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IMPLEMENTING IEEE 1451-BASED SENSOR FOR NATURAL DISASTER MONITORING

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Abstract: *The paper is focused on developing smart sensor with plug&play facilities. For this purpose we are using IEEE 1451 standard in order to design TEDs. TEDs are developed as dat file that are used as workspace for the softare. We are figuring a sofware/hardware setup for analyzing the behavoir of a simulated sensor in shifting process in between two or more situations, like calibration process.*

Key words: *smart sensors, IEEE 1451, TEDs, time delay, calibration*

1. INTRODUCTION

IEEE 1451.4 is a determinant standard for designing plug and play capabilities to classical transducers. The mechanism for plug and play identification is the standardization of a Transducer Electronic Data Sheet (TEDS) [1]. One TEDS contains the full information needed by a measurement system to detect, identify, characterize, interface, and properly use the signal from an analog sensor. An IEEE 1451- based sensor acquires the measurement, provides signal conditioning, converts the measurement into the attribute's units, and transmits the information through a communication port to the monitoring point.

2. SENSOR MODEL

For the paper purpose, we are measuring temperature and movement. The classical sensor we use is CXTLA02 (two axis tilt sensor + temperature sensor). The analog signal description is [2]:

$$\alpha_x = \frac{180}{\pi}\left[\frac{\left(V_{xout} - V_{xout0}\right)}{Sens_x}\right] \quad (1)$$

$$\alpha_y = \frac{180}{\pi}\left[\frac{\left(V_{yout} - V_{yout0}\right)}{Sens_y}\right] \quad (2)$$

$$t = 35mV/{}^{0}C \quad (3)$$

The three equations describe the x, y angles orientations (radians) and ambient temperature of the sensor. They are in accordance with the output voltages corrected with zero voltages outputs.

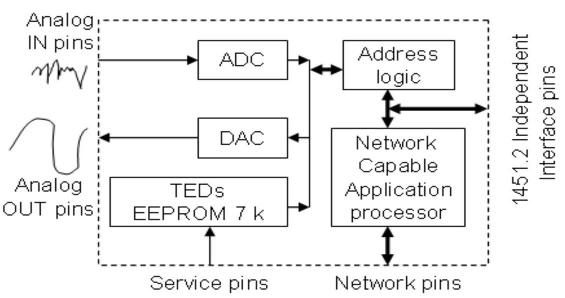

Fig. 1. Draft proposal of TEDs chip

Based on IEEE 1451 standard we have built TED table structure.

Basic TEDs [64 bits]	Manufacturer ID [14 bits], 10381 Model Number[15 bits], 200 Version Letter [5 bits], E (Chr5) Version Number [6 bits], 2 Serial Number [24 bits], 111110
Selector [2 bits]	00
Template ID [8 bits each]	ID = 25 (x axe)
	ID = 25 (y axe)
	ID = 37 (RTD)
Selector [2 bits]	00
Calibration template ID [8 bits]	ID = 41 (calibration curve)
	ID = 41 (calibration curve)
	ID = 41 (calibration curve)
Selector [2 bits]	00
User data [8 bits]	Unsigned integer

Tab. 1. Proposed structure of the TEDs

The full description of ID= 25, Id= 41 is presented in [1] and it was used to design particular application- sliding of the land detection and ambient temperature. We have used three IDs for calibration because the interface has to read three times calibration curve (for each measured parameter, the curve is different).

The user data is taken into consideration as unsigned integer with 8 bits continuous reading.

3. SENSOR TESTING SETUP

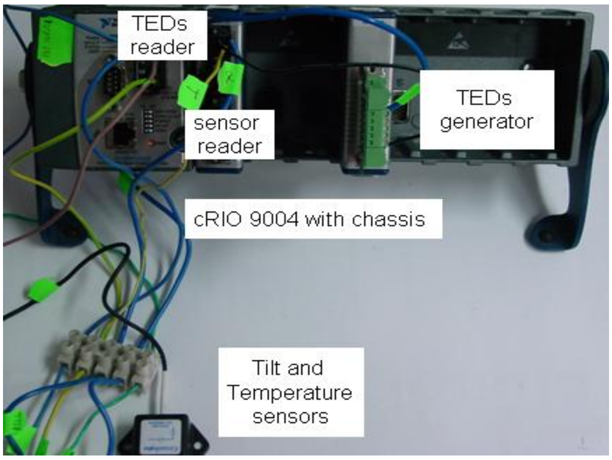

Fig. 2. Experimental setup

In order to study the behavior of the sensor in calibration process shifting we are simulation different TEDs content. The main behavioral parameters are reading delay and accuracy processing. For the lab research we are using a NI cRIO 9004 with chassis, NI 9219 DAQ module with TEDs reader facility, NI 9401 DIO as TEDs generator (Fig.2). The software for controlling entire setup is LabVIEW. The calibration curve (equations 1, 2) is settled with next values (Tab.2):

