



# Mechanical Wear out Parts Monitoring by Using Wireless Sensor System

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**Abstract**— A mechanical machine parts are experience wear out and it's widely used in motor machine tools to control the movement of processing target and spindles. Motor rotation of stator and rotor are frequently checked so that they are replacing before excessive wear occurs. Until now, there was no simple way to measure directly that state of wear quantitatively. During the operation of motor to measuring the signals of vibration, temperature and load change. This logged signal can be used to construct the wear model for estimating the remaining life time of the motor. For embedded wireless sensor used in this motor machine parts. Wireless sensor having advantages it installed freely without constraints from data or power cables. This wireless sensor has been used practically within the industrial environment. In this proposed system used for 1) Low power and Low cost in hardware design. 2) Logs the signal during the operation of the motor machine part that could experience wear. 3) It provides Guarantee that all the logged data can be wirelessly delivered to the data server. This is the first wireless sensor system for measuring the stator rotor operation signals that guarantees to complete data delivery and correctness. This can be designed implemented and evaluated system used in real industrial environments.

**Keywords:** stator and rotor, communication, mechanical wear, wireless sensor, spindles, low power

## I. INTRODUCTION

The mechanical device combined with steel balls, a shaft, and nut body. The rotary motion of operating parts of mechanical tool converted into linear motion. The motor rotation of a stator and rotor cause small friction. The friction of the balls due to improper installation may occur wear out. The wear being invisible to the eye, we take the judgments of experienced engineers who detects the unwanted sounds or vibrations that are created during the movement of machine.

To estimate the wear condition of the mechanical parts several sensor system were proposed [1][10]. It's focused on: 1) designing sensor to measure the signals of vibration, temperature and load change, speed of the motor using wireless sensor system. 2) The measured data to estimate the wear condition of machine tool.

In [1], the proposed system to measuring the signal of operating machinery to estimate the state of wear. The sensing components are attached on the surface of motor. The measuring signals are wirelessly delivered data to the data server for the future analysis. This wireless

communication provide freely installed and sensing locations. The previous studies [2] have not discussed with the data lost during wireless transmission or how to deal with data are corrected and complete. If this method to fail, some data may be discarded and then data are corrected and complete. Thus, the wireless data transmission without data correction mechanism is not possible.

The wireless sensor system useful in industrial environments. We proposed autonomous network sensing system for logging the operating signal of mechanical part that experienced wear. The goal of the ANSS used wireless sensor system for embedded within the mechanical parts that could experience wear the operating signal to collect and transmitting the signal. It considered low cost hardware and low- power consumption and small size. The ANSS used wireless sensor integrates the secondary storage to store the data then this data are delivered to the data server continuously. In summary, the contribution of these papers is as follows.

- 1) To our knowledge, no previous studies have discussed wireless interference during data transmission in the processing. It's the first wireless



sensor used to measure the mechanical signal to experienced data delivery and correctness.

- 2) The ANSS used wireless sensor stores all the logged data in the FAT (file allocation table) format in the secondary storage.
- 3) If the ANSS node malfunctions the data recovery is possible through removing the SD-card and receiving the data with a PC card reader.

## II. DESIGN GOAL

In this section, we discuss the sensor system used to monitoring the mechanical parts. Sensor system used to stored the performance of the mechanical parts are wired or wireless. Several advantages are using the wired sensor systems [1]. Transmitting data with very high bandwidth and high sampling rate also possible. It is impossible to measure movable rotating parts.

Wireless sensors having lot of benefit in the location of sensing and installation is unrestricted. So we focused on using wireless sensor system used to monitoring mechanical wear out parts. Hou and Bergmann [2] designed a wireless sensor system to log the operating signals of vibration, temperature, load and speed of the induction motor. In this paper mainly focused on neural networks to perform on sensor feature extraction and fault diagnosis. This approach used to reduce the amount of data transmitted over the wireless network it's compared with transmitting raw data signals of motor machinery. Another approach [3] installed Zigbee wireless module and sensing component of machinery parts. Another study discussed [4] wireless sensor system based industrial environment and using dynamic power management technique to identify the remaining life time of the systems. Another approach [5] focused on radio frequency Identification (RFID) based technology to transmit data with a low sample rate. Final method [6] using frequency hopping spread spectrum with Bluetooth to avoid wireless interference. The data are transmitted to audio signal (i.e Bluetooth earphone) using best effort approach but does not provide guarantee to data integrity and receiver side correctness.

