INDOOR AIR QUALITY FOR WELLBEING AND HIGH WORK PRODUCTIVITY

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Abstract: *In this paper is presented the first phases of development of the system used for improvement of indoor air quality. In order to start implementation, there was a case study on the main subject of our project and have found out the problem is an authentic one and its solution can help a lot of people to improve their health and productivity. The main purpose of the system is to inform the user about the main characteristics of indoor air, and also to give him some advice to increase its quality.*

Keywords: *Internet of Things, air quality monitoring, temperature, humidity, carbon dioxide, dust particles, air quality improvement.*

1. Introduction

Indoor air quality has a significant impact on people's health and work productivity. The most important factors that influence air quality are the factors such as temperature, humidity, dust particles and carbon dioxide level. This means that these parameters must always be in their normal level of concentration.

Generally, people spend more than 90% of their time indoors and this also shows the importance of monitoring air quality. Poor indoor air quality has many unpleasant consequences such as loss of concentration, headaches, nasal irritations, dryness in the throat, dyspnea, nausea. A report from Europe, 2011 - Promoting Actions for Indoor Healthy Air (IAIAQ) estimates that 2 million people suffer from diseases related to poor indoor air quality (Figure 1).

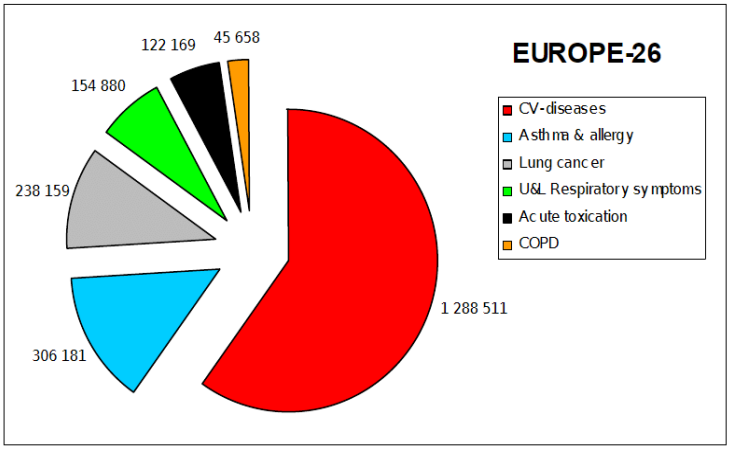

Figure 1. The IAQ associated BoD attributed to the key health outcomes. The total BoD for the EU-26 is 2 MDALY/year [1].

The most important factors to obtain a good analysis of the indoor air quality are the level of temperature, humidity and carbon dioxide level. In order to make an efficient measurement of these parameters we must automatically measure them. So, in this way people are aware about the quality of the air and are able to improve it for better health position, well-being and productivity.

Low level humidity (<25% relative humidity) causes discomfort, dry skin or irritations. High level of humidity causes condensation that facilitate the development of fungi, germs and therefore bacteria that can easily penetrate into the human body.

The most suitable temperature in the room depends on the type of activities that are practiced in it. The temperature is related to the humidity of the air, so the temperature felt depends on the humidity of the room. A good level of himidity is between 30% and 70% as this is not causing any discomfort.

The natural level of carbon dioxide (CO2) is around 400 ppm (parts per million) in the outdoor environment. A value of 1000 ppm for indoor CO2 (1800 mg / m3) is generally considered as a reference value in many European countries. Concentrations above 1000 ppm are likely to cause feelings of discomfort, such as fatigue, loss of concentration or headaches. Therefore, below 1000 ppm, we consider the quality of the indoor air as good.

2. System architecture

The general system architecture (see Figure 2) of the project includes three types of sensors, controller with Wi-Fi on board, IoT server and a mobile application. Sensors transmit data from the environment to the controller, which in turn can communicate with the ThingSpeak server that receives the data and chart it automatically. The android application makes requests for data and chart it in a user-friendly way and notify the user in case air parameters deviate from normal level.

