Original Article: Chemical Sensor Development for Real-Time Monitoring of Air Quality

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ABSTRACT

Sensors are devices that convert physical properties into electrical signals. For example, temperature sensor, humidity sensor, presence detection sensor, etc. These sensors acquire information from the real world. Air quality sensors detect various air pollutants, gases and suspended particles and provide information about air quality in terms of health and environmental standards. They are used in a variety of applications from indoor air quality monitoring in homes and offices to outdoor air quality monitoring for environmental and public health purposes. Smart sensors generate and receive data and information that goes beyond traditional switching signals or measured parameters. They take input from the physical environment and, after identifying the input using internal computing resources, process the data before sending it. These devices are used for monitoring and control mechanisms in various environments, including smart networks, environmental detection, discoveries and scientific applications. Smart sensor is a vital and integral element in the Internet of Things. All these were once done as manual processes, but with the presence of smart sensors, these processes are done automatically. Smart sensors also play a key role in the development of modern security systems. Thermal imaging sensors detect the body heat of an intruder. Similarly, devices such as smart locks, motion sensors, and window and door sensors are usually connected to a common network. This allows security sensors to work together to create a comprehensive picture of the current security situation. They are also often used in homes and industrial applications to detect various leaks.

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Introduction

Smart sensors have many applications. Their most common use in industrial environments and industrial automation is robotics. Factories often use smart sensors for diagnostic purposes. Smart sensors control the temperature of the machines and vibration sensors control the devices from the risk of vibration. Smart sensors also enable process control, such as monitoring the manufacturing process and making necessary adjustments to meet quality or production goals [1].

IoT technology makes it possible to provide a unique identifier for almost anything and transfer data from them over the Internet or a similar sensor network. One of the uses of smart sensors is as components of a wireless sensor and actuator network that can have thousands of nodes. Each node is also connected to one or more other sensors and sensor hubs as well as individual actuators.

Low-power mobile microprocessors typically provide computing resources in IoT environments. A smart sensor is made up of at least one sensor, a microprocessor, and some form of wireless communication technology. Computational resources should be an integral part of the physical design. A sensor that only sends its data for remote processing is not considered a smart sensor [2]. A smart sensor may include a number of other components in addition to the primary sensor. These components can include converters, amplifiers, excitation control, analog filters and compensation. The smart sensor also has software elements that provide functions such as data conversion, digital processing, and communication with external devices. In general, a smart sensor includes three main components:

- A sensor that takes data from an environment;
- A microprocessor that calculates the output of the sensor through programming;
- Finally, communication capabilities that enable the sensors makes to use the output of the microprocessor in practice [3].

Types of physical sensors

- ✓ **Light and electromagnetic sensors:** Which include RFD sensors for retail and logistics applications / imaging and identity sensors for security applications / light sensors for smart building automation / radioactivity sensors for health and safety applications;
- ✓ **Thermal sensors:** Room temperature monitoring in smart buildings / environment monitoring / material temperature monitoring in industrial process management;
- ✓ **Sound Vibration Sensors:** Seismic sensors for area safety / Sound pressure for health monitoring and automation and industrial processes / Specific sound monitoring for urban management applications such as gunshots / Personal health applications such as fitness / Vibration sensors for maintenance based on the reliability of equipment in factories or industrial organizations;
- ✓ **Material and material sensors:** Many applications for environmental automation, safety, health, agriculture and environment require specific liquid and gas sensors. Such as sensors to detect chemical presence or oxygen, carbon dioxide, humidity or water level [4];
- ✓ **Time and location sensors:** Location sensors in the geographic information system for logistics management of personal applications / or time sensors for speed, acceleration and vehicle and traffic management.

