International Journal of Computer Systems (ISSN: 2394-1065), Volume 02– Issue 05, June, 2015
Available at http://www.ijcsonline.com/

Design and Implementation of a Multi-Core Embedded WSN used for Self Diagnostic System

Roshani Ghugare, Vaishali Sahare

Department of Computer Science and Engineering,
G.H. Raisoni Institute of Engineering and Technology for Women,
Nagpur, India

Abstract

Now a days Industries run various heavy duty machines. These machines are very expensive and large scale manufacturing units. These machines work together to produce output. If even 1 machine fails, it can cause huge losses. For that we design a Sensor network based multi-core embedded system to detect faults in industrial machines. So, we implement system which is based on three controllers and used for the critical and non-critical cluster communication. The critical cluster contains the three sensors security, LPG gas and temperature sensor and non-critical contain RPM sensor. These sensors are work independently and successfully implemented. And we present the GUI based monitoring system for the exact fault location. Critical cluster is communicated with server for the location of fault. With this proposed system, we successfully present the work done in the development of the system for fault diagnosis.

Keywords: *Wireless Sensor Network (WSN), Critical Cluster, Non-Critical cluster, GUI monitoring system, Multi-core embedded system.*

I. INTRODUCTION

A wireless sensor network (WSN) of Spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. Wireless sensor networks (WSNs) consist of sensors or sensor nodes which is used to sense the data and these sensor nodes communicate with neighbouring sensor nodes over wireless network. Multi-core embedded wireless sensor network is used to communicate or sense the data through the more than one controller for sending the data parallel. Because the critical parameters cannot detect serially so required parallel system for this purpose multi-core embedded system is required.

Reliable self diagnostic system has always been a very challenging task for the researches. On the other hand, it has always been very difficult to implement due to all different situation that can be found in industries. Due to the difficulty of the diagnostic task, the number of techniques is large and diverse. It is not think that fault tolerance are always found in ideal conditions, it may be running. Such challenges are more prominent in industrial machineries. In last decades there were many method developed to tackle such problem. From the surveys it implies that diagnosis system is the capability of an electronic system to detect and analy ze an error or malfunction. Industrial Devices and machines work in synchronies with each other to create proper output. If any faults that occur in even one of the machines can disturb the entire synchronies machines or devices. This causes improper output and manufacturing and hence causes huge losses. For this we need to develop a single mechanism that can be installed over all the machines, and can check them for faults i.e. build a reliable self diagnostic system. To tackle such problem, a system consisting of a huge sensor network will be created that will monitor the entire industry. So, we are creating reliable self diagnostic system to detect faults in industrial devices with the help of wireless sensor network (WSN).The fig 1.shows the wireless sensor network required to link sensor with the middleware.

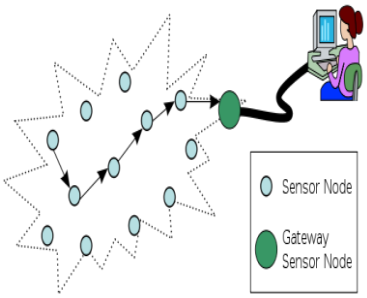


Fig.1. Wireless Sensor Network

The proposed approaches are worked for the different parameters of critical and non critical cluster. These cluster work with the help of wireless sensor network (WSN).

The paper contains the design and implementation of multi-core embedded system with wireless sensor network for the fault location or the monitoring machines and these machines work in a ideal and running condition. And multi core embedded system state that more than one controller is required for the cluster means here require three microcontroller for the critical cluster, non critical cluster and Communicate

with the server. And these controllers work independently as per the requirement.

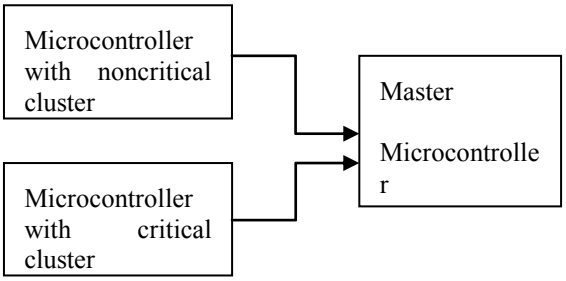


Fig 2. Multi core embedded system

The remaining paper is organized as follows: Section II describes the related work. Section III presents the hardware implementation. Section IV describes the implementation of hardware cluster and formula and calculation. Lastly section VI presents the conclusion.

