11th International Conference on Electrical, Electronics and Computer Engineering (IcETRAN), Nis, 3-6 June 2024

Central measurement system for smart parks in the concept of Industry 4.0

Jovan Mastelica
Department of Power, Electronic and Telecommunication Engineering,
University of Technical Sciences
Novi Sad, Serbia
jovanmastelica7@gmail.com

Marjan Urekar
Department of Power, Electronic and Telecommunication Engineering, University of Technical Sciences
Novi Sad, Serbia
urekarm@uns.ac.rs,
https://orcid.org/0000-0002-6089-9148

***Abstract*—This paper proposes implementing smart systems inspired by Industry 4.0 in parks, forests and urban areas. These systems aim to use sensors to measure various parameters, analyze data, and generate statistics. The goal is to engage a wide audience to improve future outcomes and enhance quality of life. This system can be used via the web or a mobile application, depending on the user's choice.**

***Keywords*—ecosystem; smart parks; green areas; sensors; UV radiation; air pollution; monitoring;**

I. Introduction

Industry 4.0 has introduced huge improvements when it comes to monitoring, automation, gathering information through smart technologies. The processing of information collected through sensors provides various possibilities such as the formation of statistics, a clear insight into the current state of measured values, etc. In addition to many environmental services, green areas provide important social and psychological benefits for every person, which enrich human life in various ways. Within this idea, prototype for automation and monitoring was created with a various sensors. Purpose of these sensors is to measure all necessary parameters. This project prototype provides us a reason why people should visit such a places, the motives of the visit and the implementation of itself. Each sensor will be exposed and their role will be explained.

Fig. 1. *Ilustrative example of a town lungs* [1]

This research has been supported by the Ministry of Science, Technological Development and Innovation (Contract No. 451-03-65/2024-03/200156) and the Faculty of Technical Sciences, University of Novi Sad through project "Scientific and Artistic Research Work of Researchers in Teaching and Associate Positions at the Faculty of Technical Sciences, University of Novi Sad" (No. 01-3394/1).

By referencing to the concept of Industry 4.0 this project takes the emphasis on digital technology for recent decades to a whole new level with the help of various sensors, access to real time data and measuring various quantities. With this concept, the idea of Smart Parks would be a perfect example of automation and monitoring various quantities that can be useful for people worldwide. The main topic related to energy saving is being discussed by most engineers and people from the other branches nowadays. The main purpose of this project is to offer a healthier environment for those who spend their time in parks. Young people need to be drawn to and aware of how important it is to have a healthy environment and how important it is to have the best possible living environment. Each post-umbilical cord of an individual, both positive and negative, affects the further progress and development of the ecosystem. Any activity in such spaces can contribute to making an individual feel healthier, fresher and more social. [2]

II. Motive and Idea

The motivation is to provide the most detailed and large amount of information available to users who use the corresponding WEB or mobile application. This application would consist of a series of measured values and parameters, the value of which is obtained and recorded through sensors that are placed on the appropriate parts of the green areas. An effective way to make good preparation for the realization of a smart park is to graphically present a 3D representation of the future smart park on the computer. This realization can be done using a drone. The user would guide the drone from the ground, which has a camera inside it, with which it would perform mapping.

In simple words, drone mapping is about taking measurements based on photographs. The drone actually captures a large overlay of images and thus renders maps and 3D models that resemble a realistic view of the park. Drone mapping uses a range of technologies including photogrammetry, LiDAR (Light Detection and Ranging) [3] and SLAM (Simultaneous Localization and Mapping) to create high-resolution images and data that can be used for various research, applications in agriculture, construction, environmental monitoring. After recording the park, they would open a graphic 3D view of the smart park on the computer and in one place they would have a clear view of the places where appropriate sensors could be implemented. [4]

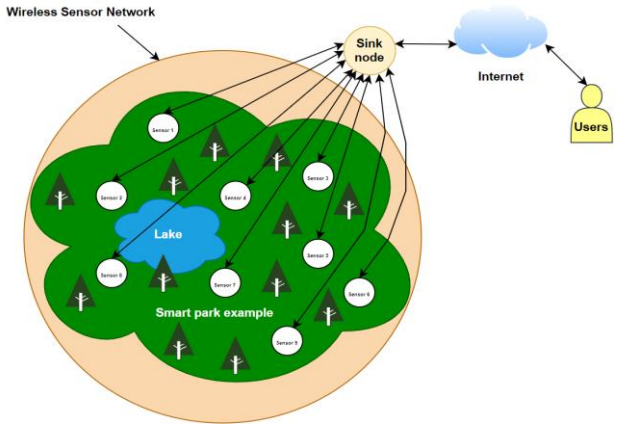

Fig. 2. *Ilustrative example of sensor implementation inside of smart park*

By provided 3D view, we would decide which places are the best to place the appropriate sensors. Also, a lot of factors influence whether the choice of a place for the implementation of rearing sensors is good, and some of the factors are:

- Placing different sensors in the same place
- External factors affecting the operation of the sensor
- Mutual distance
- The price

The very advancement of technology in the field of electronics has led to the development of extremely precise and smart sensors that would give very clear measurement results, resulting in real insight into our environment and impact on our health. Some of the sensors that would make up such a smart park system are:

- UV radiation detection devices
- Temperature sensors
- Air humidity
- Sensors for the detection of allergens and other particles

IoT was the basis of previous projects and works, and it provides a clear understanding of how much pollution is present in our environment. In addition to measuring air pollution, this work also includes other parameters that make up a very useful and complex system. [5] Every sensor that was mentioned above has a unique node architecture. This architecture is consisted of the blocks that can be found on the following picture:

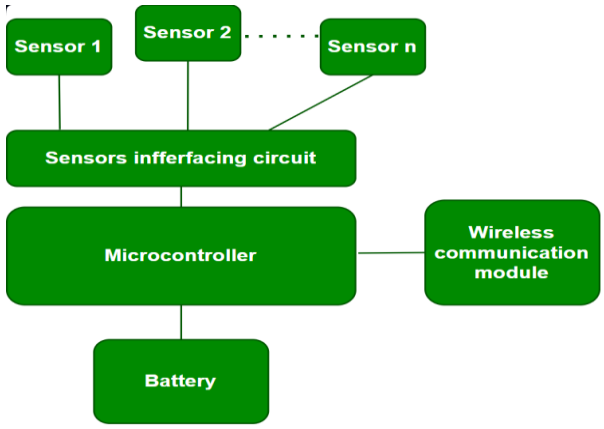

Fig. 3. *A simple representation of the sensor node architecture*

The sensors inside of the smart park would be connected to the Arduino development board via a breadboard, through which they would be powered and send information to the main Sink Node. Each place where a sensor would be implemented would have to have its own Node that would communicate with the main Sink Node. Depending on the terrain and its environment, some PCBs would have more or less sensors whose task would be to measure various parameters. Sensors would be mounted in smaller housings due to various environmental influences such as rain, humidity, exposure to the Sun or dust. Each sensor would collect information whose values would be sent for further processing and would be available to every user. Also each of those sensors would be networked to a common database within an application that could be downloaded on tablets or mobile phones. Users would create their own account on the application where, by further developing the application, fields related specifically to their health condition could be filled in, where the application could give advice based on the given information about the user and measured parameters within the park. The sensor part of our system communicates via the Internet with a server to which all the measurements taken by the sensors are sent. Their communication is based on the server sending queries to the microcontroller which individually polls one sensor at a time, retrieves its measurement data and sends it to the server.

Within the application, each user would have a clear picture and overview of the current state of various green areas, starting from parks and ending with any other green areas. The very advancement of technology in the field of electronics led to the development of extremely precise and smart sensors that would give very clear measurement results, as a result of which we would have a precise insight into our environment and our health. The user would fill out fields within the app related to their health condition as well as things that the person is sensitive to. One of the possible field ideas that could be implemented within applications is allergy to dust, pollen or other allergens. After the user would leave information and a parameter of his health condition, the application would make calculations and look for the optimal time when it is the right moment to go to the smart parks.

For example, depending on the amount of allergens, dust, pollen, smoke and other gases in the air, the sensors would send results that would be further processed and thus end up on the application that the user had previously installed on his mobile. If the percentage of allergens in the air were higher than the allowed or expected value, the application would inform the user that there is a chance of being exposed to allergic reactions, increased pollen in the air. The sensors that would be implemented inside the smart park would have continuous monitoring, where the user would have instant information about the situation in the smart park at any time of the day or night. The information that would reach the user would be sent via a Wi-Fi network.

III. WHY IT IS IMPRTANT TO BE AWARE OF UV RADIATION

Considering that the Sun is generally strongest between 10:00 and 16:00, phenomena that affect the strength of UV radiation are: altitude, cloudiness and surface reflections, asphalt, etc.,

can also determine where and when the Sun is strongest. Sensor that was described here is shown on picture above [7].