The features that should be considered when choosing a sensor are as follows

- ✓ **Accuracy:** Agreement between the actual value and the measured value.
- ✓ **Resolution:** The change in the measured variable to which the sensor responds.
- ✓ **Repeatability:** Change in sensor measurement when the same quantity is measured several times.
- ✓ **Range:** Upper and lower limit of measurable variable.
- ✓ **Sensitivity:** The minimum physical parameter input that produces a detectable output change. In some sensors, sensitivity is defined as the change in the input parameter required to produce a standard change in the output [5].
- ✓ **Linearity:** The linearity of a sensor is the extent to which the actual measured curve of a sensor deviates from the ideal curve.
- ✓ **Smart transportation:** Smart transportation is the use of various smart technologies and equipment to promote digitization, networking, and smart transportation. Among them, the network is very important for the development of intelligent transportation. Using the Internet of Things can streamline all traffic network links and effectively enhance traffic monitoring, improve existing traffic services and traffic formats. The application of Intelligent Transportation System (ITS) in urban transportation is reflected in traffic information collection, traffic control, guidance, etc. It improves traffic system efficiency by improving the effective use and management of traffic information, mainly through information gathering input, strategy control, output execution between subsystems and other subsystems, data transfer and communication. The information gathering subsystem collects the vehicle and road information through sensors, and the strategy control subsystem uses the calculation method to calculate the optimal solution according to the set goal, and sends the control signal to the execution subsystem for navigation and traffic control. The vehicles will reach the predetermined goal [6].
- ✓ **Environmental monitoring:** The application of sensor technology in environmental monitoring is reflected in two aspects: Physical or chemical reaction with pollutants in detected materials, by determining whether the pollutants are present in the materials or not. Chemical signals are converted into electrical signals. According to different detection methods, sensor technology can be divided into optical sensors and electrochemical sensors. Different response mechanisms can be classified into biosensors and immunosensors. Various detection objects can be divided into liquid sensors and gas sensors. The basic principle of biosensors is to use functional genes, antibodies, and other biological materials as sensitive materials, use a signal absorption device to collect biochemical information, and convert biochemical information into electrical signals for analysis. As biosensor technology continues to evolve, more and more sensitive materials and sensing elements are available to help accurately detect more pollutants in the environment. Compared with traditional sensors, biosensors benefit from simpler operation, faster and more accurate testing process. Biosensor technology is mostly used for atmospheric detection, including sulfur dioxide detection, nitrogen dioxide detection, heavy metal ion detection, pesticide residue detection, etc [7].

Advantages of smart sensor

Its advantages emerge when the smart sensor is used to collect data in difficult or remote locations. The following benefits depend on using the right type of sensor in the desired location.

- ✓ **Energy efficiency and stability:** A smart sensor can be programmed to be very sensitive to even slight changes in environmental conditions such as temperature, humidity, humidity or acoustics. These highly accurate and reliable measurements provide a level of monitoring and data collection that can support energy efficiency and sustainability efforts;
- ✓ **Data access in difficult environments:** Smart sensors can collect data in remote locations, where it is difficult or dangerous for people to go. Remotely operated wireless smart sensors are especially useful in challenging environments;
- ✓ **High performance:** Smart sensors can collect data stably and quickly when real-time data is needed [8];
- ✓ **Internal analysis and processing:** Unlike traditional sensors, smart sensors have internal analysis and processing capabilities of the signals and data they receive, leading to increased efficiency, as they require fewer external analysis tools or resources.

Disadvantages of smart sensor

Smart sensor developers have continuously made suggestions to fix previous bugs and will continue to do so in the future. However, it may take some time to overcome the current disadvantages of these devices:

- ✓ If the device's cyber security measures are not sufficient, those seeking access to the collected data for personal use can hack the device;
- ✓ Many devices are cost-effective, but the additional maintenance that will be required over time can also be expensive;
- ✓ Sensors sometimes need to be calibrated or upgraded due to data lag or other problems. Access to items located in remote settings or challenging environments can be difficult and costly;
- ✓ Intelligent sensor systems may require levels of IT expertise that not all organizations have. New hires or training may be required;
- ✓ Whether in a smart home or an industrial environment, other factors such as the required power consumption, the need for a stable online connection and the ability to handle higher volumes of data must be considered before deploying IoT devices (Figure 1).

Industrial applications of sensors

Automation systems sensors ensure process control and efficiency in industries such as manufacturing, logistics and energy. They monitor the health of machines, optimize production lines and ensure product quality. For example, pressure sensors in pipelines prevent ruptures and temperature sensors in furnaces optimize energy consumption. Sensors act as guardians of our planet, monitoring air and water quality, tracking pollution levels and detecting natural disasters. They provide information needed for weather forecasting systems [9], track soil moisture for sustainable agriculture, and even monitor wildlife populations for conservation efforts. Sensors are essential in healthcare, diagnosing and monitoring patients. They measure vital signs, diagnose diseases, and prescribe precise medication. For example, ECG devices use sensors to read heart activity and blood pressure devices use pressure sensors to measure pressure. In addition, wearable health gadgets have revolutionized personal health

monitoring. Sensors increase our comfort and security at home. Motion sensors activate security systems, temperature sensors adjust smart thermostats, and smoke detectors use sensors to detect potential fire hazards.

