**Paper ID: IOTTSF32**

# MOBILE PENDANT FOR GANTRY SYSTEMS

Rucha Sandeep Joshi[1],Kajal Awale[2,] Anagha Kunte [3]

Electronics and Telecommunications department

Marathwada Mitra Mandal's college of engineering , Karvenagar , Pune

***ABSTRACT***

***Mobile Pendant for Gantry System is based on controlling the actions of Gantry systems.***

***In gantry system, since the area covered is very large, it is difficult to perform manual action / teaching, using HMI (Human Machine Interface) mounted on main control panel. So the Handheld pendant has been developed for performing manual actions & teaching. The device is equipped with graphic LCD display to show the texts associated with manual actions to be performed.***

***Normally these kind of Mobile pendants are interfaced with Main system using digital I/Os in 24VDC domain. This puts restrictions such as usage of multi-core cable from pendant to gantry system control panel (which is expensive & difficult to handle). Axes positions, alarms getting generated in the system (while teaching or performing manual actions of the gantry) also cannot be displayed. To overcome all the above mentioned problems, we have used Profinet communication between hand held pendant & gantry system controller. Also the display type is TFT for better visibility. TFT display is interfaced with microcontroller on $I^2C$ bus. Anybus make Profinet converter is used which would be interfaced with microcontroller on SPI bus.***

***This Hand held pendant is designed to use with Simenes controller but can be used with any other controller like Rockwell Automation , Mitsubishi controllers just by changing SPI to bus converter.***

***This is developed for using with Gudel make Gantry systems in coordination with Gudel India Pvt. Limited.***

## I. INTRODUCTION

Gantry cranes are metal bodies in motion which are used to hoist , lower and move material horizontally.

Traditional method of controlling these systems included overhead control systems. In such systems , a joystick or thumbwheel switches are used to control the operation of motors but controller has to be present in the field.

These systems required complex hardware connections and large number of cables for exchange of data which reduced the efficiency. All the controls have to handled by human being which can lead to human error.

Hence a mobile system was formed to overcome the drawbacks. It consists of a microcontroller and the communication interface. Controller sends the start command after which a preset data is automatically sent to the PLCs for operation. This system uses digital IO for data communication .This Pendant is mobile but over distance of few meters. Also due to parallel connections large number of cables are used which can lead to twisting and tangling of cables during the operation of gantry system.

Fig.1.1 Mobile Pendant for Gantry System

Fig 1.2Gantry System

The fieldbus was thus established which used one single cable from the controller to the PLC and transfers data serially. To increase efficiency further industrial Ethernet came into existence that is PROFINET.

In Gudel gantry systems, movement of 1 part can be controlled by 8 bit sequence that is 1 byte and data from PLC comes back to controller as a floating point number that is 16 bits or 2 bytes which has to be displayed on GLCD display. Thus at present we can control up to 3 parts and this can be further extended up to 11 input 100 output words using microcontrollers with more flash memory.

## II. OVERVIEW OF PROFINET

### A. INTRODUCTION

PROFIBUS is a standard for fieldbus communication in automation technology .It is openly published as a part of IEC61158.Its goal was to implement and spread the use of a bit serial field bus based on the basic requirements of the fiels device interfaces.[1]

The cyclic data exchange mechanism of PROFIBUS DP [4] is optimized for communication between PLCs and simple devices but it is not a good solution for the connection to supervisory computers.

communication services. Another disadvantage of PROFIBUS DP for the communication with the supervisory

computer is the requirement of a PROFIBUS controller board and corresponding device driver in the computer.[1]

Thus to overcome all these problems PROFINET came into existence which uses TCP/IP model for data transfer.

In today's automation technology, Ethernet and information technology (IT) are increasingly calling the shots with established standards like TCP/IP and XML[2]. Integrating information technology into automation increases the functionality and provides extensive possibilities to deal with the data and control it.