II. RELATED WORK

Jon Perezet, et. al. [1] describes embedded system architectures for various multiple domains. This embedded system architecture is used for the development of the mixed criticality system. Some of the approach and multiple advantages described or provide is scalability, reliability and cost size weight reduction of the product .We are going to adapt embedded system architecture aspects of this technique .Which will build 2 core architecture with a separate control core, thus essentially creating a 3 core system. Any sensor network can be used this approach which is wired or wireless.

Ruan Delgado Gomes, et. al. [2] describe use of Wireless Sensor Network for motor monitoring system in industrial environment which is presents a theoretical study for verifying the impact of using smart nodes. This technique described, wireless sensor network because this wireless network is much more benefits or advantages as compared to wired network. This paper contains deployment of sensor node for the measurement of critical parameter vibration,

Temperature, pressure, and efficiency, and these measurements are transmitted wirelessly. But this wireless network is unreliable it contain interference of noise and distortion. From this paper we are using the critical parameter foe the fault diagnosis in the industrial machines but the network is wired and that is communicated wirelessly for the fault detection.

Jin jiang, et. al. [3] describes development of fault-tolerant control system, redundancy and safety critical system.

In this technique and the approach is produce to prevent the fault loss and to minimize the potential risks. Because of the development of application system contain high cost it is difficult to fault tolerant. In this paper the sensor nodes are used for the fault tolerant control system.

III. HARDWARE IMPLEMENTATION OF SENSOR CLUSTERS

1. Non critical sensor cluster

The non critical cluster means group of non critical sensor contains non critical parameter like RPM sensor which is use in the wheel rotating machines. I.e. in pumps, rollers, mixers, fan speed measurement, transmission, spindles, gear reducer rpm. The non critical cluster works in a principle of non critical system which is called whose failure will not cause huge loss in the system or the industrial machines.

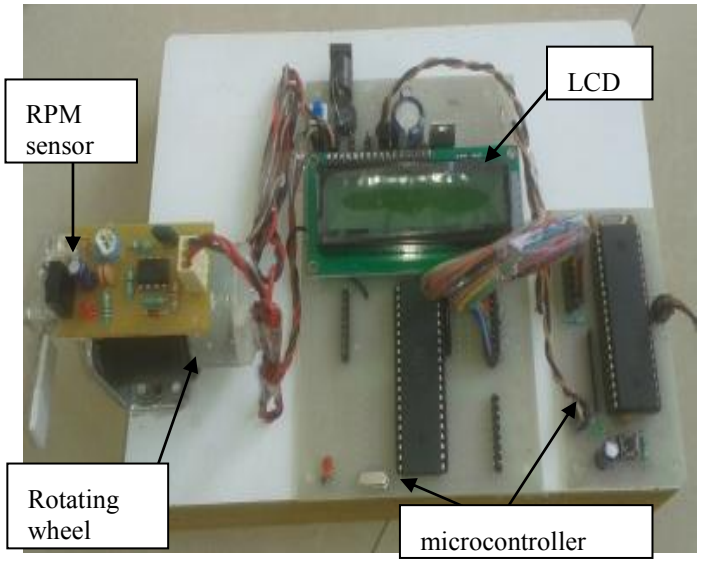


Fig 3. Test bed for creation of non critical sensor network

Fig 3 shows the test bed creation of non-critical sensor cluster with controller, LCD and RPM sensor with rotating wheel. This cluster work independently.

Working :-

It required Circumference of Rotating wheel, Marked Segment Length and the time per rotation. Ratio between marked segment and total length: 1/10. When wheel at continuous rotation first it detect marked segment and start timer after completing rotation it stop timer and note the time of rotation in milliseconds. RPM is the reciprocal of time so; we can calculate rpm with the help of time. It shows the reading in LCD.