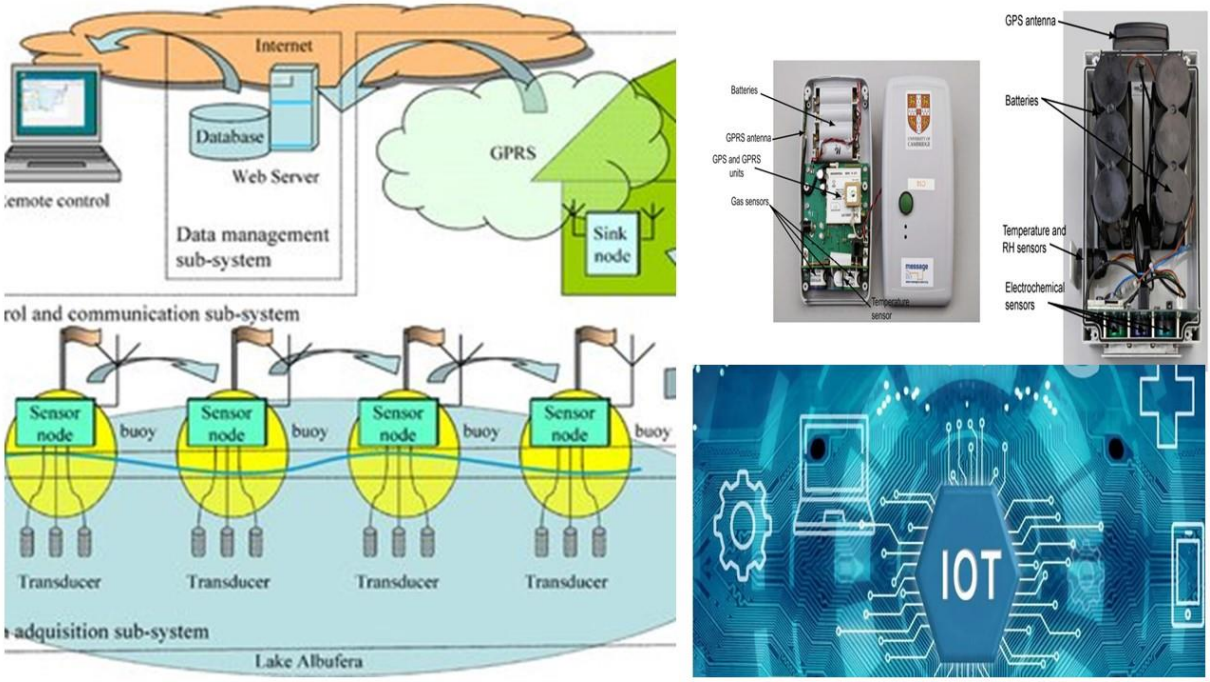

Figure 1. Chemical Sensor Development for Real-Time Monitoring of Air Quality

Pressure sensors

Pressure sensors deserve a special mention because of their wide range of applications. As mentioned earlier, they control the tire pressure and ensure safety on the road. In industries, they measure pressure in pipelines, reactors, and hydraulic systems, ensuring efficient system operation and preventing potential accidents [10]. Even medical devices such as ventilators rely on pressure sensors. The world of sensors is constantly evolving due to advances in miniaturization, the Internet of Things, and artificial intelligence. These advances will lead to more sophisticated and smarter sensors, further changing industries, protecting the environment, and shaping the future of healthcare and smart homes. Sensors are more than just a device. They are the invisible threads that weave together the seeds of our modern world. From ensuring industrial productivity to protecting health and the environment, their applications are constantly growing.

Air quality sensor components

- ✓ **Sensors for specific gases and particles:** Air quality sensors have various sensors or detectors that are sensitive to specific air pollutants. These can include sensors for gases such as carbon dioxide (CO_2), carbon monoxide (CO), volatile organic compounds (VOCs), nitrogen dioxide (NO2), sulfur dioxide (SO_2), ozone (O_3), and particulate matter (PM2) and (PM10);
- ✓ **Microcontroller:** The sensor often includes a microcontroller or processor that controls the operation of the sensor, collects data from the sensors, and processes the data for output [11];
- ✓ **Display and output:** Air quality sensors may have a display or provide data output in various forms, such as numerical readouts, color indicators, or data that can

be accessed through a mobile app or a web interface;

- ✓ **Environmental sensors:** Some advanced air quality sensors may use environmental sensors, such as temperature and humidity sensors, which can affect the air quality assessment.

How does the air quality sensor work?

Special sensors in an air quality sensor continuously or periodically sample the air to measure the concentration of target gases and particles. The sensors use different technologies, such as electrochemical, metal oxide, optical, or laser-based techniques, depending on the pollutant being detected.

- ✓ **Data collection:** The collected data is sent to the microcontroller for processing. The microcontroller may average, calibrate, or convert the data to more meaningful units;
- ✓ **Data analysis:** The processed data is then compared to predefined air quality standards or thresholds to determine the level of air pollution. The sensor may use a combination of sensor outputs to calculate an air quality index (AQI) or a similar metric [12];
- ✓ **Display or Output:** Results are usually displayed on the device's screen or provided as an output, such as a digital readout, color indicator, or mobile app notification. Users can interpret this information to assess air quality.

Air quality sensor applications

Air quality sensors are used in a wide variety of applications, including: Indoor air quality (IAQ) monitoring: They are used in homes and workplaces to assess and improve indoor air quality and to identify issues such as high levels of CO_2, volatile organic compounds or inadequate ventilation contribute.

