown below and any peripheral devices you connect to a female connector (DCE-Data Circuit Terminating Equipment). 1(RX+) &6(RX-) terminals are connected to the RS485 terminal of the PLC for communication purposes. Here master slave communication is seen [9].

USB to RS232 conversion

The USB-RS232 converter cables belong to communication devices. This model, US232R, provides a
Simple method of adapting the serial devices with RS232 interfaces to modern USB ports.A small internal electronic circuit board which utilizes the FTDI in each US232R Driver, It is mounted inside a rugged plastic enclosure capable of withstanding industrial temperature ranges. The Integrated electronics also include TXD/RXD LEDs and RS232 level shifters to provide a visual indication of data traffic through the adapter.

The Cable incorporates a standard USB device connector for connection to an upstream hub Port. RS232-level signals,

contains modem handshake signals, are available on an industry-standard DB-9Pin connector. The maximum data rate is 1MBaud in the RS232-level.
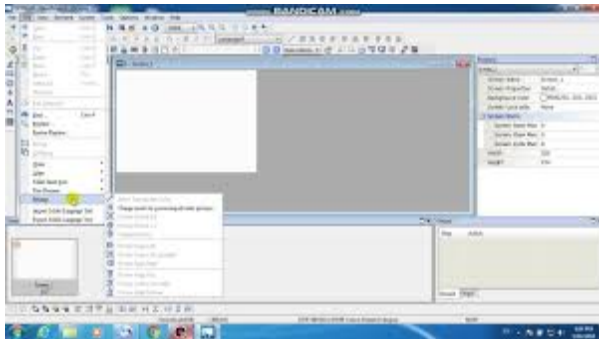
4 SOFTWARE REQUIREMENT

DOP soft

Figure 11: DOP soft software for B-series HMI.

Above figure shows the DOP Soft software for B-series HMI. In this project Button, indicator and pre-stored message display is used. Button for controlling the PLC and feed back is taken by the indicator. Pre-stored message is used for displaying the company name as well as project name. M230-235 is the address is given to the input. This address is read by the indicator. DOP Soft software is launched by Delta electronics for uploading the screen to the HMI.

WLP soft
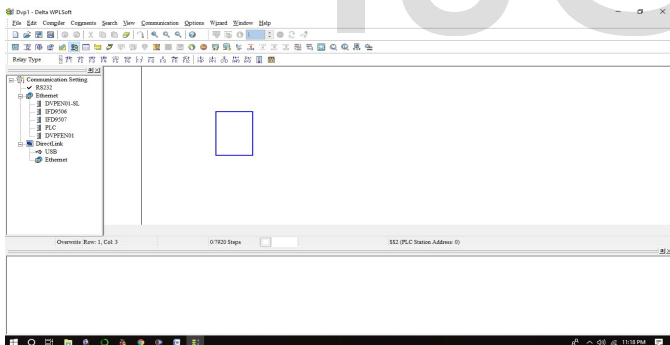
Figure 12: WLP soft for PLC 14SS series

Above figure shows the WLP soft for coding the PLC in ladder logic. Above and left side option is used for creating the ladder. For coding we must select the series of the Delta PLC series for setting up the coding screen. Here ON & OFF Push Button instruction is used for switching ON / OFF the device which is connected to the PLC. This software is launched by the delta electronics. Here M230-235 address is used by the ladder logic as output address at which Optocoupler is connected.

SMTP (simple mail transfer protocol)

For electronic mail transmission Simple Mail Transfer Protocol is a communication protocol is used. An Internet standard, in 1982 SMTP was first defined by RFC 821, and updated in 2008 by RFC 5321 to Extended SMTP additions, which is the protocol variety in widespread use today. Mail servers use SMTP, POP and IMAP are used to send and receive mail messages. Proprietary systems are Microsoft webmail, Gmail and Yahoo.com may use non-standard protocols internally, but all use SMTP when sending to or receiving email from outside their own systems. On port number 25 SMTP servers commonly used by Transmission Control Protocol .User-level email clients typically use SMTP only for sending messages to a mail server for relaying , typically submit outgoing email to the mail server on port 465 or 587 as per RFC 8314.

