A Real Time Data Driven Algorithm for Industrial Fault Diagnosis using Ethernet Based Systems

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ABSTRACT: Nowadays fault detection plays an important role in high cost and safety critical processes. Early detection of faults can help to avoid normal event progression. Fault detection can be achieved through various means. Fault diagnosis consists of all actions taken for fault recognizing, fault locating and root cause identification. For networking, Ethernet is suitable to act as the backbone to connect multiple domains and also for interworking within domains. Hence this paper proposes a real time data driven algorithm for industrial fault diagnosis and localization of an Ethernet based systems. This paper presents the development of a new real time diagnosis algorithm that continuously monitors all the electronic equipments and shows the indication accordingly. The proposed algorithm detects the abnormalities and find the root causes. Finally the results obtained by the implementation of proposed algorithm using Ethernet have been presented.

KEYWORDS: Fault diagnosis, Ethernet, Engineering applications in industrial electronic equipments.

I.INTRODUCTION

Nowadays, industrial equipment and systems have become more complex and expensive, with less tolerance for performance degradation, productivity decrease, and safety hazards caused by unexpected faults, which stimulate an increasing demand for real-time fault diagnosis and fault-tolerant control techniques. Real time monitoring and fault diagnosis aim to detect, isolate, and identify any kinds of potential abnormalities and faults, so that necessary actions can be taken to avoid damage of any components, and even disastrous situations. As the scale and the complexity of the industrial system increases, the possibility of system suffering from interference increases. Defective hardware or loose connection of electronic equipments, and the ambient interference can produce intermittent faults in the system.
The intermittent connection fault is a common but hard troubleshooting problem. Fault is usually resulted from cable related problems in harsh working conditions, such as loose connectors or cable fatigue due to vibration or inappropriate maintenance. Thus in order to minimize the adverse effects of faults on the system performance and reliability, it is needed to effectively detect and accurately locate the faults in its early stage. Ethernet is the name of the most commonly used LAN today. Ethernet is a network protocol that controls how data is transmitted over a LAN. It is applicable to multiple domains because of its higher bandwidth. Ethernet networks possess one to one communication and hence it is necessary switched Ethernet networks. The bandwidth can be used efficiently than CAN and FlexRay. The key advantage to connecting over Ethernet lies in the overall savings in software development. There are various techniques by which we can use Ethernet for fault diagnosis system. Online monitoring and diagnostics is useful tool to help operators to manage their assets and make decisions on continuous operation, maintenance or replacement. Early fault detection can increase the safety and reduce manufacturing costs. Number of issues must be considered when choosing particular fault detection method. Due to distributed generation and progression of industrialization, the fault levels are increased. This survey on fault diagnosis techniques provides us a better insight to choose and develop new techniques to obtain optimum accuracy in the diagnosis. Due to multimodalities available in fault diagnosis, obtaining high success rate and high diagnosing accuracy is prime important.

II.PROPOSED METHOD

Methodology as given below is implemented in the proposed work:

Here the PIC controller is used for the interface with ethernet card which converts protocol into TCP LAN. The system is very useful in complex machinery process and control system to diagnose the system for multiple test points using remote real time data monitoring and controlling. All sensing part is monitored by controller and information is send via network interface card using TCP frame using protocols which is displayed on the laptop. The PIC controller is used to monitor the main industrial machine parameters and send accurate information with diagnosis and also locate the faults in real time system using real time clock of PC. Ethernet acts as a backbone of the entire network. In the OSI model, Ethernet technology operates at the physical and data link layers - Layers One and Two respectively. Ethernet supports all popular network and higher-level protocols, principally TCP/IP. Data sent over the Ethernet exists in the forms of frames. An Ethernet frame contains a header, a data section, and a footer having a combined length of no more than 1518 bytes. The Ethernet header contains the addresses of both the intended recipient and the sender. Hence the proposed design for the fault diagnosis system uses Ethernet instead of traditional Controller Area Network (CAN) and it does not need a scan tool for diagnosis. This system will inform the exact place of fault occurrence in the electronic equipments to the user without the need of trouble codes. Hence one can diagnose on his own without the help of technicians and service center.