Parameter	Standard values	Experimental values		
Sensitivity - small angles (mV/O)	100 ± 10	90	110	110
Sensitivity Drift (%/OC)	0.01	0.01	0.01	0.01
Zero Angle Voltage (Volts)	2.5 ± 0.15	2.35	2.5	2.65

Tab. 2. Proposed experimental values scenario

The module NI 9219 consists of 4 analog inputs for reading the sensors signal, and 4 TEDs sincron [3] reading ports. The NI 9401- 8 bits digital IO is used to generate serial data on A0 output as a simulated TEDs. For this purpose we have created three data file with the proposed TEDs structures. The LabVIEW main virtual instrument (VI) program is reading data file as string, and then is converting it as binary data for the matrix as the source for programmed serial A0 output.

The other components of the VI are used to control the time (for measuring delay), and to make calculations of the measured data.

Time delay for calibration curves shifting is measured as the time difference between sending digital data from the TEDs generator (first bit reading),

4. TEST RESULTS

Time delay for calibration curves shifting is measured as the time difference between sending digital data from the TEDs generator (first bit reading), and the moment of delivering with the new measured value (Fig.3).

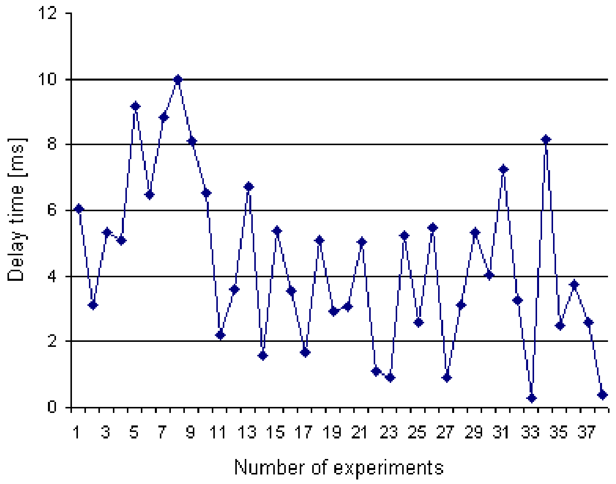

Fig.3. Time delay of calibration process shifting

The resolution of the time measurement is 0.1ms. Each three measurement consist of first, second, and third calibration curves. There are not rules/ dependencies between shifted calibration curves and delay time.With this setup, we consider that the measured delay, offer enough approach window for implementing environment sliding monitoring sensors with TEDs implementation. The environment parameters have a slow variation (sampling rate is less the 1 sample/sec), that means that a time delay in the range of 10 ms, offers an accuracy better then 0.01%.

The accuracy of processing is evaluated [5] for measuring the same values into the three calibration curves shifting process (Fig.4).

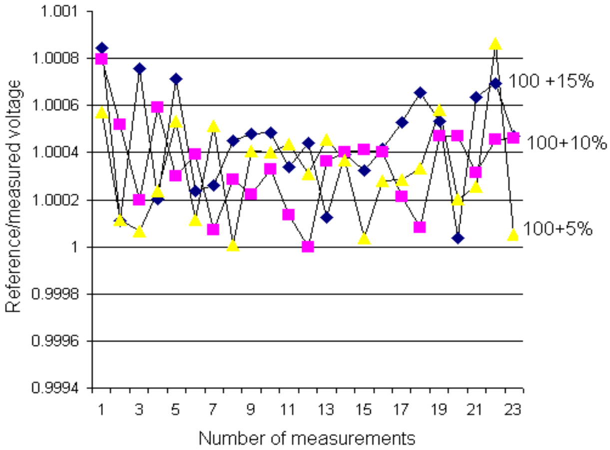

Fig.4. Figured errors in shifting process of the calibration

As we see here (Fig.4), the most constant values are related to the error class (+5%).

The worst situation is when we are evaluating throught error class (+15%). The processed differences are situated into the range of +/- 0.01%, extremally acceptable values.

5. CONCLUSION

Testing TEDs- based sensors into embedded controllers offer the possibility of finding time delay to stability of measured values. The delay is depending by far the length and structure of TEDs. Calibration process, as a preliminary processing, or as preprocessing of the data is depending also by the TEDs structure and the analog to digital conversion methods.

This level of the delay time for shifting process offers the possibility to implement some preprocesing stage into the sensor- like self calibration for automatic sampling adjusting, or filtering.

There is not much influence of controller, which means that computational resources are not strongly demanded. It means that the computational resurces (speed processor and memory) could be used for some preprocessing functions.

6. REFERENCES

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