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Development of an Internet of Things-based Environmental Information System for Realtime Monitoring of Air Conditions

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ABSTRACT

This study aims to develop an environmental information system called the Environmental Monitoring System (EENNOS) to monitor air environmental conditions. ENNOS is an Internet of Things (IoT) based system that monitors air environmental conditions in the form of temperature, humidity and carbon dioxide. The research was conducted using the 4D development method which consisted of the Define, Design, Develop, and Disseminate stages. EENNOS was developed using a DHT 22 sensor for DHT 22 temperature and humidity and a carbon dioxide sensor with MQ-135. The controller used is Arduino uno ESP8266 with output sending using the internet to the database and presented on the dashboard and displayed on a 16x2 liquid crystal screen. The output is in the form of dashboard innovations that are registered with copyrights and scientific publications in the form of articles in the Journal of Environmental Sciences.

KEYWORDS

Arduino
Air Conditioning
EENNOS

1. Introduction

Real climate change occurred with the extreme weather that hit the city of Surakarta. After flooding in 15 urban villages as a rainy season phenomenon in February 2023, the people of Surakarta City are facing a dry season which is predicted by the Meteorology, Climatology and Geophysics Agency (BMKG) to start in early March 2023 (www.bmkg.go.id). However, entering the end of March 2023, the City of Surakarta actually experienced a storm as a result of Cyclone Herman.

The extreme weather that occurs is a reciprocal of community activities that produce greenhouse gases (GHG). Greenhouse gas products will increase global and local atmospheric warming by people who are active in Surakarta City. For example, the estimated emission of carbon dioxide in the City of Surakarta is 729,961 tons of CO2/year and increased to 1.36 million tons of CO2e/year in 2013. The largest producer of energy consumption is road transportation used by the people of Surakarta City and commuters from the surrounding area (Sunarto dkk, 2016).

Indonesia from 2017 to 2019 was flooded with an increase in motorized vehicles. Since two years ago, the number of motorized vehicles has increased by around 5 percent. The population number of motorized vehicles in 2018 was 118,922,708 units, showing an increase of 5.9 percent compared to 2017. Furthermore, 2019 recorded an increase to 133,617,012 units from the previous year or an increase of 5.3 percent (BPS, www.bps.go.id)

The increase in the number of motorized vehicles increases the need for an environmental information system to monitor exhaust emissions in the form of carbon dioxide (CO2). Manual monitoring has the disadvantage of having to allocate time and manpower at the location. The information system will improve monitoring efficiency by using an Internet of Things (IoT) based Environmental Monitoring System (ENNOS).

EENNOS will provide real-time and continuous information for 24 hours regarding the level of air pollution gas carbon dioxide (CO2), humidity conditions, and temperature at the location.

EENNOS also displays information about temperature changes caused by the gas through the device screen. The internet connection used makes it easy to monitor temperature and carbon dioxide conditions from anywhere.

This research develops EENNOS as an environmental information system which consists of developing dashboards, circuit boards, and cases. Dashboard development is carried out to display measurement results that can be read by visitors to this information system. The EENNOS dashboard is presented online and functions as an interface sub-system by basing the gap on the dashboard of another party, namely ThingSpeak.com. A sub system interface will be created to display measurements per 15 seconds. Measurement data is presented on the dashboard of each point.

The development of circuit board circuits is based on effectiveness to meet the criteria for running the measurement function. The components that will be used in building this measurement sub system are controllers and sensors. The controller will make arrangements for data collection from sensors that work in response to environmental conditions. Sensors and controllers require an arrangement on a circuit board that ensures they work as a system for detecting ambient CO2 levels, humidity, and temperature.

Development of cases for protection of EENNOS at installation sites, power supply lines, and control ports. This container sub-system has a role for the protection of the measurement sub-system and aesthetic interests. The receptacle shall allow the metering sub-system to work with the mains support and controller control lines.

Monitoring environmental conditions in real time and continuously recorded in a good database is a necessity at this time. Development of an Environmental Information System in the form of EENNOS fulfills this need.

2. Method

This research is part of the fulfillment of the research Roadmap in the field of Environmental Information Systems. At this stage, EENNOS is part of realtime monitoring. This condition can help present data for various purposes and especially in this case from the side for the benefit of systematic environmental monitoring. The EENNOS development roadmap that will be developed can include environmental, health, disaster, radiometric, and deep learning interests. As presented in Figure 1, the EENNOS roadmap can be used as an environmental information system for displaying incoming data, monitoring or monitoring, early warning, further development is also related to predicting events or involving decision making from Artificial Intelligence.

The method of conducting this research uses the 4D development model, which consists of Define (defining), Design (model design), Develop (model development), and Dissemination (socialization) (S. Thiagarajan dkk, 1974). The flow of research implementation is presented diagrammatically as shown in Figure 2.