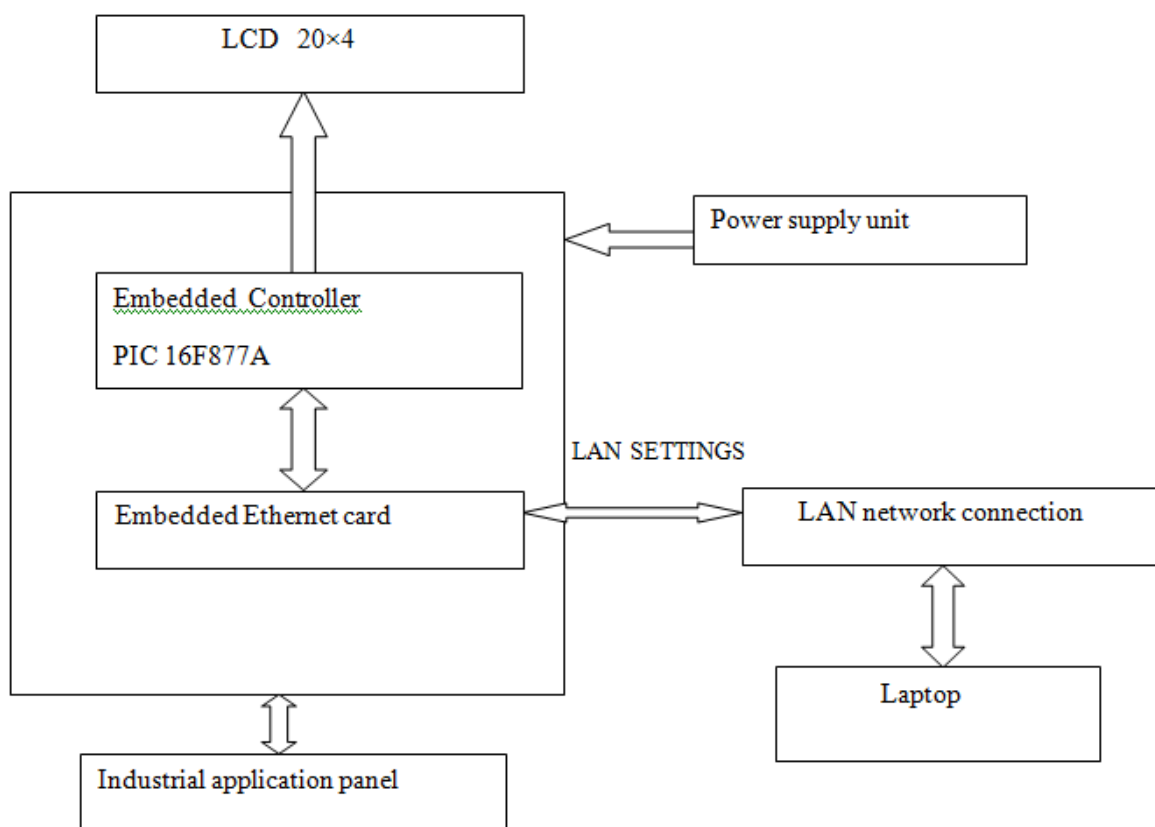The proposed block diagram is mentioned below:

Figure (1): Basic Block Diagram

The entire system has one PIC 16F877A microcontroller, an Ethernet card, laptop, and Ethernet cables. The PIC controller and Ethernet card acts as an embedded integrated server and laptop acts as a client. This follows the server-client architecture, the PIC controller being the server and it has an LCD display associated with it. The serial data from the microcontroller is converted into Ethernet packet data by using the Ethernet card. The Ethernet cable from this interface unit is connected to laptop. The transmission control protocol is used here, as we have an option of acknowledgement in it.

III.SYSTEM IMPLEMENTATION

Design of faults in parameters, notification of sudden changes to the driver and indication regarding the reason for the fault are included in the setup.

In this paper, we are going to diagnose following electronic equipments.

AC FUSE:

Here the fuse is connected to primary mains side applying 230 volt ac signal. The phase is connected in series with the fuse. The output is same which is connected to series resistance of 2 watt which drops mains voltage & current in circuit. The capacitor holds & boost the current compensation which was drop by resistance. The output is connected to bridge rectifier which converts ac to dc voltage with suitable resistance to connect with optocoupler which is nothing but isolate mains voltage to circuit voltage for TTL logic.
The MCT2E isolator has internal led which is on & focused on photo transistor which conducts as light fall on base & thus we get digital o/p in form of 1 & 0 the o/p is connected to 40106 Schmitt trigger with not gate which inverts the state . Also give pulse in sharp rise & fall to recognize the output change.
Assume if mains =1 (230v) then optocoupler led =on, collector of phototransistor = 0v , Schmitt trigger o/p = 1 ,so we get logic 1 to interface for microcontroller.
Assume if mains fail =0, optocoupler led = off, ,collector of phototransistor = 1v , Schmitt trigger o/p = 0 ,so we get logic 0 to interface for microcontroller.
In this way we can detect AC mains failure.