For receiving the messages, IMAP and POP3 are standard, but proprietary servers also often implement proprietary protocols, e, g., Exchange ActvieSync. In 1971 describes SMTP traces its roots to two implementations, the Mail Box Protocol, whose implementation has been disputed, but is discussed in RFC 196 and other RFCs, and the SNDMSG (send message) program, which, according to RFC 2235, Ray Tomlinson of BBN invented for TENEX (operating system which is developed in 1968 by BBN company) computers to send mail messages across the ARPANET. Fewer than 50 hosts were connected to the Advanced Research Projects Agency Network at this time [10].

Further implementations include Mail Protocol and FTP Mail, both from 1973. Development work continued throughout the 1970s, until the Advanced Research Projects Agency Network transitioned into the modern Internet around 1980. In 1980 Jon Postel then proposed a Mail Transfer Protocol that began to remove the mail's reliance on FTP. On November 1981 SMTP was published under RFC 788, also by Postel .The SMTP standard was developed around the same time as Usenet, a one-to-many communication network with some similarities.

5 METHODOLOGY

Block diagram and Explanation

In below figure raspberry pi is connected to the Hotspot for internet accessing for sending the mail via SMTP sever. SMPS is connected to the HMI as well as PLC Here HMI acts as a master and PLC act as a slave.PLC is connected with the raspberry pi via Optocoupler. Raspberry pi is connected to the PLC via Optocoupler. On raspberry pi side LED (Machine) is connected. Raspberry pi as two media for sending the status one is GSM Modem for sending the message and another is Hotspot for accessing the SMTP server for ending the mail.

LED is considering as a machine, for further implementation machine is connected to the raspberry pi via isolation device (Relay or isolator). Jio hotspot is not physically connected to raspberry pi, only connected via Wi-Fi. Battery eliminator is
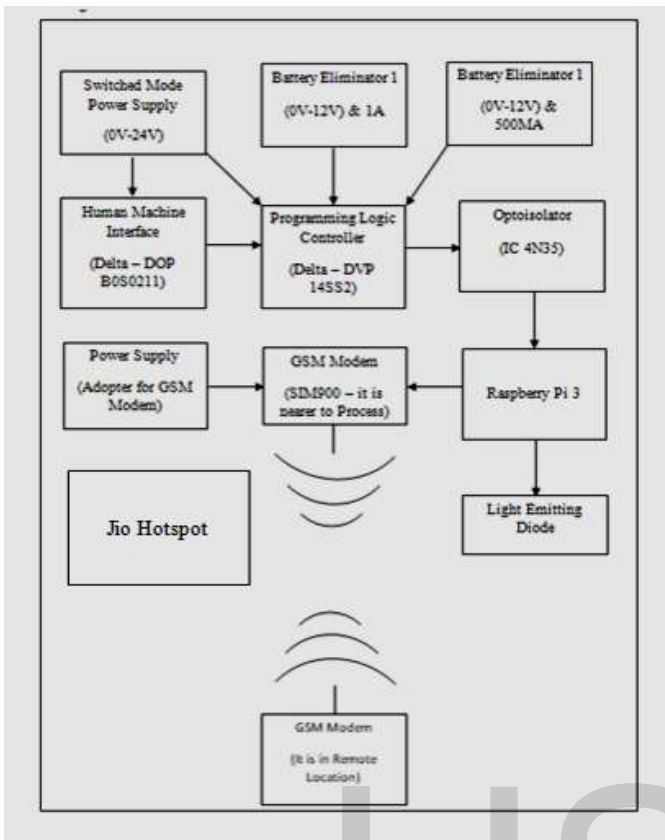
Figure 13: Block diagram of this project

connected to the PLC for triggering the Optocoupler and it rating is 1A, Max voltage of 12 V and Min voltage of 0V.