3. Results and Discussion

The development of the EENNOS system for the manufacture of this tool was selected by the NodeMCU device as the main controller and also equipped with the MQ-07 sensor as a sensor for detecting air pollution levels in the form of carbon dioxide (CO2) and the DHT11 sensor as a temperature detector in the area around the air environment.

Definition of the EENNOS Environmental Information System

The EENNOS Environmental Information System consists of inputs obtained from temperature, humidity, and carbon dioxide sensors. Temperature and humidity sensors use DHT 22 while carbon dioxide sensors use MQ-135. The results from the sensor are forwarded to the controller to be processed as data on environmental conditions of CO2, humidity, and temperature using the Arduino Uno ESP8266.

The development of EENNOS from the hardware side is carried out on the circuit board with the specified arrangement as shown in Figure 1. With regard to the case, the required functions and outdoor conditions must be considered. Arduino Uno Esp8266 needs to be connected to the DHT22 sensor where it is necessary to pay attention to the cable pins used and the MQ-135 sensor which has four pins to connect to the controller.

EENNOS Development of The hardware side is done on the board the circuit with arrangement determined as in Figure 1. In connection with the container (case) must be consider required function _ as well as condition outside room . Arduino Uno Esp8266 need connected with a DHT22 sensor where you need to pay attention to the cable pin used and the MQ-135 sensor which has four pins to connect to the controller.

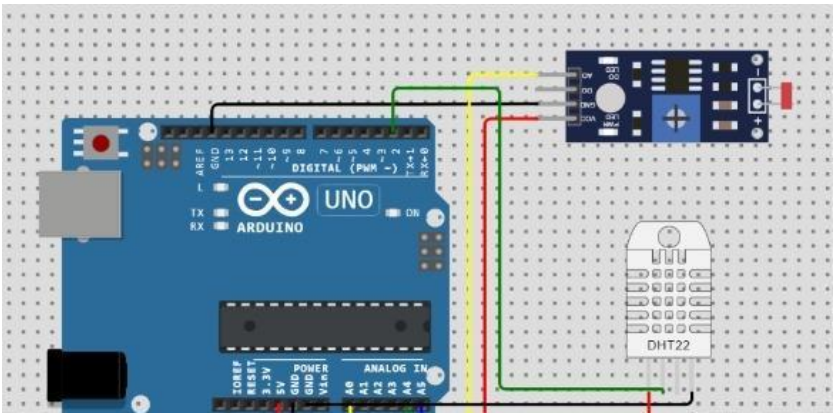

Figure 1. Arduino Sensor Schematic

Prepared hardware given receptacle certain For makes it easier storage and management . Temporary container This use used receptacle food so that role in use return (reuse) for subtraction waste as presented in Figures 2 and 3.

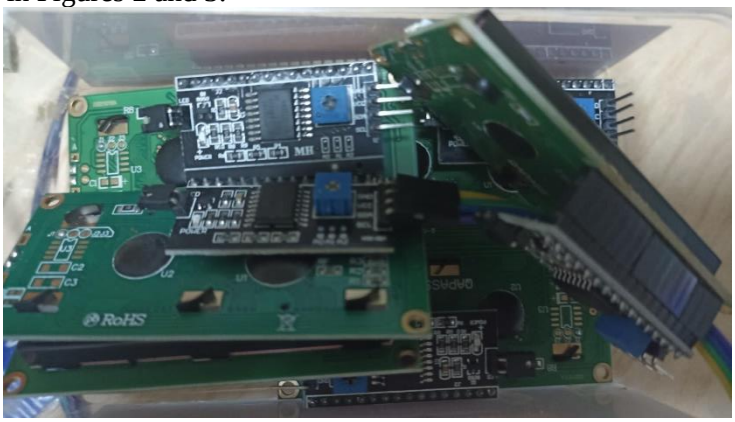

Figure 2. *Hardware model* in the form of controllers and sensors used in EENNOS

Figure 3. *Reuse* food containers For keep EENNOS *hardware*

NodeMCU is a microcontroller already be equipped with the ESP8266 WIFI module inside , so NodeMCU Actually The same just like Arduino only just own excess Already has WIFI, so suitable for IoT projects. NodeMCU as an interactive Firmware LUA based Espressif ESP8266 WIFI SOC. The NodeMCU ESP8266 has 4MB flash, 11 GPIO pins (10 of them Can used for PWM), 2 pairs of UART, 1 ADC pin, 2.4GHz WiFi as well supports WPA/WPA2, NodeMCU can also be programmed with using LUA and C language using Arduino IDE (M. F. H. Wicaksono, 2017).