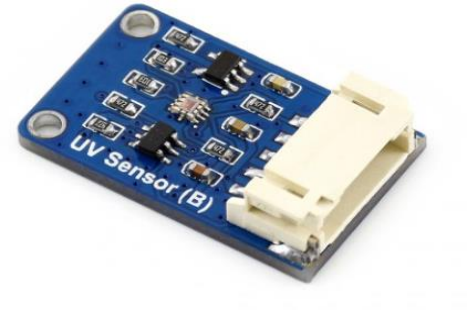

Fig. 4. *Sensor for detection of UV radiation* [7]

This tells us that one sensor is not enough to get a clear picture of where and when the Sun is strongest and how long we can be exposed to the sun's rays. [6] Sensors for the detection of UV radiation could be implemented on individual benches in the park or in the shell of some other mentioned sensors, where they could measure the temperature throughout the day. In this way, every user who had this application with him could decide, based on the processed data, whether it is the right time to go for a walk at a given moment. Regardless of whether people in the park spent time in the shade under a tree, they would still be exposed to UV radiation. One of the sensor models that could be used in the realization of a smart park is the Ultraviolet Sensor. This sensor is an ultraviolet chip that directly emits the UV index value via I2C communication. It is compatible with levels from 3.3 V to 5 V. [7]

Specifications of sensors for detecting ultraviolet light [7]

Features	***Specifications***	***Pinouts***
Integrates Si1145 chip with embedded ADC, detects not only ultraviolet, but also ambient light intensity	Operating voltage: 3.3 V ~ 5 V	VCC: Power input, 3.3 V/5 V
Directly output UV index value via the I2C interface, needs no calibration	Dimension: 26 mm × 16 mm	GND: Ground
Supports interrupt output, programmable upper/lower threshold	Mounting hole size: 2.0 mm	SDA: I2C data pin
Onboard voltage translator, compatible with 3.3 V/5 V operating voltages	Operating temperature: –40 ~ +85 °C	SCL: I2C clock pin

IV. WHY IT IS IMPORTANT TO TAKE CARE OF AIR POLLUTION

Fig 5. *Example of sensors for measuring air pollution* [9]

The impact of air pollution on health has been the subject of intense study in recent years. Air pollution is known to directly interact with our brain cells in the short term, changing the way they communicate with each other, especially in the regions that control our emotions. This could partly explain why some people exposed to high levels of air pollution experience anxiety and depression. [8] Placing such air quality sensors in parks could appear in areas of parks where pollution is at its highest. These sensors would be implemented in the parts where the park ends in order to have the measured limit values of air pollution in that part. It is also an idea to place the same sensors in the central parts of the parks, whose area is much larger, so that their measured value can be compared with the values of the sensors at the ends of the park. Monitoring would be carried out without interruption. Depending on the concentration of certain gases in the air, the application would send users the measured values and give a suggestion as to whether it is the right time to visit the smart park and spend time in it at a given moment. The sensor that would be implemented to measure air pollution would be the AKT420. It is a device that measures up to the four most common pollutants, such as: nitrogen dioxide (NO_2), nitrogen monoxide (NO), sulfur dioxide (SO_2), carbon monoxide (CO), hydrogen sulfide (H_2S) and ozone (O_3) and weather data, such as humidity, air pressure and temperature, plus measures particulate matter (PM 2.5 and PM 10) in the air. Measurement data would be sent wirelessly to a database on the Internet that would be accessible to users who would like to visit a given location. With the help of this sensor, we have covered most of the parameters that are measured at a given location. The idea would be to implement this kind of sensor in 3 to 4 places within one park. In this way, they would cover a large part of the surface of a park. [9]

V. CONTINUATION OF RESEARCH

The use of sensors to detect UV radiation could be implemented on individual benches in the park, where these sensors could measure the temperature throughout the day. In this way, every user who had this application with him could decide, based on the processed data, whether it is the right time to go for a walk at a given moment. Regardless of whether people in the park spent time in the shade under a tree, they would still be exposed to UV radiation. This smart park system would contribute the most to people who like to go out into nature and spend time there organizing picnics, doing physical activities or walking their pets. It would also improve and raise the standard of quality of stay inside smart parks, where they would gradually receive the values of the measured parameters. Of course, there are exceptions to the placement of the appropriate sensors, as only one may be needed at a location. Therefore, a special node must be provided in that place, which will carry out further communication and which will provide the sensor with power for smooth operation. In this way, the number of nodes would increase, but this would be a specific case where the measured value of a parameter or quantity from that place would be of great importance for further analysis. It is enough for the device to print the values of the appropriate parameters at a given moment, by categories for children, adults and the elderly, whether it is desirable to be exposed to parameters that

are not desirable for humans and, if so, how long is recommended.