Recently proposed many wireless sensor system designs does not discussed about the wireless communication quality. For that reason, all suffer from wireless interference and data loss is possible for existing system design. In building simultaneous multiple wireless sensor communication could be worsened.

When the data cannot be reliably transmitted to the data server over a wireless network the solution is buffer to unsend data to the temporary local storage and it retransmit data to the wireless channel is available. However the microcontroller used in this type of applications due to low hardware cost and in build memory element, low-power constraints.

To provide guarantee of all the measured data can be transferred from the wireless sensor to the data server. The data transmission purpose the integrate reliable communication protocol then it store all the transmitted data in the permanent storage if it lost means again it retransmitted the data.

The design goals of the proposed system are follows:

- 1) The measured data of wireless sensor must able to transmitted data to the data server is 100% accurate.
- 2) Data transmission interference is avoided for wireless sensor systems
- 3) It provides better communication performances.
- 4) No data loss or distortions is tolerable.
- 5) It's low cost hardware design, to increase the performance of manufactures of mechanical parts that integrate this system in this future.

## III. SYSTEM DESIGN AND ARCHITECTURE

By the response of previous issues the ANSS was proposed and implemented in this paper. As shown in fig.1 the ANSS node and ANSS server has two type of ANSS device. The machine tool have several ANSS node and ANSS data server is used to control and monitor the data from many ANSS nodes in several machine tool.

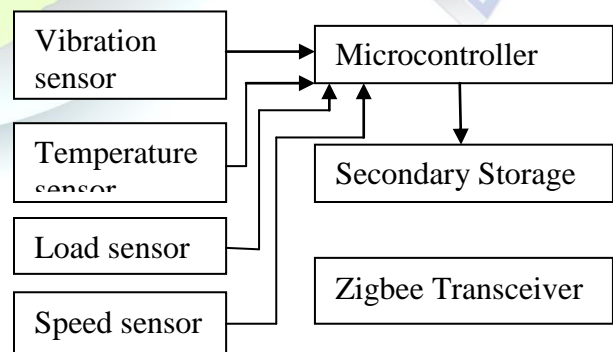


Fig 1: ANSS NODE



TABLE 1  
 ANSS NODE DETAILS

ANSS NODE PROTOTYPE
1) PIC MICRO CONTROLLER
2) RF TRANSCEIVER: ZIGBEE
3) SECONDARY STORAGE: SD CARDS
4) BATTERY
5) VIBRATION SENSOR
6) LOAD SENSOR
7) TEMPERATURE SENSOR
8) SPEED SENSOR

**A) ANSS NODE**

Referring to Fig 1, the ANSS node is an embedded system is used to measured signals of mechanical parts during operation, it is cleared that should be integrated into mechanical part manufactures. The ANSS node consists of PIC micro controller and several sensing component to measures vibration, load, temperature, speed of the mechanical part. All the measured data transmitted wirelessly to the ANSS server by using Zigbee.

The ANSS node is provide guarantee to all logged data are transmitted simultaneously to the ANSS data server without data loss and distortion. The ANSS node also saves all the logged data to the secondary storage of the SD cards and sends out the buffered data in the response of ANSS server requests. In addition the network protocol of the ANSS node and ANSS server provide integrity of the data by adapting the transmission acknowledgement and checksum techniques. All the logged data in the ANSS node can reliably transfer to the ANSS server through wirelessly.

The ANSS node hardware is based on low cost design, low power consumption in micro controller and the performance is also limited. The designing of ANSS node is simple and possible. The performances of ANSS node are 1) logging the sensed data at a defined sampled rate and 2) Receiving command to the ANSS server.

TABLE 2  
 ANSS SERVER DETAILS

<b>ANSS SERVER PROTOTYPE:</b>
INTERNAL STORAGE: RAM
RF TRANSCEIVER: ZIGBEE
SECONDARY STORAGE: SD CARDS

**ANSS SERVER**

The ANSS server consists of Ram plate form with the radio interference zigbee . This designed used for interfacing and controlling data from the ANSS node. It implemented two types of command that is control command and download command.

