INTERNET OF THINGS (IOT) ENABLED SENSOR CALIBRATION SYSTEM

This invention provides a method for obtaining the sensor data; acquiring the ground truths (standards) using a ground truth measurement system, which is typical for the sensor group under which the sensor falls is being calibrated; data transmission to a remote location and analysis using any IoT enabled device, with which the sensor and ground truth measurement system are interfaced; error estimation and development of the Quality Profile; sensor selection based on developed Quality Profile; error compensation of chosen sensor using Neural Network based compensation techniques; and display the results to the end-user using a GUI.

Calibrating a sensor is a mandatory part of any measurement procedure and provides a novel approach towards this end. Many kinds of errors creep into the process of data acquisition from sensors and exact causes of all errors cannot be determined and modelled for. Few of the errors can be removed by suitably configuring the system to monitor the surrounding environments and modelling for a compensation based on those observations. However, there will always remain errors which cannot be modelled and Calibration provides a means to compensate for these kinds of errors.

This invention provides a method, which is effective in terms of cost of calibration setup (for sensors of the same kind) and transferring data to a remotely located computational device for further processing. It provides a way for obtaining the sensor data and also acquiring the ground truths (standards) using a ground truth measurement system. These ground truths are typical to the sensor group, under which the sensor falls, is being calibrated. It also describes the process of data transmission to a remote location using an IoT enabled microcontroller. It provides a mean to decrease errors in sensor readings by implementing a compensation technique involving probability theory for estimating random variables, which could be implemented over neural networks in the form of PNN (Probabilistic Neural Network).

This Figure 1 shows the interfaces between all the modules present in the system and also gives an idea of data flow. Data from the sensor as well as the ground truth measurement system is collected by Arduino via its input ports. It then sends this data to the internet using the Ethernet module ENC28J60, which is connected using the SPI interface. A remotely located computer can then access that data from the internet using its own Ethernet connection. In the current setup, the database for storing the data is present in the computer itself. It is also possible to store it in a different computer, whose sole purpose would be act as a server and the remote computer could send HTTP requests for accessing that data.

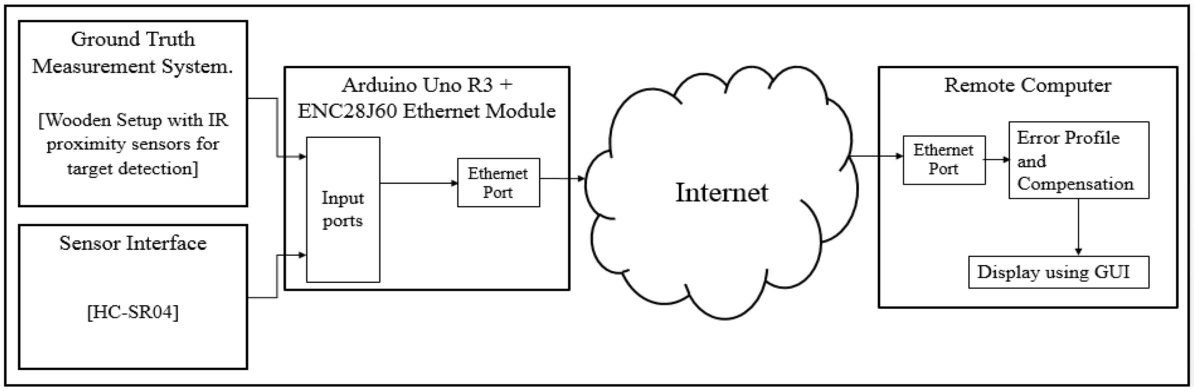

Figure 1: shows Complete Block Diagram according to the invention.

A prototype has been designed using a wooden plank of 1 meter with an ultrasonic sensor placed at one end of it. Figure 2 shows the dimensions in the cross-sectional view as well as a top view of the prototype. IR proximity sensors placed at different positions so as to enable them to sense the motion of the target. The positions of the IR sensors are fixed such that they detect the target at pre-fixed distances of intervals of 10 cm.

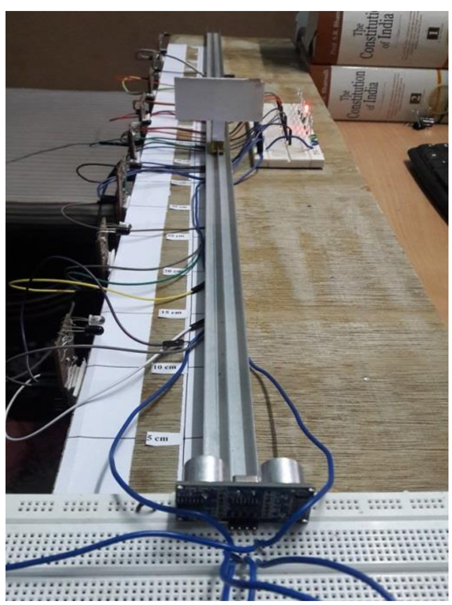

Figure 2: shows Ground Truth Measurement System for Ultrasonic Sensor Calibration according to the invention.

Ultrasonic sensor HC-SR04 has been interfaced with a computer via an Arduino Uno board. Arduino Uno R3 board supports ATmega32 microcontroller and provides the sensor with required 10 microsecond pulse at the 'Trig' terminal through a pin acting as an output port. As soon as the sensor receives the trigger input, it transmits 8 pulses of 40 kHz and raises the echo pin value to high. On reflection, the pulses return back to the sensor and the echo pin goes low. Now, the width of the 'echo' pulse gives information about how far the target is from the point of measurement. A code has been written to interface HC-SR04 with Arduino Uno and to count the number of milliseconds for which echo has remained high. This data has then been converted to distance reading using the echo ranging technique. Apart from the 10 cm interval data obtained with the help of the ground truth measurement system, another set of readings known as validation data has been obtained. This validation will be used for checking the efficiency of error compensation technique being employed. This data constitutes sensor readings for every 10 cm starting from 5 cm, within the range of 1 meter as shown in Figure 3.

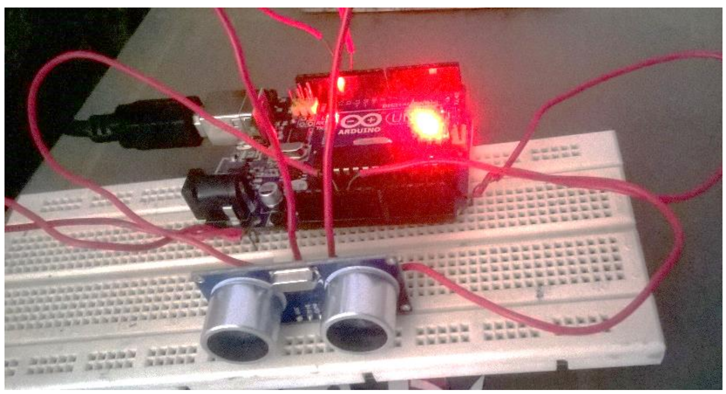

Figure 3: shows Arduino Uno board interfaced with wired ultrasonic sensor HC-SR 04 according to the invention.