### B. PROFINET IO OPERATION

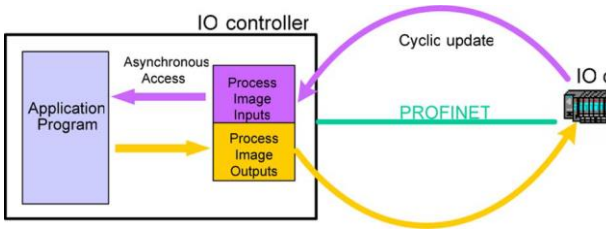



Fig 2.1 Cyclic message exchange.

The IO controller(mobile pendant in this project) initiates the data transfer

• Each configured IO device is checked and the IP-address is assigned with the Discovery and Configuration Protocol(DCP).

• Communication connections to all IO devices are formed with the so-called context management services.

• With the so-called acyclic record data services all IO devices and their sub modules are configured and parameterized.

• After successful configuration and parameterization an IO device enters the cyclic data exchange mode, where processed data are exchanged cyclically. According to Fig. 2 the transmission occurs from and to prepared buffer areas.The buffer areas are read and written by the application processes in IO controller and in IO device asynchronously to the communication cycle. In the cyclic data exchange mode also acyclic messages for alarms and their acknowledgement are exchanged. The cycle time is supervised by controller and device. After three consecutive violations of the maximum allowed cycle time the communication is considered to be disturbed and the connection is aborted.[1]

### C. ADVANTAGES OF PROFINET

- **One cable for everything:** Transfer of data of all relevant data via a single network.
- **Open standard**: Smooth connection between products by various manufacturing through ProfiNet standard.e.g. SPI,I2C.Ethernet standard as basis for the application of wireless technologies.
- **Expandability** :Effortless integration of additional network components also order plant pert based on PROFIBUS can be integrated.
- **Long distance communication**.
- **Smaller diameter of cable**

### D. PROFINET AND GANTRY SYSTEMS

Ethernet is ideally suited for the task of surfacing process data stored in control systems. Bringing industrial Ethernet into process plant presents process users with a variety of cost saving opportunities. It also allows valuable field data to flow directly into a real time, high bandwidth network making data available with no additional programming [3].

Gantry systems are heavy metal bodies which basically requires very fast data transfer with minimum error . Small change in data can disturb the motion of the system which can cause several serious problems. Industrial Ethernet that is Profinet provides extra functionality to minimize the problems.

## III. SYSTEM DECRIPTION

### 1) Block Diagram

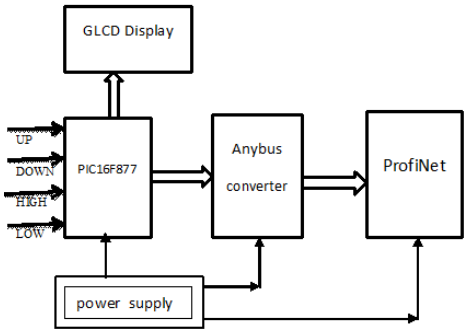



FIG 3.1 BLOCK DIAGRAM OF MOBILE PENDANT

### 2) DESCRIPTION OF BLOCK DIAGRAM

- **Microcontroller:** Microcontroller is used to set the required output according to the inputs , set the data and send that data to next block. It is also used for interfacing GLCD display .
- **GLCD display:** It is used to display what actions the Gantry system will perform when particular input is given at a time.
- **Anybus make Profinet converter:** Data is sent by microcontroller using serial bus which has to be converted to Profinet compatible. This conversion takes place in Anybus make Profinet converter.
- **Profinet :** Used for data exchange between controllers and PLC as well as for parameter setting and diagnosis.
- **Power Supply :** 5V DC

## IV. HARDWARE SPECIFICATIONS

1. PIC microcontroller(PIC16F877a) :
   - It takes the data from digital inputs , decides what data has to be sent ,and sends that data to Anybus make profinet converter.
   - Displays the data sent on the TFT display.