- ✓ **Environmental monitoring:** Air quality sensors are deployed outdoors to monitor pollutants and particulate matter in urban and rural areas, helping governments and organizations track and manage air quality;
- ✓ **Health and Safety:** Used in industries to monitor air quality in potentially hazardous environments or confined spaces.

Discussion

In today's society, with the development of the society and the continuous improvement of the national economy [13], we are facing serious air pollution problems, and the air quality has also entered the early warning stage. More and more people are starting to pay attention to air quality. Detection of toxic gases in gases and gases is inseparable from the air detection system, and air detection and car detection are inseparable. The measurement of human facial features cannot be solved in any way. Therefore, air detection sensors are essential. Only through this diagnosis system can accurate diagnosis be made and provide a better living environment for people. It can be said that the detection of air quality is related to the life and health of every person. With the rapid development of industry and transportation, especially the extensive use of coal and oil, a large amount of harmful substances is produced. Nowadays, people pay more and more attention to air quality and environmental protection and put forward more requirements for gas detection tools. At present, people have not only studied sensors with high measurement accuracy, integration, intelligence and application, but also achieved remarkable results [14].

Research on gas detection sensors is no longer limited to a measurement and control technology and instrumentation expertise. It is developed based on comprehensive multidisciplinary technologies such as microelectronics science and technology and electronic information technology. The

development of a fully automatic digital smart gas sensor that can monitor multiple gases simultaneously will be an important research direction in this field. The volume of the software product can be greatly reduced, the software product is easy to use, quick to operate, widely used, can bear heavy responsibilities in families and public places, and has a large profit margin in production. There will be deeper research and a wider market space for current air quality problems and air quality detection system health standards that people will continue to improve.

Chemical sensors based on smart phones

Smartphones are used as the most popular advanced mobile devices, with various applications, as physical and chemical sensors. The integration of chemical sensors with smartphones leads to the creation of more compact, lighter, more durable devices in terms of performance, which meet all the criteria of the World Health Organization, such as cheapness, simplicity of the method, high sensitivity and selectivity, portability, availability, no need for complex equipment. Smart chemical sensors have entered our lives due to their countless advantages for personal care, clinical analysis, allergen detection in food, and environmental monitoring, and pave the way for more application of these sensors in daily life, especially care tests [15].

In this review article, several main issues related to smart chemical sensors have been discussed, the most important of which is the identification of wireless chemical sensors that use different parts of smart phones such as the LED screen, phone battery, phone camera, data transfer system and special programs have been created. In the following, their application is mentioned, such as environmental sensors to control the quality of air and water, wearable sensors and care tests. The most important application of mobile phones in these sensors is to use the phone's camera as a detector to record color change images and relate it to the concentration of the analyte.

Wearable sensor to know the level of air pollution

A start-up plans to create a wearable air quality monitor that uses technology to detect the presence of chemicals around you in real-time at a low cost. This sensor transmits the information obtained from the environment to the application that is installed on the mobile phone. In this way, this technology, if necessary, warns those who are exposed to respiratory diseases or live in polluted environments about air quality. The company plans to initially market $150 wristbands for children who suffer from asthma. According to the Center for Disease Control and Prevention in the United States, about 7 million children in this country have asthma. The information obtained from these patients helps to identify the places and pollutants that lead to disease attacks [16].

Also, the length of time that each person is exposed to pollution is also checked. This company hopes that their product will attract the attention of other people who suffer from respiratory diseases or care about the quality and amount of air pollution. In America, thousands of air quality control stations have been installed across the country and it is possible to view maps online and predict the state of pollutants, but these stations accurately show the state of air pollution only in the same place where the devices are installed. and in other areas they lack sufficient accuracy. The Chemisense company has not yet completed its product, but it plans to design polymer wristbands that are charged with carbon nanoparticles, and when exposed to certain chemical particles, the polymer swells and increases circuit resistance. In this way, it is possible to send a warning to the owner of

the wristband. This company has expressed hope that the first manufactured sample of their product will be released to the market within the next 6 months. The company's current technology is able to identify several chemicals and their compounds that are suspended in the air including benzene, hexane, nitrogen dioxide and carbon monoxide. They plan to add 19 more substances to this list [5].

A professor of chemistry and environmental health at the University of Michigan, who studies chemical sensors, said in relation to the Chemisense project: Although different polymers can detect different chemicals, if two chemicals are simultaneously in contact with If they are a sensor, the ability to detect the sensor drops drastically. If the number of these chemicals increases to three, it becomes almost impossible to detect them [1].

Reducing the emission of fuel-burning industries with nanotechnology

ISNA wrote: While these days breathing in the country's metropolises has been reduced due to diesel fuel burning, researchers believe that the air in big cities can be kept fresh in the cold seasons of the year with the country's up-to-date technologies, provided that in addition to these technologies, clean fuels should be used. These days, fuel oil is the main culprit of air pollution. A fuel that is considered as an affordable fuel in most advanced countries is known as a polluting agent in Iran and a new label is put on it every day [17].