2. Critical Sensor Cluster

The critical cluster means group of critical sensor contains critical parameter like temperature, vibration, gas, voltage, and security sensor which is use in the nuclear power plant, chemical plant, wind power plant, aircraft and automobile power plant. The critical cluster works in a principle of critical system which is called whose failure will cause huge loss in the system or the

industrial machines and even making system down. This critical cluster contains the first priority as compare to non critical one. Because if fault occur in the critical cluster it is difficult to solve or it contain heavy loss because of this critical cluster contain high or first priority at the time of fault diagnose.

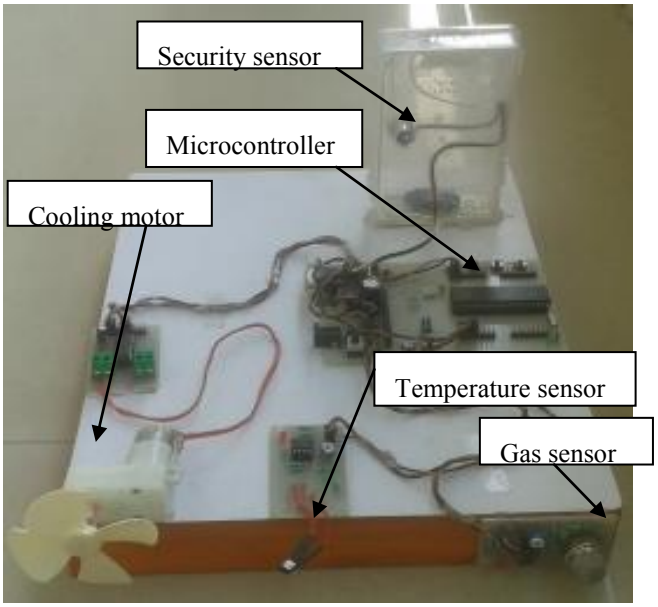


Fig 4. Test bed creation of critical sensor cluster

Fig 4 shows the test bed creation of Critical sensor cluster with microcontroller Cooling motor, Security sensor Controller, Gas sensor and Temperature sensor. In this critical cluster we are using three sensor for the fault diagnose which is temperature, LPG gas and security sensor.

Working :-

If we want to check the temperature or the fault in the temperature sensor if temperature goes to the above normal the it shows the fault. In the security sensor door is lock by key if any one try to open without key then the security sensor shows the fault and in case of gas there is leakage in the gas then it shows the fault.

IV. SOFTWARE DEVELOPMENT

The software is developed for the fault location or detection which is called GUI based monitoring system. It uses serial communication to communicate with controller. Fig 5 shows the disply map of monitoring machines/factory. Currently 3 sensors are use Temperature, LPG, Security breach. It is expandable i.e. more sensors can be added. Auto interrupt for critical faults. The visual basic simulator 6.0 is used for the software development.

Fig 5. Display map of monitoring software machine/factory

V. PERFORMANCE ANALYSIS

The system gives the performance analysis for the various sensor here we used three sensors temperature sensor, gas sensor and security sensors.

1. Temperature sensor

Fig6. Shows the temperature sensor. From the table 1 we can see the different values for the analyzing the performance of temperature sensor. Values are calculated for the normal temperature in degree Celsius, pot output in mv and threshold or throughput in degree. If normal temperature goes to above throughput then the fault is occur which is in digital output 1. And if normal temperature is below threshold then the system is OK which is in digital output 1. Graph 1 shows as pet the values of temperature sensor.

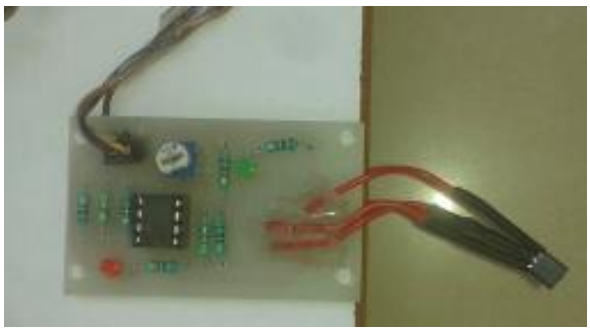


Fig 6. Temperature sensor

TABLE 1. TEMPERATURE SENSOR

Normal temperature	Pot output mv	T th 0c	Fault state	Digital output
38	350	35	F	1
38	540	54	Ok	0
65	350	35	F	1
65	540	54	F	1