Figure 4. NodeMCU ESP8266

MQ-07 is a gas sensor is used in equipment For detect carbon gas monoxide (CO). This sensor is a perfect fit For detect CO gas with range CO gas detector with range detection start from 20 to 2000ppm (Parts per Million) for powerful measure carbon gas monoxide . Shape of this Sensor similar with the MQ-3 Sensor used For detect alcohol. This sensor own High sensitivity and time _ fast response . _ Sensor output in the form of analog resistance . The driver circuit is very simple , which is what is needed only supply 5V power for heater coil, add load (RL), and connect the Output to the ADC. Structure and configuration of the first MQ-07 gas sensor The sensor material is tin dioxide (SnO2). MQ-07 has 4 pins, 2 pins are used For take signal , and 2 pins are used For give heating of the Sensor material (A. Rasyid, 2020).

As for the sensor other namely , DHT11 is a digital sensor that can measure temperature and humidity the air around you. This sensor also has good stability as well as feature accurate calibration . coefficient calibration saved in One Time Programing (OTP) program memory , so that when the sensor detects something , then module This enclose coefficient the in calculations . This sensor including Sensors that have quality best , rated from response , fast data reading , and anti-interference capabilities . Small size , and with transmission signal up to a radius of 20 meters (M. A Sebayang, 2017).

Figure 5. MQ-07 sensor

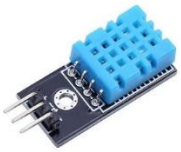

Figure 6. DHT11 sensor

Internet Access Gadgets

Internet access is possible use a number of gadget type , start from desktops, laptops and smartphones. The most mobile gadget option possible brought everywhere is a smartphone. Under development system information EENNOS environment , in addition to desktop and laptop, is necessary notice access to the system via smartphone.

Smartphones are telephone handheld that has ability with use and function resembles a computer. There are n't any yet standard the factory that determines the meaning of Smartphone. For some people, Smartphones are working phone _ use all over device soft system operations that provide connection standard and basic for developer application . In other words, a Smartphone is computer small who have ability A telephone . Growth request will tool sophisticated as can be brought everywhere makes _ progress big in processing , memory , layers and systems outside operations _ track phone handheld since a number of year this (I. T. M. Daeng, 2017).

In the case of the Arduino Uno ESP8266 software connected to the DHT 22 and MQ-135 sensors connected with using the following program:

```
#include <DHT.h>
#define DHTPIN 0
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);
int MQ135 = A0;
int digitalPin = 2;
void setup() {
  Serial.begin(9600);
  dht.begin();
}
void loop() {
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float v = analogRead(MQ135) * 5.0 / 1024.0;
  int quality = digitalRead(digitalPin);
  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.print(" %\t Temperature: ");
  Serial.print(t);
  Serial.print(" *C\t MQ135 Voltage: ");
  Serial.print(v);
  Serial.print(" V\t MQ135 Quality: ");
  Serial.println(quality);
  delay(2000);
}
```

Figure 7. Source Code Censor

The measurement results from the MQ-135 and DHT22 sensors will come out after programming. The next results can be displayed via the interface. The ESP8266 is connected via the internet to a dashboard. The index results and all temperature temperatures are displayed to produce a website-based dashboard output. Arduino instruments and sensors are provided with a case to protect the monitoring equipment from water or extreme weather.

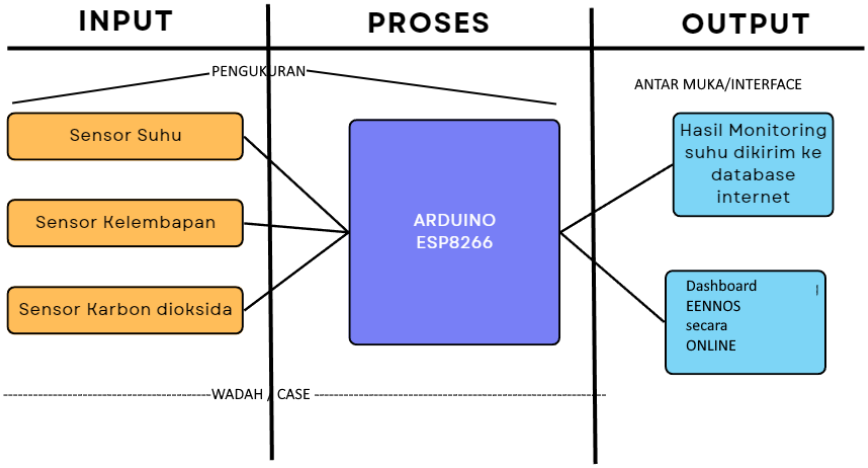

Figure 8. EENNOS System

Furthermore, as an output, data from the Arduino is presented in the form of a database which is installed on the internet and presented to the dashboard. In this case, both are EENNOS interfaces *which* are prepared online so they can be accessed from anywhere and at any time as long as there is an internet connection.