A city without soot is not created only by equipping diesel cars with soot filters; Because the air pollution in big cities these days is caused by fuel burning in power plants, when crude oil enters the distillation tower, products such as gasoline, diesel, liquefied gas and jet fuel come out, and a heavy product called fuel oil comes out from the end of the distillation tower. This petroleum product was used in power plants, locomotives and ship fuel in the past, and is currently used as a popular fuel in advanced industrial countries, such that coal and fuel oil are the main fuel for power plants in the world. In order to reduce the emissions of diesel power plants, it should either be replaced with suitable fuel or by installing a filter to prevent the aggravation of air pollution. In advanced countries, decontamination and filtration equipment is installed on the chimneys of power plants in order to purify and filter the exhaust gas from power plants, and this problem prevents the spread of pollution caused by coal and diesel fuel in the environment. In Iran, due to the lack of use of existing technologies in the field of filtration, gas and diesel fuel are delivered to all power plants, but in the cold seasons of the year, due to the lack of gas and diesel, fuel oil is distributed and provided in a limited way in some power plants. But besides that, standardization of power plants should be done [18].

Considering that the sulfur derivatives present in diesel fuel are the main cause of pollution of this petroleum product, therefore, removing this element can reduce up to 90% of the pollution transferred to the air. Based on this, the two methods of removing sulfur derivatives from fuel before entering the power plant, as well as removing sulfur derivatives through smoke filtration after diesel fuel in the power plant, are among the technical ways to significantly reduce air pollution. On this basis, according to the economic analysis and the available time, one should choose one of these two solutions to reduce the pollution caused by the consumption of fuel oil. Installing a filter and using methods to remove sulfur derivatives in the chimney of power plants can prepare the ground for the use of fuel oil and lead to the effective passage of the challenge of power outages and gas outages without aggravating air pollution. According to Ali

Asghar Najimi, director of the industry group of the Nano Technology Development Headquarters, nano filters include two categories of "Inlet air" and "Outlet air" of factories and industrial units, and every industry that has an engine or turbine has an inlet air that is being in this field, we have the "Nano fiber" technology at our disposal, which includes devices for producing nano fibers and nano filters, which have been developed by knowledge-based companies since 2011.

He stated that some industrial companies tried to import these types of filters to purify the exhaust air of their industrial units, he continued: But due to sanctions, they refused to sell them to Iran, and knowledge-based nano companies entered in this field and were able to produce these types of filters industrially, in such a way that currently 5 production lines of these types of filters have been set up in one of the industrial companies and they have created a high capacity of producing special filters for the intake air of factories and industrial units and power plants. Najimi stated that other industrial companies also bought devices producing internal nano filters and started to set up lines of nano filters for the inlet air of industrial units, and noted:

The characteristic of these filters is that they bring cleaner air into the combustion chamber. When clean air enters the chamber, combustion is complete. Najimi added: This feature both reduces fuel consumption and reduces damage to the moving parts of the engine, and the result of these two factors will be the reduction of maintenance costs in complexes that use nano filters [17].

The director of the industry group of the Nano Technology Development Headquarters considered the increase in the efficiency of electricity generation in power plants as another achievement of fuel consumption optimization and noted: According to published reports, the use of nano filters to purify the air entering power plants increases the efficiency by about 1%. which is a high number for power plants. He stated that currently about 30 power plants use this type of filters, and added: In addition to power plants, oil and gas companies also use this type of filters in their units. Currently, knowledge-based companies started to produce filters for air purification for power plant applications, but according to the manager of the industry group of Nano headquarters, two factors "Clean fuel" and "Use of air purification system" should be used together in power plants and if the fuel needed by the power plants is not clean, the air purification system needs to be replaced quickly and it will increase the costs.

The new generation of nano filter with the ability to absorb soot

In the situation where the air pollution of the big cities has caused many problems, the innovation of Iranian researchers has helped to remove the hydrocarbon pollutants of the environment. The produced soot filter can be used on all types of diesel vehicles and even with Euro 2 engine base and with Euro 2 diesel fuel conditions and 700PPm of sulfur. It also has 3 times more life and stability than the external ceramic filter sample. This air filter has the ability to absorb particles smaller than 2.5 microns. So it can be an important step to control pollution, while these filters can also be used in gasoline cars by installing an absorbing nano catalyst [18].