Further research would aim to reduce the number of Nodes and increase the effective operation of the sensors. This could be done by implementing a larger number of sensors in a suitable place within the memory park, where one Node would consist of several sensors.

Further steps in the development of such an idea would be to implement this kind of smart park system in as large a number as possible, where statistics could be developed on a global level, and not on the level of one city. In this way, additional attention would be drawn to future users, and they would also reduce the negative external impact on individuals who would adhere to the indications obtained by sensors, artificial intelligence and the application. Due to the use of such an application, the desire of a large number of people to further improve the parks by planting additional plants would surely arise, where they would strengthen the lungs of a city at least a little.

VI. Conclusion

Industry 4.0 represents the complete digitization of all processes and the application of digital technologies when creating the idea of a measuring system. The improvement of the park can be reflected in the complete connection with measuring devices and sensors that provide all users with clear information about the current state inside them. The introduction of a central measurement system for smart parks is very suitable for use in Industry 4.0, due to its high efficiency, accuracy in measurement and high accessibility of the measured parameters. Contributions in this work are that information about the measured parameters is sent to the users and that they have a clear insight into the state that is there based on them. Statistics have the potential to influence the global development and expansion of smart parks. Further research and improvement of a system can be facilitated by such statistics, leading to even better, more precise, and useful results.[10] With this idea, the digitization of the future smart park was achieved. As stated earlier, this work offers solutions that could improve the life of every person in places where nature exists in a very small percentage. This idea of realizing a smart park system gives people a chance to influence their own health and the state of their environment on a global level. Therefore, the idea would certainly raise awareness of the importance of preserving our environment. It is important to emphasize that during the implementation of such an idea on a global level, a very serious system could be formed, which could certainly improve and increase the quality of life on the planet. In this way, we would enable monitoring that would follow all possible phenomena over long distances and we would have a clear insight into how far the pollution of both air and other things has reached. By using a huge database when developing this idea on a global level, very clear statistics would be formed that would indicate the course of events. With the help of analysis, we would react preventively to the expansion or to the construction of an even greater number of smart parks, which would affect the negative parameters on a global level to be reduced as much as possible. Such an idea could certainly be realized in a relatively short time and could be put into operation very quickly. The first phase of the realization of such an idea would take a slightly longer period of time due to the fact that it is necessary to create a mobile application, create statistical analysis and create such a system. With the completion of the first phase, a very large part of the work would be completed. The rest would be upgraded and added to the application, the system would be multiplied and the only thing left is the manual placement of nodes and sensors in various places inside the park.

References

[1] Lungs of town https://www.chinadaily.com.cn/a/201904/23/WS5cbe47c4a3104842260b7a04.html

[2] Air pollution and health Prof Bert Brunekreef, PhD Prof Stephen T Holgate, MD Published: October 19, 2002 https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(02)11274-8/abstract

[3] What is LiDAR? National Ocean Service https://oceanservice.noaa.gov/facts/lidar.html

[4] What is simultaneous localization and mapping? (SLAM) https://www.flyability.com/simultaneous-localization-and-mapping

[5] J-Park Simulator, an intelligent system for information management of eco-industrial parks, Published: August 21-24, 2017 https://www.sciencedirect.com/science/article/pii/S1876610217360551

[6] Peck, M. (2018, August 02). City of Hope. Retrieved from https://www.cityofhope.org/living-well/what-is-uvradiation-and-why-is-it-harmful

[7] Ultraviolet UV sensor https://www.waveshare.com/uv-sensor-b.htm

[8] Planetary Health and the Future of Human Capacity: The Increasing Impact of Planetary Distress on the Human Brain https://www.researchgate.net/figure/Air-pollution-and-greenspaces-multiple-pathways-to-the-brain-Once-inhaled-pollutant_fig1_329132267

[9] Air quality sensor AKT420 https://www.vucomm.rs/kvalitet-vazduha/spoljni-senzor-kvaliteta-vazduha-kt420.php

[10] Environment Pollution Analysis on Smart Cities Using Wireless Sensor Networks, Published: December 28, 2022 https://journals.riverpublishers.com/index.php/SPEE/article/view/19337