DC FUSE:

 This circuit is used to detect blown DC fuse ,so we can identify the status of fuse. Basically circuit is built using Opto-Coupler as it can be used to isolate I/P & O/P stages .
1. I/P = 1, LED of Optocoupler = On, collector of phototransistor = 0,

Schmitt trigger I/P = 0, Schmitt trigger o/P = 1 this is feed to PIC controller I/P port. (Fuse OK condition)

2. I/P = 0, LED of Optocoupler = Off, collector of phototransistor = 1,
Schmitt trigger I/P = 1, Schmitt trigger o/P = 0 this is feed to PIC controller I/P port. (Fuse Blown condition)

PIC controller reads this signal and acts accordingly.

H BRIDGE INVERTER CARD:

This circuit is designed to control the load. The load may be motor or any other load. The load is turned ON and OFF through relay.

For h bridge we have selected full removal of IC instead of gates due to avoid imbalance in the circuit which can damage certain components which can create major faults while testing. So for safety measures we remove IC and balanced the circuit in order to give readings on GUI.

MINIATURE CIRCUIT BREAKER:
The main function of an MCB is to switch the circuit, i.e., to open the circuit (which has been connected to it) automatically when the current passing through it (MCB) exceeds the value for which it is set. It can be manually switched ON and OFF as similar to normal switch if necessary.
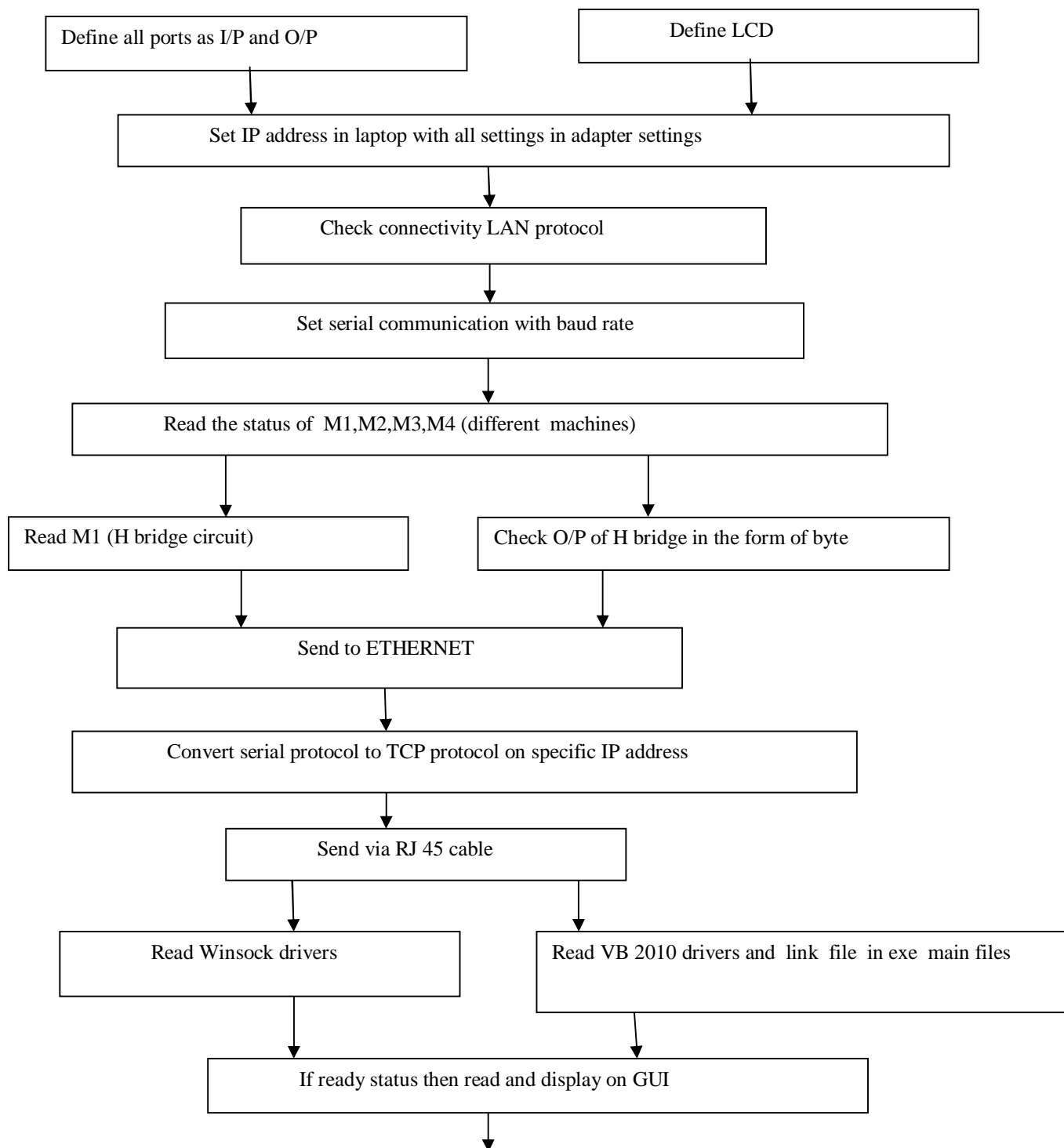
Flowchart of proposed algorithm is as follows:

```
┌─────────────────────────────┐          ┌─────────────────────────────┐
│ Define all ports as I/P and │          │        Define LCD           │
│            O/P              │          │                             │
└──────────────┬──────────────┘          └──────────────┬──────────────┘
               │                                         │
               ▼                                         ▼
        ┌──────────────────────────────────────────────────────┐
        │ Set IP address in laptop with all settings in adapter │
        │                    settings                           │
        └──────────────────────────┬───────────────────────────┘
                                   ▼
              ┌──────────────────────────────────────┐
              │     Check connectivity LAN protocol    │
              └──────────────────┬───────────────────┘
                                 ▼
            ┌──────────────────────────────────────────┐
            │     Set serial communication with baud rate │
            └──────────────────┬───────────────────────┘
                               ▼
   ┌──────────────────────────────────────────────────────────┐
   │  Read the status of  M1,M2,M3,M4 (different  machines)     │
   └──────────┬─────────────────────────────────┬─────────────┘
              ▼                                  ▼
 ┌──────────────────────────┐      ┌────────────────────────────────────┐
 │ Read M1 (H bridge circuit)│      │ Check O/P of H bridge in the form of │
 │                          │      │               byte                  │
 └────────────┬─────────────┘      └─────────────┬──────────────────────┘
              ▼                                   ▼
        ┌──────────────────────────────────────────────┐
        │             Send to ETHERNET                  │
        └──────────────────────┬───────────────────────┘
                               ▼
   ┌──────────────────────────────────────────────────────────┐
   │ Convert serial protocol to TCP protocol on specific IP    │
   │                      address                              │
   └──────────────────────┬───────────────────────────────────┘
                          ▼
              ┌──────────────────────────────┐
              │       Send via RJ 45 cable    │
              └──────────┬─────────────┬─────┘
                         ▼             ▼
 ┌──────────────────────────┐   ┌────────────────────────────────────────┐
 │   Read Winsock drivers    │   │ Read VB 2010 drivers and  link  file  in │
 │                          │   │            exe  main files               │
 └────────────┬─────────────┘   └──────────────────┬─────────────────────┘
              ▼                                     ▼
        ┌──────────────────────────────────────────────┐
        │   If ready status then read and display on GUI │
        └──────────────────────┬───────────────────────┘
                               ▼
```