Export capacity of power plant industrial filters

Another knowledge-based company has produced industrial nano filters and has been able to export its power plant filters to Iraq and car filters to Afghanistan. Nanofibers are used in the air filters of this company, and these nanofibers are also produced in this company by purchasing 4 Iranian nanofiber production

machines. Car combustion air filters are responsible for absorbing and separating suspended particles in the fresh air entering the engine. These filters are parts that are placed on the way of air intake to the internal combustion engine of cars (both light, semi-heavy and heavy) to prevent insects, dust and other suspended particles from entering its sensitive parts. The industrial and power plant filters produced in this knowledge-based company also have features such as better protection of power plant turbine parts, reduction in downtime costs, increase in power generation capacity, and increase the life of the filters to at least 1.5 times the current life [1].

Production of nano filters for air pollutant sampling

The researchers of Shahid Beheshti University of Medical Sciences have succeeded in obtaining a nanoscale certificate for a crystalline silica sampling filter, which is used in the process of quantitative and qualitative identification of air pollutants. So far, the production of air pollutant sampling filters inside the country has been limited and its imports have been difficult due to economic sanctions and currency fluctuations. Based on this, the development of commercial filters based on nanofibers for the purposes of sampling air particulate pollutants was considered by these researchers. The main goal of this project is to prevent the import of this product and the outflow of currency, to introduce new and alternative samples for the usual sampling filters, and to provide conditions for the sale of nanofiber production lines for use in the production of a new product to the world. In identifying and determining the amount of chemicals in the air of the workplace, there is a stage called sampling, which is of particular importance, and based on these samplings, the necessary tests for the quantitative and qualitative identification of air pollutants are carried out, and the results obtained are used for the next steps, i.e. controlling the risk of chemical pollutants is used [19].

Production of woven media for industrial air filters

Iran's air is among the most polluted in the world and is getting worse due to industrial growth, and suspended particles from the process of producing minerals and cement in factories are considered as one of the important factors causing these pollutions. Therefore, the researchers of Amir Kabir University and Industrial Jihad put the production of woven media for industrial filters on the agenda. Regarding the use of dust produced by cement factories in the country, it should be said that strong filtration systems (hybrid filters) with woven media made of heat-resistant mineral fibers with an efficiency factor of less than 10 milligrams per cubic meter have been imported into the country, which are in accordance with international standards. Due to its import and price, these systems have been installed in only a few cement factories in the country. With the use of these types of filters in the cement industry, this branch of industry has also joined the group of environmentalists. Localizing the technology of producing woven media from mineral fibers to remove dust from the exhaust gases of air-polluting factories and cut off dependence on the outside and respond to the current needs of air-polluting industries such as cement, minerals, and metals are among the necessities of implementing this plan. Among the achievements and output of this project, we can compile the technical knowledge of the production of woven filter media made of heat-resistant mineral fibers, evaluate the quality performance of woven filters made of heat-resistant mineral fibers in real conditions, stop dependence on woven filter media. He

mentioned imported heat-resistant mineral fibers and prevention of currency outflow and environmental pollution [20].

Industrial production of air filters

The country's researchers released nanostructured air filters to filter the air intake of turbines and industrial compressors with anti-dust and hydrophobic capabilities. An air filter is a device consisting of fibers that removes solid particles such as dust, pollution and bacteria from the air. When these pollutants pass through the filter, they will be attached to its constituent fibers and will not pass through it. Therefore, the smaller the pores in the filter, the higher the efficiency of the filter and it can prevent the passage of smaller particles. In addition to the property of separating pollution, these filters also have the power to separate liquid from liquid or liquid from gas. In the production of this product, the filter substrate, which is responsible for the main function of filtration, is covered with nanofibers, which will increase the efficiency and properties of the filter. This product, which is specifically used to filter the inlet air of turbines and industrial compressors, rotary engines and dust collection systems in the industrial area, has a higher efficiency than common filters in terms of quantity and quality, and sometimes has special features such as anti-dust properties (anti-dust) and hydrophobic [20].

Reducing air pollution with industrial nano filters

Due to the increase of pollutants in the country's metropolises, one of the knowledge-based companies has released industrial nano filters to the market, which have the ability to absorb more pollutants than other filters. Due to the presence of nanofibers, this product has a much higher ability to absorb pollutants than common filters, and it is possible to trap particles below 2.5 microns in these filters. Therefore, manufacturing companies and factories can use these filters to absorb fine dust from the factory outlet, and finally, the amount of dangerous fine dust released into the environment will be minimized [21].

Decontamination of industries with polymer nanofibers

Industrial filters containing polymer nanofibers are other knowledge-based achievements of the country's researchers, which have the ability to remove polluting particles from the output of factories and are used in cement, steel, flour, plaster, vegetable oil industries and any industry that creates dust during production. The filters that are normally used in factories and industries are micro filters that do not have a high filtration capability, but nano filters have the ability to remove dust to a significant level due to high absorption and surface filtration that is done using industrial nanofibers.