2. Design of the EENNOS Environmental Information System

The form of a flow diagram of an algorithm in a program that states the direction of the program flow in solving a problem.

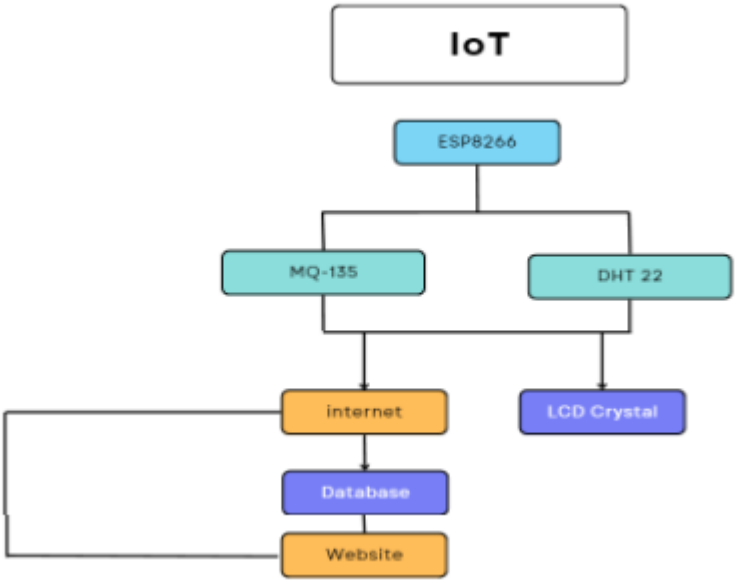

Figure 9. ENNOS Environmental Information System Design

Development of the ENNOS Environmental Information System

There are three sensors that will be tested at various points on the UNS Kentingan Campus and considering the signal quality at the installation site so that the data produced by the sensors is sent to the dashboard easily. The sensor installation was carried out by a team of students and assisted by the Environmental Information Systems Laboratory. The two stages required in this development are as follows.

a. *Expert* Appraisal (Expert Appraisal)

Expert appraisal is a technique for getting suggestions for improvements to the design. Assessment by experts and obtaining suggestions for improvements. The ENNOS Environmental Information System was developed and then revised according to expert suggestions. Expert judgment is expected to make EENNOS more effective, function well, and provide a good monitoring process.

b. *Developmental Testing* (Development Trial)

Development trials were carried out to obtain direct input in the form of EENNOS responses in the form of measurement data flows as well as experts on the EENNOS Environmental Information System that had been prepared and tested. Trials and revisions were carried out repeatedly with the aim of obtaining an effective and consistent tool (Thiagarajan et al, 1974).

The DHT22 sensor in the program will read the temperature and humidity in the surrounding environment, while the MQ-135 sensor will read the air quality based on the analog output voltage received. This information can then be sent into a database and displayed on the website. With the information produced by these sensors, users can monitor environmental conditions in a room or area in real-time, and take action to improve environmental conditions if necessary. The results of the THI calculation in the classification of comfortable, uncomfortable and very comfortable will proceed to the collection and evaluation stage

Dashboards are information management tools that receive data from linked databases to provide data visualization. These typically offer high-level information in a single view that end users can use to answer a single question. In many cases, they can be configured to provide specific information to the end user and how this information is visualized. For example, Numbers, charts or graphs.

EENNOS dashboard gives users from all different businesses the ability to monitor performance, create reports, and set estimates and targets for the future. The benefits of data dashboards can be to present visuals of performance, identify data trends, measure efficiency, a

means to produce detailed reports. dashboards can also be used for the capacity to make more informed decisions, total visibility of all systems, campaigns, quick identification of outliers, and data correlation.

In addition to the above, dashboards can be very useful when providing real-time data, which is automatically updated with the latest information. Having real-time data is pertinent for many businesses, especially app marketers who want to optimize their campaigns as quickly as possible for maximum success.

Dashboards cannot be confused with reports, although both are important tools for assessing historical data, but they differ in their presentation. The dashboard displays live data that is dynamically updated while the data in the report is inactive. Similarly, the meaning of dashboards is for ongoing monitoring and interaction with data while reports are used periodically, such as quarterly or annually, and present a static view of data.

Figure 10. EENNOS dashboard that can be accessed on EENNOS *Online* Already get Property Rights Intellectual

4. Conclusion

EENNOS Development as internal monitoring tool management condition air based *Internet of Things* has succeed developed For measures humidity and temperature. As ah unity system so has made *dashboards* System Information EENNOS environment featuring results reporting condition air *Internet of Things.*

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