Display value in the text box with comments

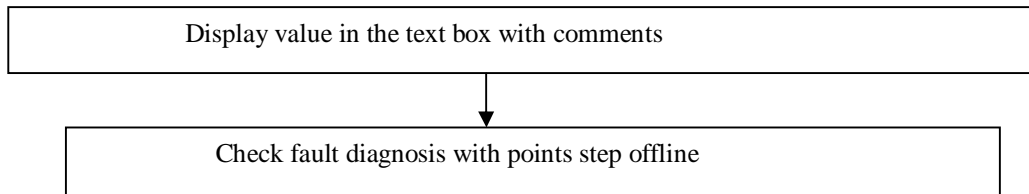| Check fault diagnosis with points step offline |
|---|

Figure (2): Flowchart

Repeat the same procedure for different machines e.g. AC fuse (M2), DC fuse (M3), switch circuit (M4) and MCB for fault diagnosis.

IV. RESULTS

The lab setup for proposed algorithm is as follows:

Figure (3): System Setup

Here the industrial application panel refers to as the several electronic equipments that is AC fuse, DC fuse, H bridge inverter card, MCB etc. Once the equipment is connected to the Ethernet network, it can be monitored and controlled through the PIC controller and displays the results on Laptop.

Figure (4): GUI

This GUI screen indicates that there is some fault in H bridge inverter card, AC fuse and DC fuse and also shows that all switches are off. In this way we can diagnose the faults in the electronic equipments by monitoring the system.

V.CONCLUSION

This paper presents the monitoring of different electronic equipments and the challenges involved in developing such an algorithm. A typical setup for implementing the proposed real time data driven monitoring algorithm has been also discussed. This algorithm is easy and cost effective to implement and it does not need the past performance and health history of different parameters for monitoring.

ACKNOWLEDGEMENT

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