Power plant filter with nanofiber technology

By acquiring nanofiber production technology, the country's researchers succeeded in the industrial production of upgraded power plant filters using this technology, which increases the annual power plant productivity by about 200 billion tomans. With the use of nano filters, we will have about one million and 400,000 megawatts of electricity production in the whole power plants of the country in a working period of the filter (one year). The average cost of each megawatt of electricity produced in the country is equal to 1,400,000 Rials, and therefore, using this technology, about 200 billion Tomans more electricity will be produced per year. Currently, Bandar Abbas Combined Cycle Power Plant uses these filters and with the use of nano filters, the depreciation of the turbine blades has been

reduced, so that for each repair period for each power plant, it will save about one billion tomans. Among the advantages of power plant filters modified with nano fibers can be increased filter life by about two times, control and no increase in pressure drop, significant increase in filtration efficiency, increase in energy conversion efficiency in automotive and power plant industries along with reducing equipment and time depreciation. Sleep and repair them and increase the level of protection of the turbine pointed out [4].

Industrial filters with the ability to collect dust

The production process of most industrial factories is accompanied by dust, and if these dust particles are not collected, they will easily enter the environment and cause its pollution. An example of this pollution is the increase of particles less than 2.5 microns in the cold seasons of the year, part of which is produced by industrial factories. Therefore, the researchers produced filters that contain nano-fiber coatings and have the ability to absorb particles of 300 nanometers. In the past, factories used micrometer filters that did not absorb high particles, but manufactured nano filters prevent the release of particles less than 2.5 microns into the air [19].

Introducing the ambient dust sensor model FMD1210-01

With the increase in environmental pollution and the importance of maintaining air quality, the ambient dust sensor has become one of the essential tools for monitoring air quality in sensitive centers including server rooms. The FMD1210-01 environmental dust sensor is able to measure the concentration of airborne particles and provide valuable information to maintain the health and safety of work and public environments.

Important features of FMD1210-01 environmental dust sensor

- ✓ **Quick response:** The ambient dust sensor model FMD1210-01 has a quick response to changes in the concentration of suspended particles. This feature allows users to quickly identify changes in air quality and take necessary actions. The quick response time of this sensor allows it to be used in environments that require accurate and immediate monitoring;
- ✓ **CAN Open Network Connectivity:** This sensor connects to CAN Open industrial networks and this feature allows you to easily send collected data to central management and control systems. This simple and integrated connection helps facilitate the monitoring and management of air quality in industrial automation systems;
- ✓ **Accuracy of particle detection in dimensions of 1, 2.5 and 10 microns:** The FMD1210-01 environmental dust sensor is specifically designed to detect particles of different sizes. Particle detection accuracy down to 1, 2.5, and 10 microns makes this sensor ideal for air quality-sensitive environments, including server rooms, hospitals, laboratories, and the food industry. With the ability to accurately measure these particles, we can help improve air quality and monitor environmental conditions;
- ✓ **Compatibility with CAN Open card model FBC0232-01:** This sensor has the ability to communicate with CAN Open card model FBC0232-01, which provides the possibility of recording relevant data by connecting the said card to FIDAQUIRE data logger model FCD6455-01 [20].

Applications of the ambient dust sensor

- ✓ **Server rooms:** The dust sensor is specially designed to monitor the air quality in

server rooms. These sensors can measure the concentration of particulate matter and ensure that cooling systems are functioning properly and damage to equipment is prevented;

- ✓ **Data Centers:** In data centers, strict control of air quality and prevention of particle pollution is very important. Dust sensors can help optimize the performance of cooling systems and energy management [21];
- ✓ **Laboratories and research centers:** To conduct scientific research and maintain controlled conditions, monitoring the air quality in these environments is very important. Dust sensors provide accurate information about the concentration of particles;
- ✓ **Sensitive industrial environments:** Such as the production of medicine and chemical products, which require strict control of air pollution. These sensors help maintain safety and health standards.

What is an AQI sensor or air quality index sensor?

Air Quality Index (AQI) is a standard measurement used to know how polluted or clean the air is in a specific area at a given time. This index is an easy-to-understand way of communicating information about air quality to the general public. The AQI index typically measures several major air pollutants regulated by environmental agencies worldwide, such as ground-level ozone, particulate matter (PM2.5 and PM10), carbon monoxide (CO), sulfur dioxide (SO_2), and nitrogen dioxide (NO) (NO_2) is considered. Each pollutant has its own scale and threshold levels that determine the AQI value. The AQI scale ranges from 0 to 500 and is characterized by the following specific categories that indicate the level of health concern related to air quality:

- ✓ **0 to 150 (normal to moderate):** This range includes air quality conditions that are considered acceptable for most people, although sometimes with concerns for sensitive groups in the upper number of the range;
- ✓ **151 to 200 (bad):** All people can experience the effects of this weather and sensitive groups are more affected;
- ✓ **201 to 300 (very bad):** Health warnings about emergency situations. Entire populations are likely to be affected and serious health effects may occur;
- ✓ **301 to 500 (Toxic):** This scale indicates a serious health warning and may have more serious effects on everyone's health due to very poor air quality.