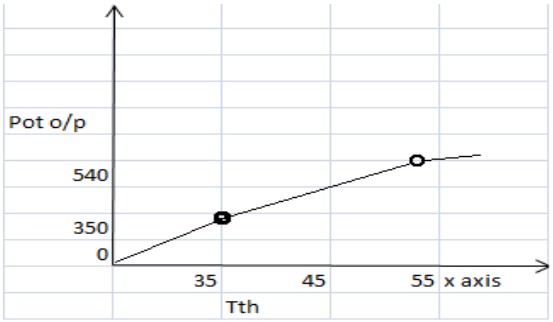


Fig : Graph for temperature sensor

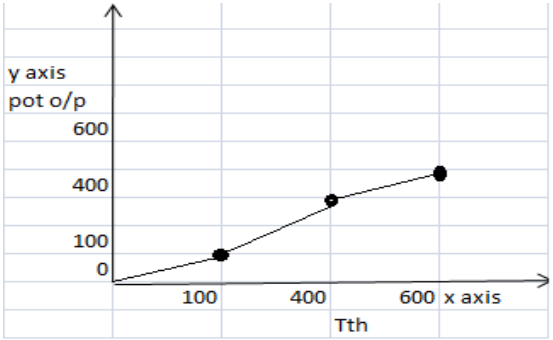
2. Gas sensor

Fig7. Shows the gas i.e. LPG sensor. From the table 2 we can see the different values for the analyzing the performance of gas sensor. Values are calculated for the current LPG level in ppm, pot output in mv and threshold or throughput in ppm. If current gas level goes to above throughput then the fault is occur which is in digital output 1. And if current LPG level is below threshold then the system is OK which is in digital output 1. Graph 2 shows as pet the values of temperature sensor.

Fig 7. Gas sensor

Table 2 GAS SENSOR

Current LPG level ppm	Pot output mv	Tth	Fault state	Digital output
110	100	100	F	1
110	400	400	Ok	0
560	100	100	F	1
560	400	400	F	1
560	600	600	Ok	0



Graph 2 for Gas sensor

3. Security Sensor

Fig8. Shows the security sensor. From the table 3 we can see the different values for the analyzing the performance of security sensor. The security fault calculated on the basis of magnetic sensor and key switch. When magnetic sensor is 0 and key switch is 0 fault is not occurring system is OK. But in other case fault is occur or diagnosis.

TABLE 3 SECURITY SENSOR

Magnetic sensor	Key switch	output
0	0	Ok
0	1	Ok
1	0	Ok
1	1	Fault

Fig 8. Security sensor

VI. EXPERIMENTAL RESULTS

These are the experimental result of monitoring machines on the basis of three critical cluster i.e. Gas sensor, temperature sensor and security sensors.

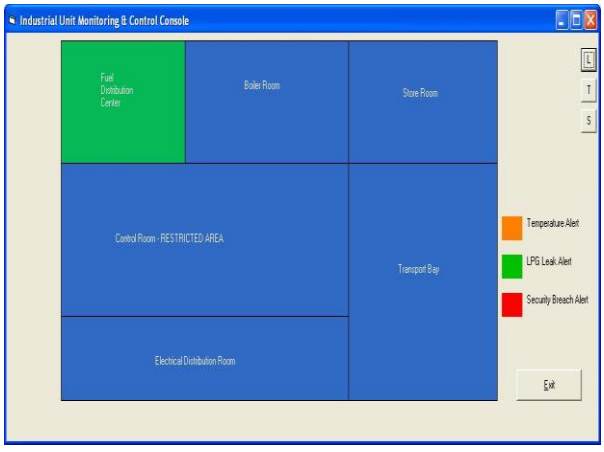


Fig 9. Experimental results of monitoring system

VII. CONCLUSION

We have been successfully design a 2 core system which contains critical cluster node and non critical cluster node to demonstrate multi-core approach. And these two cores critical and non-critical contain high and low priority system. These are the part of a huge fault diagnostic system. They have independent and are partially autonomous. We have developed GUI software in visual basic to control and monitor the industries. The system is working successfully and detecting faults in time. In future the System is expandable and scalable i.e. More sensors can be added to each cluster. Also no of cluster can also be expandable. System can be made more generic to be able to use with any industries. Use of advanced algorithm can be implemented like fuzzy logic, for auto detection and correction of parameter.

