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SMART SENSOR DATA ACQUISITION FOR INDUSTRIAL WSN's IN IOT ENVIRONMENT

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***Abstract*— Now a day's internet is like a life breath to everyone. People uses this amazing resource for various purpose right from simple to the maximum applications. It is very important to make smart industries and cities to cope up the speed of the internet. The IOT is such an idea to connect various needful things to the internet .In this paper we proposed a design for reconfigurable smart sensor interface for industry in which ARM is adopted as the core controller. The standard of IEEE1451.2 intelligent sensor interface specification is adopted for this design. The data will be sensed with different sensors and transferred over network via serial port communication or via Zigbee wireless module. The acquired data can be monitored via web page from anyplace in the world.**

***Index terms*—Internet of things (IOT),IEEE 1451.2 protocol, ARM, sensors.**

I. INTRODUCTION

In the future, Internet of things plays a major role in everyone's life which includes existing and evolving internet with network developments. It could be conceptually defined as a self-motivated global network infrastructure with self-configuring capacity based on standard and interoperable communication protocols where physical and practical "things" have identities, virtual personalities and physical attributes, use intelligent interfaces, and are flawlessly integrated into the information network.

In the IoT environment, things are known as smart things because they are expected to interact with other things and with the environment. They exchange information about the sensed data with the environment so that they behave independently to the real/physical world events by triggering signals or actions with or without the direct human intervention. Services will be performed using standard interfaces that will provide the necessary link via the Internet.

The Internet of Things could allow people and things to be connected Anytime, Anyplace, with anything and anyone, ideally using any path/network and any service.

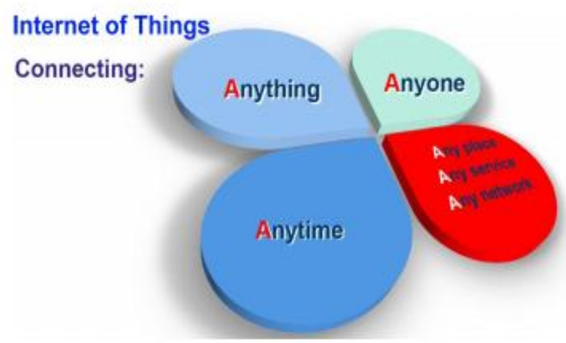

Fig 1. Internet of Things:6A connectivity

There are a lot of data acquisition several interface equipments with reputable technologies on the market with rapid development of IoT. But these data acquisition interface has some limitations such as sampling rate, signal types. Now, micro control unit (MCU) is used as the core controller for data acquisition .Micro controller unit plays a vital role for its low power consumption, less price which makes micro controller relatively easy to implement.

For manufacturing and other industrial operations, equipment are challenged to perform operations at a quicker rate ,low expenses, and with most excellent quality .As embedded electronics is growing at a faster rate, Automation engineers find new opportunities to monitor and control their processes .Equipment embedding with sensors can provide monitoring capabilities to satisfy the needs. The IEEE has developed some standards for intelligent transducers, including smart sensors and smart actuators. The IEEE 1451.2 is adopted in new type of network-enabled equipment for monitoring purposes. This standard provides sensor to network interface which transforms conventional, standalone manufacturing equipment into continuously monitored online resources.

II. STIM

The IEEE 1451.2 standard defines the TEDS, and a Transducer Independent Interface (TII) to a Network Capable Applications Processor. The TEDS description ranging in size from 256 bytes which fully describes the type, operational characteristics, and calibration, attributes, and data format aspects of transducers. The TEDS is proposed to be stored in electrically erasable programmable read-only memory (EEPROM) so as to be field updated when transducer sensitivity or any other characteristic of the physical measurement and control changes . The 1451.2 standard also requires that the TEDS shall be physically inseparable from the transducer. This reveals the fact that TEDS are readable by upper levels of the standard ensuring the critical transducer information such as calibration constants are maintained with the transducer.

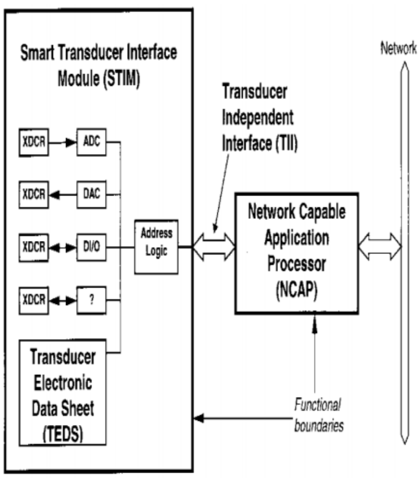

Fig 2: STIM block diagram

The Transducer independent interface specified in IEEE 1451.2 standard consists of a set of 10 signal wires which are liable for interfacing Smart Transducer Interface Module (STIM) with the Network capable application processor (NCAP).It behaves as a point to point communication. The sensor or actuator performs in various operational modes which forwards the TEDS information as bi-directional communication. The maximum communication speed between NCAP and STIM are also determined by the TEDS and the NCAP capabilities. It also supports features such as hot swap, and power -down, thus permissively components of upper level to detect transducer or STIM swaps, as well as power saving operations.