2. Power supply : 5V
3. Voltage regulator : IC7805
5. Anybus make profinet converter :
6. Power supply : 5V

## V. SELECTION OF COMPONENTS

### A. SELECTION OF A MICROCONTROLLER

Comparison between 8051 and PIC microcontroller.

| Parameters | 8051 | PIC |
|---|---|---|
| Flash memory | 4K | 16K |
| Inbuilt ADC | No | Yes |
| RTC | No | Yes |
| SPI serial bus | No | Yes |
| I2C serial bus | No | Yes |
| External interfacing | Very easy | Sometimes complicated |
| Cost | Cheaper | Costlier |
| Instruction set | Smaller | Large |
| Output DC current | 15ma | 25ma |

Table 4.1 8051 and PIC microcontroller comparison

**PIC16F877A**

**Operating Frequency** : DC 20MHz
**Resets(and delays)** : POR,BOR
**Flash program memory** : 8k
**Data memory** : 368 bytes
**EEPROM data memory**: 256 bytes
**Interrupts**: 15
**I/O ports**: Ports A,B,C,D,E
**Timers**: 3
**Capture/Compare/PWM modules**: 2
**Serial communication**: MSSP ,USART
**ADC**: 10 bit , 8 input channels
**Instruction set**: 35 instructions
**Packages**: 40 pin PDIP
44 pin PLCC
44 pin TQFP

### B. SELECTION OF BUS CONVERTER

With HMS connectivity, we can:

- Connect an industrial device with a proprietary protocol to PROFINET.
- Connect PROFINET to any other industrial network.
- Make your product compatible with PROFINET by embedding a communication module, brick interface or a fully integrated PROFINET chip solution.

4. GLCD display : 3.2"

some advantages of using anybus are :

- available for almost every industrial network
- can be easily connected to any device using RS232 connector.
- handles the complete serial protocol without the need for extensive PLC function blocks.
- consumes very little space.
- No hardware or software changes required for connected automation device.
- Available for all major fieldbus and industrial Ethernet networks
- One communicator can connect upto 31 serial devices .

Other converters like COMX 51 CA-RE , UNIGATE converter etc. are designed for specific applications but Anybus is avaiable for conversion of serial data to many different buses. Thus this bus satisfies all the needs of our system and hence we select Anybus make ProfiNet converter.

### A. SELECTION OF COMMUNICATION STANDARD

**PROFINET** is the standard for industrial networking in automation. It connects devices, systems, and cells, facilitating faster, safer, less costly and higher quality manufacturing. It easily integrates existing systems and equipment while bringing the richness of Ethernet down to the factory floor.

Some advantaged of profinet are :

1. Long distance communication.
2. Single cable connection.
3. High speed
4. Smaller diameter of the cable.
5. Lesser cost.
6. Two way data tranmission
7. Data exchange up to 244 byte inputs & 244 byte outputs.
8. Communication on industrial standard bus & hence better noise immunity.

Profinet as compared to other protocols :

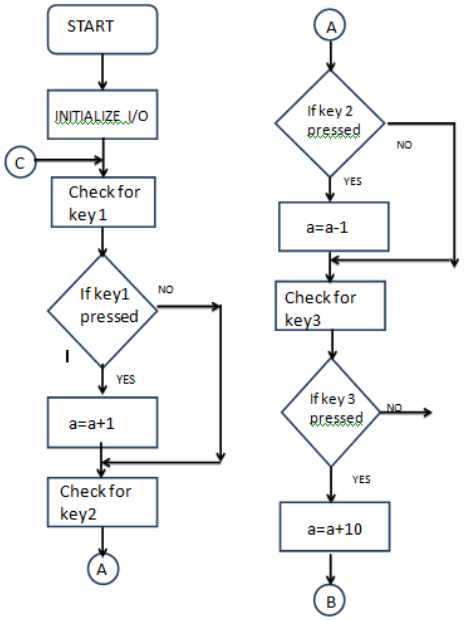
| Properties | ProfiNet | powerlink | Ethernet IP |
|---|---|---|---|
| Organization | PNO | EPSG(ethernet powerlink standardization group) | ODVA |
| EMC suceptibility | High | high | high |
| Topology | Tree , star , ring , chain | Tree , star , ring , chain | Tree , star , ring , chain |
| Hot plugging | Yes | yes | yes |
| Transfer | Synchronized switches | Authorize indivisual node to send data. | Uses CIP synchronizatio n protocol. |
| Purchase cost | Low for ProfiNet IRT, Medium for ProfiNet IR | High | medium |
| Operating cost | Medium | high | medium |
| External devices | Standard switch | Standard hubs or switches | Managed switch with complex functionality |