REFERENCES

[1] Jan Neuzil, Ondrej Kreibich and Radislav Smid"A Distributed Fault Detection System Based on IWSN for Machine Condition Monitoring," IEEE Trans. on industrial informatics, vol. 10, no.2, pp1118-1123, May 2014.

[2] A. Rowe, M. Berges, G. Bhatia, E. Goldman, R. Rajkumar, L. Soibelman, J. Garrett, and J. Moura, "Sensor Andrew: Large-scale campus-wide sensing and actuation," IBM J. Res. Develop., vol. 1, pp. 1–6, 2010.

[3] Rossi, G. Zanca, L. Stabellini, R. Crepaldi, A. F. Harris, and M. Zorzi, "Synapse: A network reprogramming protocol for wireless sensor networks using fountain codes," in Proc. 5th Annu. IEEE Commun. Soc. Conf., pp. 188–196, 2008.

[4] Roshani Ghugare and Vaishali sahare "Implementation of wireless sensor network based multi-core embedded system" 5th international conference on communication system and network technology 2015 IEEE, pp 865-868.

[5] Arslan Munir, Ann Gordon-Ross and Sanjay Ranka "Multi-Core Embedded Wireless Sensor Networks: Architecture and Applications," IEEE Trans. on parallel and distributed system, vol. 25, no.6, pp1553-1562, June 2014..

[6] Jon Perez, David Gonzalez, Salvador Trujillo "A safety concept for a wind power mixed-criticality embedded system based on multi-core partitioning" 11th International TÜV Rheinland Symposium May 13 – 14, 2014, Cologne, Germany

[7] Ruan Delgado Gomes, Marcéu Oliveira Adissi,Abel Cavalcante Lima-Filho, Marco Aurélio Spohn, and Francisco Antônio Belo "On the Impact of Local Processing for Motor Monitoring Systems in Industrial Environments Using Wireless Sensor Networks" International Journal of Distributed Sensor Networks Volume 2013, Article ID 471917, 14 pages.

[8] K. Tan, S. Huang, Y. Zhang, and T. Lee, "Distributed fault detection in industrial system based on sensor wireless network," Comput. Standards& Interfaces, vol. 31, no. 3, pp. 573–578, Mar. 2009.

[9] C.-L. Fok, G.-C. Roman, and C. Lu, "Agilla: A mobile agent middleware for self-adaptive wireless sensor networks," ACM Trans. Auton. Adaptive Syst., vol. 4, no. 3, pp. 1–26, 2009, Art.16.

[10] Jin jiang "Fault tolerant control system-introductory overview" ACTA automatic sinica vol.31.no.1, January 2005.

[11] B. Krishnamachari and J. Heidemann, "Application Specific Modeling of Information Routing in Wireless Sensor Networks," Proc. IEEE Int'l. Performance, Computing and Commun. Conf., vol. 23, 2004, pp. 717–22.

[12] O. Younis and S. Fahmy, "HEED: a Hybrid, Energy-Efficient, Distributed Clustering Approach for Ad Hoc Sensor networks," IEEE Trans. Mobile Computing, vol. 3, no. 4, Dec. 2004, pp. 366–79.

[13] W. R. Heinzelman, A. P. Chandrakasan, and H. Balakrishnan, "An Application-Specific Protocol Architecture for Wireless Microsensor Networks," IEEE Trans Wireless Commun, Oct. 2002, pp. 660–70.

[14] W. R. Heinzelman, "Application-Specific Protocol Architectures for Wireless Networks," Ph.D.thesis, Massachusetts Institute of Technology, June 2000.

[15] Src (for figure 1) : Duel core processor : http://en.wikipedia.org/wiki/Multi-core_processor