III. IEEE 1451.2 STANDARD

The IEEE 1451.2 defines a set of protocols for wired and wireless distributed measurement, controls applications and performs plug-and-play operation through the TEDS (Transducer Electronic Data Sheet).The standard is divided into two modules as NCAP and TIM. The NCAP is a network node composed of hardware and software that provides the gateway functions between the user network and TIM. The TIM is a module that contains signal conditioning circuit, analog-to-digital converter or digital to analog converter circuit and an interface to communicate with NCAP.

The most widely used technique to achieve plug-and-play function was the definition of a minimum set of transducers and for more advanced functions, it provides some optional features. When TIM is connected with NCAP, it transfers TEDS information to protocol manager .It also sends the acknowledgment of transducers in the network automatically. Each table in TEDS there is a standardized format based on IEEE 1451 standard being: Length, Data Block and Check sum, where, each line is denominated of TLV (Type/Length/Value).

A. TEDS Format

The TEDS contains the common TEDS format in which the first field is the length and it is represented by 4 octet's unsigned integer. The next block of TEDS represents the TEDS's content and it is represented by data binary or based on text. The checksum is the last field in any TEDS. The checksum is also used to check the integrity of TEDS's data. The TEDS fields are described like:

Table 1: Format generic to TEDS.

Field	Description	Type	Octet
--	TEDS length	UInt	4
1 to N	Data block	Variable	Variable
--	Checksum	UInt16	2

• TEDS length - it is the number of octets in the data block containing more two octets in the checksum;

• Data block-it is the field that contains specific information according to TEDS. For each type of TEDS, the data block structure is different and the structure is based on TLV. Within the table structure,each row was constructed using TLV for TEDS. The TLV is defined as:

– Type- this field was defined by 1 octet and it represents the identification of TLV line;

– Length- this specifies the number of octets in the field Value;

– Value-it contains the information about the TEDS field;

• Checksum - it is the complement of the sum of all octets in the preceded field including the initial size of the TEDS.

B. Transducer Interface Module(TIM)

The TIM was developed using the micro controller, wired or a wireless module for interface between NCAP and TIM. When the user connects the NCAP with the TIM,the TEDS information are transferred to NCAP and made the recognition of the transducers connected to the TIM. Another way to ensure whether the TIM is connected to the NCAP is when the

TIM receives a command request, it process the command and sends the reply message or acknowledgement to the NCAP based on IEEE 1451.0 standard. The command can be a data request from the sensor or actuator or any kind of TEDS.

In Figure 3 shows an example of reading the TEDS stored on file in NCAP.

In Figure 4presents an example of features relating to theSTIM1-RS232 module.

In Figure5presents the description TEDS for sensor.

In Figure 6presents the description TEDS for Actuator.

Meta TEDS

Field Type	Field Name	Description	Data Type	Length	Value
--	Length	Octet Numbers	UInt32	4	00025
3	TEDSID	Identification TEDS	UInt32	4	0111
4	UUID	Universal Unique Identification	UUID	10	8FB61B4808 F6 43 A1 B1
A	OHold Off	Time limit to response	Float32	4	40A000
C	Test Time	Time to self-test	Float32	4	40000
D	Max Chan	Transducer channel number	UInt16	2	03
--	Checksum	--	UInt16	2	62F

Fig 3:Example of reading the TEDS stored on file in NCAP.

Phy TEDS

Field Type	Field Name	Description	Data Type	Length	Value
--	Length	N octet META TEDS	UInt32	4	0 0 0 1 9
3	TEDSID	TEDS Identification Header	UInt32	4	0 C 1 1
10	RS232	IEEE 1451.2-RS232 Physical type	UInt8	1	1
12	MaxBPS	Max data throughput	UInt32	4	0 0 4 B0
13	MaxCDev	Max Connected devices	UInt16	2	0 1
14	Encrypt	Encryption	UInt16	2	0 0
15	Authent	Authentication	Boolean	1	0
16	MinKeyL	Min Key Length	UInt16	2	0 0
17	MaxKeyL	Max Key Length	UInt16	2	0 0
18	MaxSDU	Max SDU size	UInt16	2	0 1
19	MinXLat	Min Access latence	UInt32	4	0 0 0 5
20	MinTLat	Min Transmit latency	UInt32	4	0 0 0 5
21	MinXact	Min simultaneous Transaction	UInt8	1	1
22	Battery	Device is battery powered	UInt8	1	1

Fig 4: Description of TEDS for the STIM1_RS232 module.