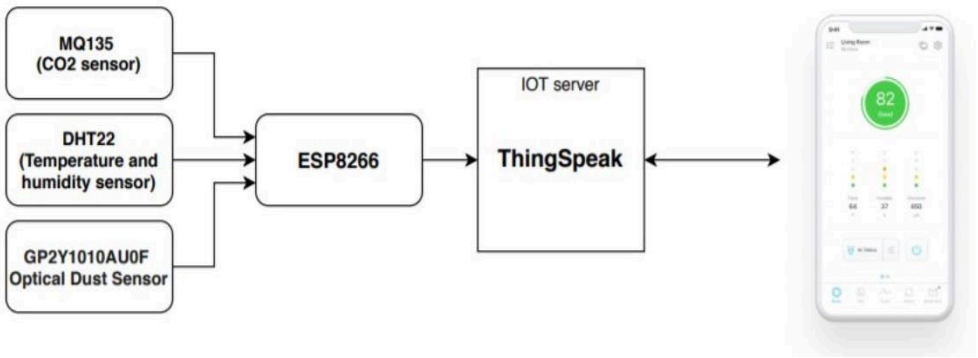

Figure 2. General system architecture

MQ135 Air Quality Sensor is a gas sensor which is used to measure the concentration of combustible gases. It has lower conductivity in clean air while its conductivity increases with the presence of the combustible gases in the air. The MQ135 comes at low cost and is suitable for project requirements. It can measure levels of NH3, NOx, Alcohol, Benzene, Smoke, CO2. Indoor air CO2 is a good measure of overall indoor air quality. Therefore, below 1000 ppm, the team considers the quality of the indoor air as good. Above 1000 ppm, the impact on health and well-being can be felt [2].

The *DHT22 Humidity and Temperature Sensor Module* is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It is fairly simple to use, but requires careful timing to grab data. The only real downside of this sensor is that one can only get new data from it once every 2 seconds, so when using the library, sensor readings can be up to 2 seconds old [3]. The DHT22 sensor is very important for the project as temperature and humidity are two factors that the team must keep track on as these are significant in work efficiency and productivity.

As the goal of the system is to improve the quality of the air, the dust and smoke particles also must be tracked on, as for the wellbeing of people a clean air is an important factor.

The *GP2Y1010AU0F Optical Dust Sensor* is small in size and can detect dust and smoke particles in the environment. It consumes very little power while it is running, making it ideal for an always-on monitoring system. The sensor has a tiny six-pin connection interface, it comes with a connector when you usually buy it. The sensor generates an analog output signal on pin5- Vo, it does not require any external components for operation and requires only a 3.3V supply, making it easy to interface with the Arduino board [4].

ESP8266 Wi-Fi Module is a complete SOC with integrated TCP/IP protocol stack that can give any microcontroller access to the Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

This module has a sufficient power on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime [5].

In the project, ESP8266 Wi-Fi module is used for transmitting data from sensors to the IoT server that processes it.

ThingSpeak is the most important platform that is used in the project. Thing Speak allows one to publish their sensor readings to their website and display them in a plot with time stamps. Then, one can access their readings from anywhere in the world. The team can also send data to ThingSpeak from machines or local gateways using REST API or an MQTT API [6].

ThingSpeak stores all the information people send it in one central location in the cloud, so they can easily access their data for online or offline analysis. The devices can also read data from a ThingSpeak channel by subscribing to an MQTT topic. ThingSpeak automatically charts the data that one sends it, so one can remotely monitor their devices or equipment from anywhere. View their data from any web browser or mobile device. Share read-only views of their data with the clients and colleagues that they specify. Alternatively, they can use ThingSpeak to manage their data, and the team can build their own front end for their clients and customers to log in to.

3. Mobile application

The final step in elaborating the project is building a user-friendly application that can achieve the main goal: informing people about the air quality to ensure a better productivity and wellbeing.

The application uses data about changes that occur in quality of air and environment, such as, increase or decrease of temperature, humidity, dust particles or carbon dioxide. There are two methods how the user interacts with the application.

- First one is when he or she opens the app and can view data and statistics in a user-friendly manner, such as charts and diagrams. These display important information about the quality of air. They are positioned based on the level of increase.
- Second way is when the user is notified by the application when a gas increases to a critical level. The notifications inform the user about the change in air and display an informative message with suggestions to the user.

The purpose of the application at this level is to make the user aware about the environment changes. In this way, the application can be used as a main factor in increasing productivity of different companies.

Conclusions

Air quality is directly proportional to human productivity and ability to perform tasks with less failure probability. It is important to track and to perform certain actions in order to improve such parameters as temperature, CO2 and dust level. Being aware of this deep connection between air quality and human wellbeing is meaningful for further activity not just of the private sector, but also of public institutions like schools, hospitals and national departments.

The presented system has the aim of informing users about the environment that surrounds them and keeping them posted on any changes that can happen to it. This solution must detect each of the parameters that influence the air quality: temperature, humidity, CO2 concentration and existing dust. Data extraction is done by a set of sensors that retrieve information about the air

condition and pass it to a Wi-Fi microchip. The app retrieves data from the database and updates the user interface, thus making the connection between the initial parameters of environment and final user. Building and using such a system represents the key in the wellbeing of employees and high productivity of the whole company.

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