Working

On HMI screen buttons assigned with address PLC reads that address and execute the instruction which is written in the ladder logic. Response is feedback by the indicator on the raspberry pi. Voltage source is connected across the PLC and Optocoupler for triggering the Optocoupler. When HMI sends high signal to appropriate address (ex M230) then PLC execute the instruction which is written in the ladder logic. When Optocoupler triggered then raspberry pi gets high signal to the input pin. LED (Machine) gets switched ON for high signal. For low signal LED is in OFF state. This is state is send to the Remote GSM Modem via GSM Modem as well as Mail via SMTP server.

During the ON period of the led, it is indicated by the indicator which is displayed on the HMI (Human Machine Interface). This sends ON command of the appropriate LED in the form of SMS to remote GSM Modem & LOW to the PLC. And raspberry pi getting the HIGH command from the Optocoupler side. By using internet raspberry pi send the email which contains the status of the machine. This uses the SMTP Server. SMTP stands for simple mail transfer protocol. Raspberry pi which is connected to the internet access, which in term access the SMTP server for sending the mail.

6 RESULT AND CONCLUSION

The machines were controlled by the system but the status of the machine is sent to remote GSM Modem. This uses the internet for accessing the screen of the raspberry pi window and the status of the machine is displayed on it and also sends the status to the email via the internet as well as sending the messages to the supervisor mobile. The command is fed by the HMI and the process is done by the raspberry pi 3, and process data is fed to SMTP and GSM Modem for sending email as well as a message to the mobile.
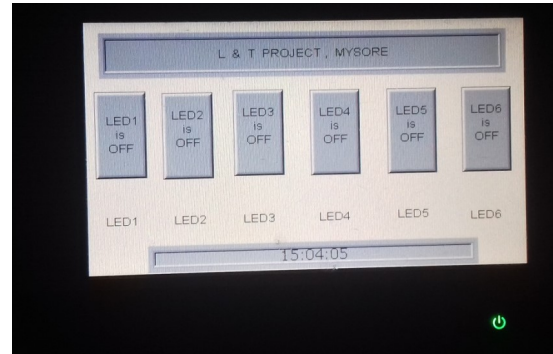

Figure 14: HMI Screen shows that all are in OFF state (Input)
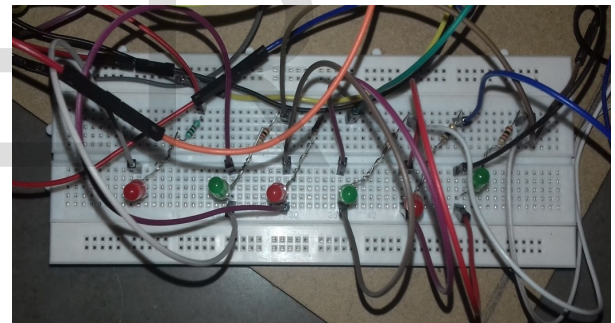

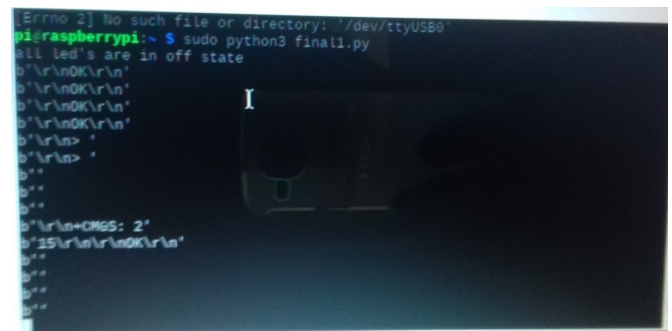Figure 15: LED indicates that all LED's are in OFF state (output)