Transducer Module

Module Identification:	8 FB 61 B4 80 81 F6 43 A1 B1
Time Limit to response	5.0000
Time to self test	2.0000
Transducer channel number	3

Transducer - Channel 1

Calibration Key	0
Channel Type	Sensor
Physical Units	32 1 0 39 1 82
Low Limit	0.0000
High Limit	55.0000
Operational Error	0.5000
Self Test	1
Sample	28 1 0 29 1 1 30 1 8
TransducerChannel update time	0.1000
TranducerChannel read setup time	0.0000

Fig 5: Description of TEDS for Sensor

Transducer - Channel 2

Calibration Key	0
Channel Type	Actuator
Physical Units	32 1 0 33 1 82
Low Limit	0.0000
High Limit	360.0000
Operational Error	1.8000
Self Test	0
Sample	28 1 0 29 1 1 30 1 8
TransducerChannel update time	0.1000
TranducerChannel read setup time	0.0000
TransducerChannel sampling period	0.1000
TransducerChannel warm-up time	41 F0 0 0
TransducerChannel self-test time requirement	30.0000
Sampling	31 1 0
End-of-data-set operation attribute	1
Data Transmission Attribute	1
Actuator-halt attribute	1

Fig 6: Description of TEDS for Actuator

IV. ARCHITECTURE

We design a reconfigurable smart sensor interface device that integrates data collection, data processing, and together with wired or wireless transmission .The device can be widely used in many application areas of the IoT and WSN to collect various kinds of sensor data in real time. We program the ARM core module based on the IEEE 1451.2 which automatically discovers the connected sensors.

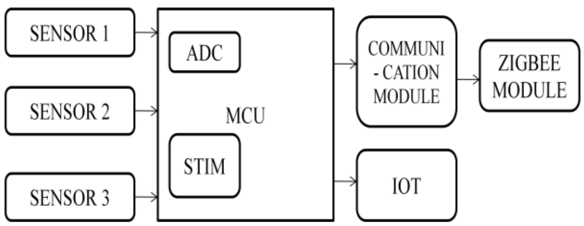

Fig 7: Block diagram of the proposed system

The sensed data from different sensors were transferred to the ARM micro controller which was programmed with IEEE 1451.2 protocol. The acquired data can be transferred to the internet via serial communication or either by means of wireless communication. Then the data can be continuously monitored from anyplace in the world by means of internet which eliminates the need of person monitoring the situation of industry by sitting and monitoring the data inside the monitoring room.

V. HARDWAREIMPLEMENTATION

A sensor is a device used for detecting the changes in quantities and it provides a corresponding output, generally as an electrical or optical signal. A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. The resolution of a sensor is the smallest change in the quantity that is measured.Various sensors are used for measuring temperature, humidity, pressure etc.

The core controller of the interface device is the ARM controller. It is used for data acquisition, processing and for transmission. Some preprocessed work must be done for the collected data from the sensors with the ARM controller .The interface device containing driver of chips is programmed inside the ARM. The equipment contains multiple scalable interfaces which are extended to analog signal interface (8-channel) and digital signal interface (24-channel). This ensures the number of sensors can be connected with our interface device which is used among the application of industrial IoT. The data transmission can achieve through Universal Serial Bus interface.

The ARM controls the ADC module and signal interface on the interface device. It collects analog signals (8-channel) and digital signals (24-channel) and stores the data collectively in the Static Random Access Memory on the interface device. By means of USB serial communication, the collected data can be transmitted to the host computer so that the user can monitor the data continuously on the web page. The snapshot of the hardware kit is shown in the fig 8

The webpage as shown in the fig 9 which is used to monitor the sensor data.

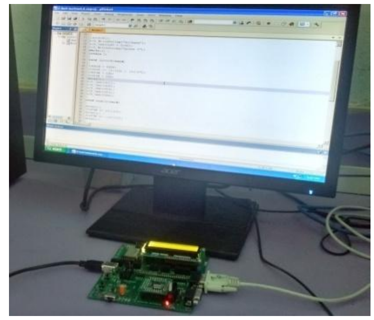

Fig 8:Snapshot of kit

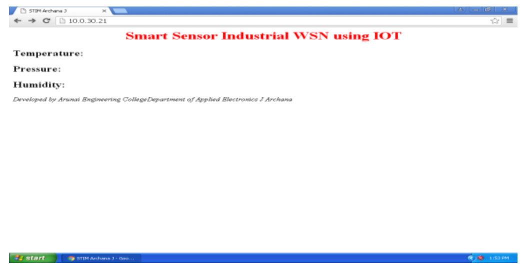

Fig 9: Monitoring of sensor data in web page

VI. CONCLUSION

This paper describes a smart sensor interface for industrial WSN in IoT environment. The proposed system can wisely collect sensor data. It was intended based on IEEE1451 protocol by combining with ARM and the application of wireless communication. The acquired data can be transferred over the network via serial communication. It becomes as a continuously monitoring online resource so that the operator can monitor the data from anyplace in the world.

In the future, the function of spreadsheet should be expanded and can be perfected in IEEE 1451. It will have a broad space for development in the area of WSN in IoT environment.

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