Installation and maintenance of ambient dust sensor model FMD1210-01

Fidar electronic environment dust sensor is designed in such a way that its installation is quick and easy. This sensor can be easily used in various industrial environments. Also, due to the use of high-quality raw materials, this sensor requires little maintenance and ensures a longer useful life. The ability to connect to the CAN Open card also makes this sensor quickly integrate into large industrial networks and transfer data optimally [14].

Honeywell air pollution detection sensor

85 years after the establishment of Honeywell and 50 years after the start of its operations in Iran, in 2016 Honeywell and Iran Control Center Company have decided to further develop in the sector of providing goods and services to the final consumer. In this regard, with an innovative approach, Honeywell air purification products with the Air Touch brand and Honeywell water purification with the Aqua Touch brand, as well as Honeywell super-smart "Gadgets" with the name IAQ, have been prepared for the Iranian market. After the

successful launch of Honeywell Air touch air purifiers in December 2017, in line with long-term goals, Meka Group decided to expand and supply Honeywell air pollution detection smart gadgets. Today, measurement tools play a significant role in our lives. We have all been familiar with the first measuring tool since childhood, which is the clock. Then we continued our progress with a ruler, gunya, protractor and thermometer. Each of these tools is a touchstone so that we can better understand our surroundings and somehow take a step towards comfort or escape from possible dangers. Considering the severity of air pollution in Iranian cities, fighting with air pollution is inevitable and every fight requires the right tools. The device that shows the exact amount of PM2.5 particles, temperature and humidity is called IAQ Sensor made by Honeywell. This display also announces visual warnings by changing color. This sensor has several very important steps:

- ✓ Air enters the sensor and continues its path, and along the way, the laser passes over it;
- ✓ A photoelectric transducer converts the signals into particle size and density;
- ✓ The signal is transferred to a microcontroller to analyze the information and results of particle density with a suitable algorithm;
- ✓ The process of displaying information and commands to display screens starts;
- ✓ The blue color indicates the standard of PM2.5 particles less than 79 micrograms per cubic meter;
- ✓ The orange color indicates the dangerousness of PM2.5 particles in amounts greater than 80 and less than 199 micrograms per cubic meter;
- ✓ The red color indicates the very dangerousness of PM2.5 particles in the amount of more than 200 micrograms per cubic meter [21];

Conclusion

Environmental pollution has always been a problem that cannot be postponed in our country, and among these numerous environmental pollutions, air pollution is the most serious. Therefore, the diagnosis of air quality is of particular importance. Currently, my country is facing "Soot pollution" and "Photochemical smog pollution". While "Air pollution" is the main environmental pollution. Relevant experts in our country have found that the air contains a large number of organic compounds, including some carcinogenic substances and viruses. More and more practical examples prove that air pollution has become the "Invisible killer" of humans, and air detection is also an issue that countries around the world must face. It has been reported that more than half of the population of northern China is exposed to air pollution, which has also caused a large number of respiratory disease infections and negatively affected local production and development. The most worrying harmful gases in current air pollution are mainly: Carbon dioxide, formaldehyde, carbon monoxide, PM2.5. Sensors play a big role in our daily life. Air pollution and temperature sensors exist on a large scale in the city and living environment. These sensors can be used to control and measure air pollution, etc. A sensor is defined as a device that can convert a physical parameter into an electrical signal and display it on a monitor or display. Graphene is one of the newest materials synthesized from carbon, which is in a sheet (two-dimensional) state. It has a honeycomb structure and has very high electron mobility and very low resistance. By changing the electrical conductivity, it shows a very high sensitivity to the absorption of gas molecules (NO_2, NH_3, H_2O and CO).

In addition, because graphene has a high specific surface area and high sensitivity to less electric or thermal noise, it can be considered as one of the best materials for gas sensors. With the help of graphene, the sensitivity and resolution up to one atom or molecule of polluted gas increases. Air purity and impurities play a vital role in human health. In order to realize accurate detection of air pollutants by the detection system, the air quality sensor is equipped with formaldehyde sensor, PM2.5 sensors, TVOC sensor, temperature and humidity sensor and other sensors. In order to ensure that the components of various pollutants are affected by the current temperature and humidity of the air, the system adds a temperature and humidity sensor module, and at the same time accurately detects the temperature and humidity of the air and displays them on detector displays. The main design system of this system is: First, the gas collected by the balanced array gas sensor is identified and processed. We use an operational amplifier to amplify the collected signal and use a filter to optimize the signal and then pass. Through the signal conditioning circuit, the signal is transmitted to the MCU, and the collected data is accurately analyzed and processed through the MUC, and finally the sorted content is transferred to the display.

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