Figure 16: Output state of the LED is shown on the terminal of the raspberry pi that all are in OFF state message is sending using AT command & Python code via GSM Modem (output)
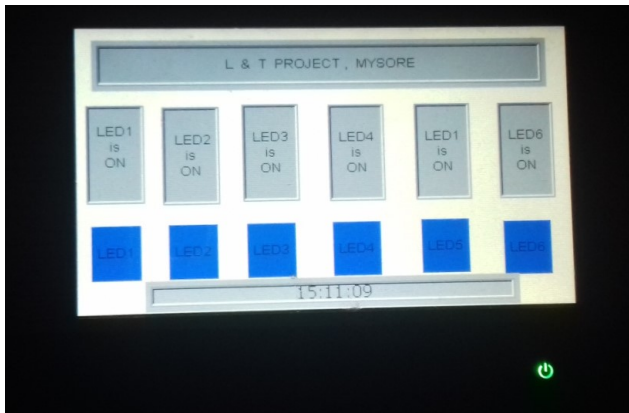
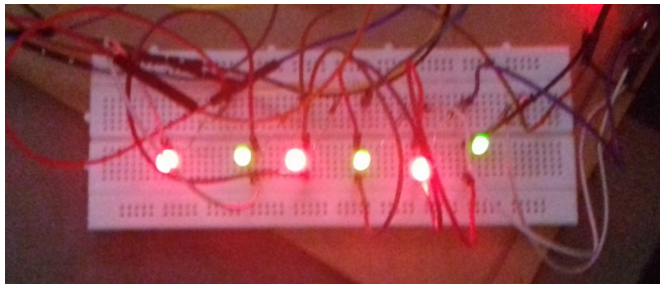Figure 17: HMI Screen shows that all are in ON state (Input)

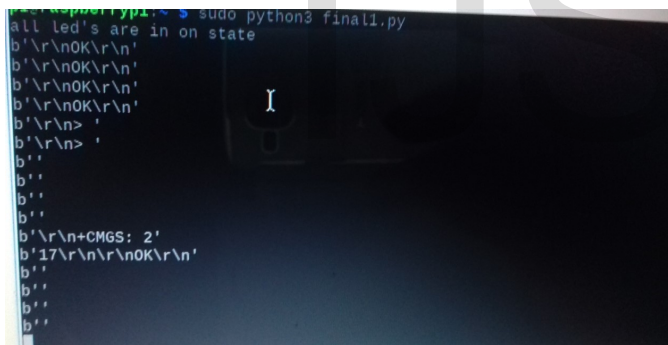Figure 18: LED indicates that all LED's are in ON state (output)

Figure 19: Output state of the LED is shown on the terminal of the raspberry pi that all are in ON state, message is sending using AT command & Python code via GSM Modem (output)
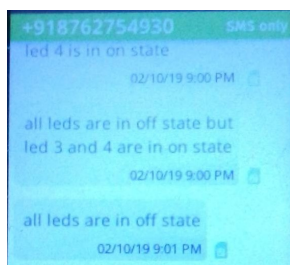

Figure 20: Output state of the LED which is displayed on the message inbox act as a remote GSM Modem (output)
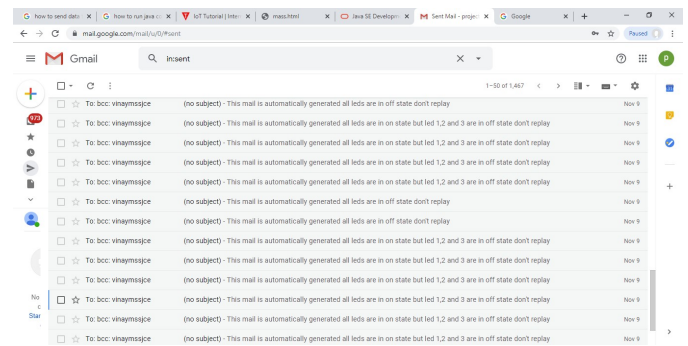

Figure 21: Screen shows the status of the all machine (output)

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