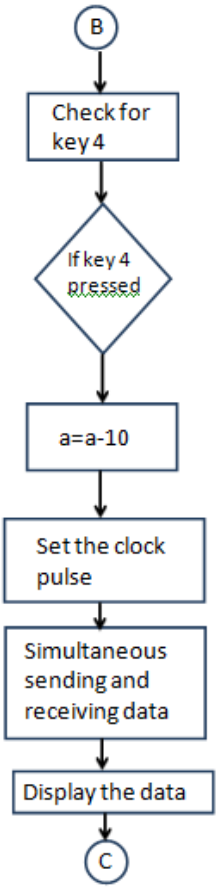
COMPARISON BETWEEN PROFINET AND OTHER PROTOCOLS

## VI. SOFTWARE DESCRIPTION

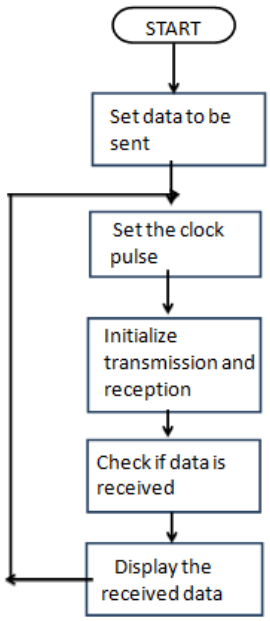
### A. FLOWCHARTS

- **Master**



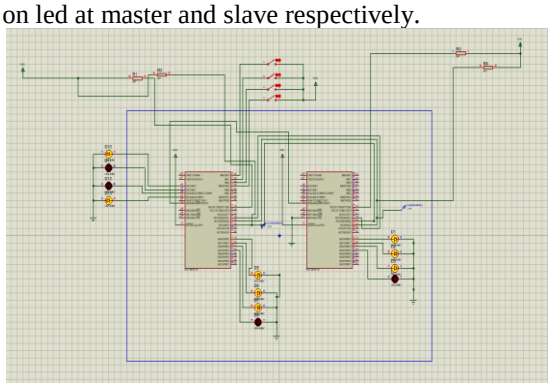

- **Slave**



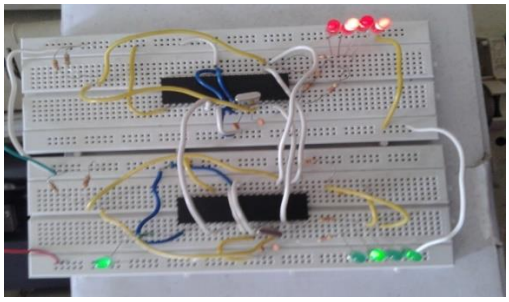

## VII. RESULTS

### A. Simulation results for full duplex SPI communication

Transmitted and received data is displayed on led at master and slave respectively.



### B. Results from hardware testing for full duplex SPI communication



## VIII. CONCLUSION

For easy and efficient handling and control of gantry systems, the mobile pendant is designed which includes a microcontroller to decide what action has to be performed . Data is serially carried through profinet to the PLC for operation to take place with greatest efficiency and speed. After the action is performed, a floating point number is received through profinet to the controller which can give the acknowledgement that the task is completed.

This system is flexible and can be used for other Ethernet standards like powerlink , Ethernet IP etc. by simply converting SPI to that particular standard.

## REFERENCES

**[1]** Harald Kleines, Sebastian Detert, Matthias Drochner, and Frank Suxdor "Performance Aspects of PROFINET IO" IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 55, NO. 1, FEBRUARY 2008

**[2]** "PROFINET System Description – Technology and Application" Publisher PROFIBUS Nutzerorganisation e.V. PNO Version June 2011

[**3**] Profinet in the process industry By ARC advisory group

**[4]** "Digital Data Communication for Measurement and Control—Fieldbus for Use in Industrial Control Systems," Int. Electrotechnical Commission, 2003, IEC 61158.