- 1) **CONTROL COMMANDS:** The user select the ANSS node target to send the control command CMD STATUS means its in operating state of nodes. CMD-DATANUM number of data in the secondary storage. CMD-ERASE means delete all the data in the secondary storage.
- 2) **DOWNLOAD COMMAND:** The ANSS server can send command CMD-DL to the ANSS node to download the data item in secondary storage.The download procedure is repeated until the data item is downloaded.

As we implement in 1) secondary storage, 2) CRC verification and 3) data retransmission in ANSS simultaneously the copies of the data item on the server will match those ANSS node the multiple downloads. It provides data integrity and completeness.

**IV. PERFORMANCE IN FIELDS**

Implemented design in ANSS node shown in fig 1. The Proposed ANSS is need to provide correctness of data transmission. It checks the communication performance with in different environments. The ANSS node simply read the data from the sensors of temperature, load, vibration and speed that are transfer to the data server. This transmitted information to estimate the wear. The data delivery rate is 100% accuracy in wireless transmission performance.

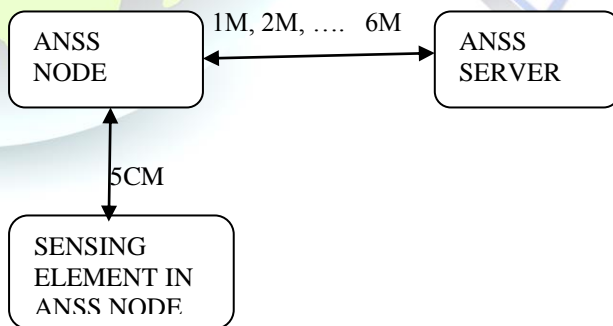


FIG 2: Experiment Test

**V. EXPERIMENTS IN INDUCTION MOTOR TOOL**

In the following, we verify the communication performance of ANSS in the mechanical parts. The ANSS



node is fixed on induction motor. It is used to carry the processing element and its linearly moved the induction motor is turned on. Then we discuss the communication performance in different distance in state of the induction motor on/off condition.

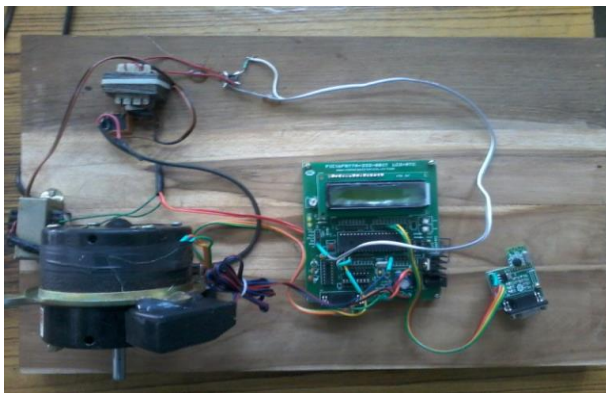


Fig. 3 Overview Of Hardware



Fig.5 Anss Server Side Monitoring In 5s Variations

## VI. CONCLUSION

We implemented in ANSS prototype and executed a Series of tests to evaluate the communication Performances. This paper focused on design of wireless data transfer for monitoring mechanical wear out parts. Some approaches ignore the possibility of losing data to the wireless communication. We purpose to use the secondary storage as a buffer and data retransmission is provide guarantee the data can transmit to the server reliably.

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## Motor Wear and Tear Monitoring

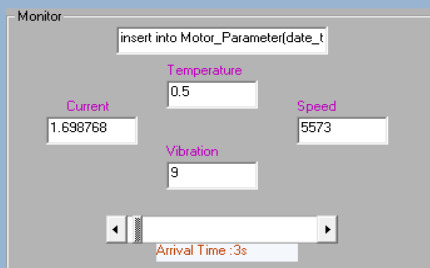


Fig. 4 Anss Server Side Monitoring In 3s Variation

The data delivery rate in ANSS node to ANSS server provides better communication performance using zigbee. The data delivery rate decrease means the distance of server is increase. We tested data delivery rate in various location. The 3m distance it's provide 100% accuracy in data delivery rate. When induction motor is on condition, the data delivery rate drops, and DDR various increase simultaneously if the distance is larger than the 1m. It indicates the location of the ANSS node can affect the data delivery rate greatly and data delivery rate is possible in same applications.