Methods for monitoring metrological characteristics of scientific and physical parameters of intelligent sensors in real operating conditions

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Abstract. Intelligent sensors - the direction of studying the characteristics of scientific and physical parameters in real conditions (in the regions of Uzbekistan at the Aral Sea). This article provides brief information on monitoring methods using software, an analysis of the physical activity of various sensors in an area of over 220 hectares given in the Khorezm region. Creating a common relationship between humanity and the environment with the support of information technologies.

At present, smart sensors and smart measuring systems are actively being developed and applied in the world, and our country is by the way no exception. The Agency for "Standartization, metrology and certification" of Uzbekistan has approved a number of national standards for technical regulation and put into effect that apply to smart sensors and intelligent measuring systems developed and used in Uzbekistan too. Observations of the ecological state of the environment, in particular, atmospheric air were conducted in our country for many years very accurately, however it was done mainly in manual mode (go to the zone - receive analysis, transport to the laboratory - perform synthesis - record to the paper - prepare final reports - transfer to the management) which did not allow to receive and use also to compare data in real time scale.

Intelligent sensor is an adaptive sensor with metrological self-monitoring function. Metrological self-monitoring of a sensor is an automatic check of the metrological serviceability of a sensor during its operation, carried out using an accepted reference value formed using a means built into the sensor (measuring transducer or measure) or a dedicated additional output signal parameter. Metrological self-control of the sensor can be implemented in two forms: direct metrological or metrological diagnostic self-control [5]. Metrological direct self-monitoring of a digital sensor of distance to a conducting surface can be implemented on the basis of structural redundancy in a test
mode: the sensor contains an exciting inductance coil, a receiving coil and inductance, and additionally, a target simulator made in the form of a switched flat inductance coil. The simulator is placed in front of the target. The part fixing the distance between the receiving coil and the simulator serves as a measure of length [3].

Metrological direct self-monitoring of a temperature sensor with a resistance thermometer can be realized on the basis of temporal and functional redundancy. In a resistance thermometer, both its resistance and the parameters of the noise spectrum depend on temperature. Temperature measurements based on noise spectrum parameters are more accurate than resistance measurements. Therefore, the temperature value measured from the noise spectrum can be taken as a reference value [4]. Metrological diagnostic self-control of a thermoelectric temperature sensor can be implemented on the basis of structural redundancy: the sensor contains several thermocouples that are close in accuracy. The dependence of the average value of the output signal of thermocouples on the value of the measured temperature is used as a function of the sensor transformation [6].

When determining methods for monitoring, the metrological characteristics of physical and chemical parameters of smart sensors in real operating conditions play an important efficiency for converting our atmosphere into digital data. To be precise, one of the most important subjects must be selected, for example "heat and cold" from the atmosphere, where the weather is climatic. Our team has decided, as far as possible, to make an attempt to use foreign experience and its development.

According to the agreement with the departments of the Yangibazar district of the Khorezm region, 220 hectares of land were allocated with the authority for scientific activities, where we conduct research on the areas of work ability of intelligent sensors for measuring temperature and other air parameters based on the existing databases of the centre ZEF/UNESCO at the Urgench State University of the Khorezm region on the territory of Uzbekistan.

The function uses a thermistor NTC with negative temperature coefficient for our purposes, and practice, this means that the value of its resistance is low when the sensor equipment warmer, and conversely, when the sensor is cold, the values of "temperature change immediately," "how humid is breathing in cold or warm", "do you need to drink water" terminology can be easily determined using air pressure sensors. The indicated resistance value of the sensor is suitable for measurements in the climate of Uzbekistan in the range from -50 to 50 degrees Celsius. To find one of the best methods, we will immediately connect computers with Arduino using the following algorithm (figure 1), the operating mode of the software with the Arduino is set based on the configuration file system.
Information - managing subsystem is based on personal computer compatible the Mini Computer the ASUS PN 60- BB3006 Barbone and performs all functions related to the processing of data and control system, including the survey instrument measuring subsystem:

**Double Thermistor (int warm_hot_ADK)**

```c

{ double temperature_air; /**< - hot variable ***/
  temperature_air = log (((10240000/warm_hot_ADK) - r_condition_50_grad)); /**< r_condition_50_grad - this one function of resistance and has the type of int, and it will be equal to 20000 in our example, which is determined immediately after loading the required libraries ***/
  temperature_air =1/(0.00129148+(0.00023415* temperature_air )+(0.0000000876741 * ( temperature_air * 3 )));
  temperature_air = temperature_air - 273.15; /**<with converting calvin to celsius***/
  return temperature _ air;
}

... [ The program is compiled in the compiler exactly by using C++, and, therefore, is to push to the beginning main functionality and to the end with the END function, then will be get through compiler results 7-8 degrees of fluctuation, only according to spring weather].

As results, we get a comprehensive solution to the necessary operations as:

- collection, accumulation and processing of measurement data;
- analysis of the environmental situation on the ground;
- distribution of monitoring results among users (our goal is still for veterans and old people over 60 years old)
- creation of a database based on WEB - technologies.

The scientific foundations of monitoring the metrological characteristics of air through the operation of intelligent sensors are continuously associated with mathematical and technological laws, in particular with the theory of probability, because the work itself is related to nature, since the results or final estimates of forecasts are very changeable in a particular scientific field, for example in the past and currently (we are going to analyze), and the future can only be assumed.

The first attempts to make a classification of scientific results were made in 2010-2020 on the implementation of analog and digital sensors in the field of the most important indicators of real achievements based on weather forecasts from the sources of the information and library center of the Khorezm region. Now the platform is being created with the existing physical features so that in addition to viewing the data scopes and studying the work done, it leads to a detailed analysis and assessment of their use (smart sensors with software). I think that the consideration of integrated systems for environmental monitoring of the atmosphere is the definition of air pollution, in which there will be gas and salt, and water, and essence, and smoke, and others that have grown currently into powerful dangers for humanity. The most important question here is described by maintaining a constant air temperature in the workplace, where we conduct experiments, which is actually controlled by nature. We decided to stay with a changeable temperature, that is, to conduct experiments on an open campus as weather is natural. This gives results in relation to the nature of the enhanced organization of labor in unscheduled and emergency checks of indicators. For the interconnection of technical tests and measurements within the framework of our project, objects were obtained in priority zones along the supporting Eulerian circles, where all localizations are concentrated mutually (figure 2)
Figure 2. Theoretical perspectives on workplaces to reduce the excess activities and on setup of equipment.

Works for the implementation of the program continues, further scientific and technical proceedings only in places will be changed. The regulatory acts of Uzbekistan are designed to ensure the creation of such systems for monitoring ecology and other information data, to activate the participation in the international information exchange of innovative developments, and solve a number of existing figure 3: Location sensors at the plane of projection with the main head attributes explored as axis $X_1$ and $X_2$, B - positioned sensors with results, A - schema of repeated location area.

Figure 3. Location sensors at the plane of projection with the main head attributes explored as axis $X_1$ and $X_2$. B - positioned sensors with results, A - schema of repeated location area.
Important issues for the climatic sphere. Uzbekistan is vulnerable to other extreme situations, such as high temperatures, heavy climate changing, unloads of water resources and unexpected weather setting. Climatologically changes has considerable affecting key environmental aspects of life in the Khorezm region at present, and this situation is set to worsen. Accordingly, consequences of all scientific topics should be developed related to this situation. Taking into consideration IT-supporting at this point will be helpful for long-term, the issue is equal to Sustainable Development Goals under SDG project. Next research points will be set up in the Republic of Karakalpakstan nearest to the region “Chimbay”, where scientific areas have to widen up to 400 hectares.

To achieve the goal, it is necessary to solve the following tasks, to analyze the existing methods and means for measuring the physical factors of the microclimate, to evaluate the characteristics and serially obtained analyzes. As a system has been successfully integrated Sensor Modelling Language (SensorML - an XML-based modelling language). Experiments over the issues within several days gave results, where data was obtained by changing the operation of the devices by different places each time. In the development of a method for increasing the speed of temperature measurement, based on short-term temperature control at the initial section with a transient response. When the parameters to the monitor are identified (figure 3), the characteristics of these parameters, such as the possible range and frequency, should be understood. The current status of air by the 'error mode' has been covered a wide range of other area (detected in cubic mode). These characteristics can be obtained based on the historical records of the data or the specifications of the air. It was also proposed to equip the location with the brands of the GY-65 sensor based on BMP085 devices with a channel for measuring atmospheric pressure and enter a correction factor into the data processing program with $\bar{\Pi}$:

$$V_{\text{resources}} = P \times V_{\text{change}}; \bar{\Pi} := 1 - 0.75 \times \frac{P - 100}{5}; C = \sqrt{(20.07 \times (1 + 0.3192e/P)T)};$$

where $P$ is the atmospheric pressure at the time of measurement, it lies in a circle somewhere around 1000 kPa.

The air temperature $T$ is determined from the known ratio $C$, where $e$ is water vapor, $T$ is the absolute air temperature. Information about the measured pressure is displayed using the protocol and I2C with SMBus, and caught the library for Arduino "gy_65" (to retrieve functions as readTemperature(); readPressure(); calculateAltitude(pressure); readCalibrationData()). Because of the sensor uses a different byte order than the Arduino, the bytes of double-byte integers must be swapped. It should be noted that "Two-Byte-Integer (2^4 Bit)" with each iteration correctly points to a new of two-byte integers, and not to separate ones, as might happen with a naive approach to Bytes. And now the function Call_data creates an approach to information management in "information ecologies" under a Web-Application. The physical characteristics of a sensor system include its weight, size, shape, packaging, and mounting of sensors into the localhost. In the motherboards of modern computers, some sensors are embedded in the chips to save space and improve performance. For instance, the temperature of the CPUs (this method should be helpfully for short checking) and graphic processors are measured by thermal sensors built into the processor chips. By the WEB-portal method is used to identify the sensor status of a laptop by monitoring the internal environmental parameters, such as temperature, shock, and humidity. For actions server data processing part consists of a server HP ProLiant DL 985 G7 modifications on the basis of four processors XeON and software, including reception and data preparation module, the metrological character prediction module, a database of ecological parameters of the ZEF/UNESCO center of the Khorezm region.

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