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Utilization of Neural Network for Local Processing on the Internet of Things (IoT)

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ABSTRACT

This research is intended to produce a smart sensor system using a Neural Network which is implemented through the design of an Occupation monitoring tool and application (presence). Sensor equipment uses Arduino UNO, EST8266 Wifi, DHT22 and LDR. The readings of these sensors are then sent remotely via the internet and read by the application. Based on the research training conducted, a prediction model will be born where this model will translate the sensor data received and then generate data on the presence in an environment where the sensor is placed. IoT sensor tools and applications that are placed in several locations are very useful in carrying out daily human activities such as monitoring security in the home environment, schools, offices and warehouses for storing goods.

KEYWORDS

Internet of Things (IoT); Neural Network (NN); sensors; security; human environment

INTRODUCTION

Environmental monitoring is a mechanism for measuring environmental changes that is carried out repeatedly so that we can study patterns, structures and functions related to the environment. Once we know the environment well, then we can control the environment in a better way. One of them is by monitoring changes in the surrounding environment such as monitoring humidity, temperature using sensors (Martin, A. H., et.al, 2019).

In measuring this environmental change, humans can use various sensor devices that have increasingly diverse functions, such as in the transportation environment, dozens of sensors are needed for transportation equipment to work, ranging from simple sensors to sensors based on Micro Electromechanical System (MEMS). In modern homes, various sensors are found, such as thermostat and infrared sensors to detect motion and gas sensors to detect gas leaks in the air. The mobile phones that we hold today also have various kinds of sensors such as touch sensors, image sensors, inertial sensors, magnetic sensors and environmental sensors such as temperature, pressure and humidity.

The sensors we use today are becoming more and more diverse and have functions that we never imagined. Combining a microchip device with multiple sensors makes the sensor better and smarter than ever. The term Smart Sensor is applied to sensors built like this. Smart sensors will provide much more information by processing measurement data obtained with various data processing methods. The currently available microchips are smaller and require less power, reducing the complexity of sensor design. There are even some microchips that are equipped with data transmission facilities with Wifi and Bluetooth, where continuously measured data can be sent to a storage area (server or cloud computing) with internet media. Usually the sensors that can send data remotely are called the Internet of Things (IoT).

When the sensor measurement data is obtained, a series of data evaluation processes must be carried out. The process of evaluating sensor data is defined as a scientific method

for measuring, analyzing and interpreting data as a form of response to the observed situation

The most effective approach in processing sensor data can be done with Intelligent Methods such as fuzzy, Neural Network, data aggregation, classification and clustering. The advantage of this method is that it can process numeric and linguistic type data simultaneously and can also analyze non-linear relationships that occur in the data. The results of the interpretation of sensor data with this method can be generated with a high accuracy value. Neural Network (NN) models are widely used in obtaining predictive data. This is because this model is very suitable for analyzing non-linear trend data that appears in several variables. This model can adapt to data that contains a lot of noise. The estimation results generated by the NN model have high accuracy if the parameters used can be determined correctly.

LITERATURE REVIEW

Internet of Things

The term Internet of Things (IoT) became known in 1999 when it was first mentioned in a presentation by Kevin Ashton, cofounder and executive director of the Auto-ID Center at MIT. According to Ashton Internet of Things (IoT) is defined as a technology that allows for control, communication, cooperation with various hardware, various data, virtualizing all real things into the form of the internet, and others through the internet network. (Destyan Wayusih M, 2017)

According to Lewis T. Lewis in a speech in Washington D.C. the term Internet of Things is the integration of people with connected technology and sensor devices that can access them remotely and can manipulate and evaluate these devices (Wikipedia, 2020).

Security System

Network security system is a process to protect and prevent unauthorized/unknown people. Connecting a device such as a camera, sensor device to a computer network security system is important to anticipate disturbances and threats and can maintain existing resources (Nasution, AM et.al, 2021)

Neural Network

In 1943, Warren McCulloch and Walter Pitts collaborated to research the formulation of how to determine the performance of the human brain. Through electrical circuits They make imitations of human nerves. In 1949, Donald Hebb strengthened the concept of neural work through writing in his book The Organization of Behavior. Donald Hebb explains that the pathways of electron flow in nerves become stronger after use. In 1950, Nathaniel Rochester of the IBM research laboratory succeeded in performing the first simulation of a neural network. In this year also, Rossenblatt discovered 2 layers of neural network which later became known as perceptron. In this perceptron, the inputs can be combined by adding weights and when entering the next layer, the weights can be applied. This information was accessed on October 3 2020 at https://www.sas.com/id_id/insights/analytics/neural-networks.html

Nowadays, neural networks are able to perform several tasks, such as recognition classification, approximation, prediction, clustering and memory simulation (Suhartono, D. 2012).

Arduino UNO

Arduino is an open source physical computing platform based on a simple input/output (I/O) board and a development environment that implements the Processing language.

(Banzi, Massimo, 2008). Microcontroller is an electronic brain that can control other electronic devices. Arduino UNO is a microcontroller variant that has a memory chip of the ATMega type

DHT11. Temperature and Humidity Sensor

This DHT11 Temperature and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor complex. (DFRobot. (2012). This DHT11 sensor has a calibrated temperature and humidity setting with a digital signal output. With a good digital signal detection technique at temperature and humidity, it produces a sensor that is reliable and has long-term stability.

RESEARCH METHODS

The methodology in this thesis is adopted by collecting data. The data is then analyzed for problems and adjusted to the needs. This data is adapted to the workings and environment of the system to be designed. In this study, the data that will be used as a benchmark for the system training process is existing data (secondary data). In this way, research will be easier because it is cost-effective.

Research activities are carried out starting from studying the problem and designing a system that is able to solve the problem. Therefore, several steps were implemented, namely:

Collecting data

Data collection is a procedure in obtaining data, measuring and analyzing it accurately using standard validation techniques. In conducting this research, the data used is of secondary type

Analyzing Data

The data obtained has several information fields such as data number, date, temperature, humidity (humidity), brightness (light), CO2 content, Humidity Ratio and human presence (Occupancy). Some sample data can be shown in table.1

Table 1. Occupancy

No	Date	Temp	Humidity	Light	CO2	Humidity Ratio	Occupancy
1	2/4/2019 17:51	23.18	27.272	426	721.25	0.004792988	1
2	2/4/2019 17:51	23.15	27.2675	429.5	714	0.004783441	1
3	2/4/2019 17:53	23.15	27.245	426	713.5	0.004779464	1
4	2/4/2019 17:54	23.15	27.2	426	708.25	0.004771509	1
5	2/4/2019 17:55	23.1	27.2	426	704.5	0.004756993	1
6	2/4/2019 17:55	23.1	27.2	419	701	0.004756993	1

Based on the need, the data fields that are suitable for measuring instruments in the field are temperature, humidity, brightness (light) and Occupancy. So that the data that is used as training data on the neural network is shown in table 2 below:

Table 2. Training Data

Temp	Humadity	Brightness/Light	Occupancy
23.18	27.272	426	1
23.15	27.2675	429.5	1
23.15	27.245	426	1
23.15	27.2	426	1
23.1	27.2	426	1
23.1	27.2	419	1

Analyzing and Designing Systems

The process of System Analysis and Design in this study is divided into 3 parts, namely:

- Selection of the Artificial Neural Network Model to be used
- Measurement Device Selection
- Software Development

Data in the form of variables from temperature, humidity, brightness of light and human presence are converted into numerical form to be recognized by the network and can be processed by applications. The artificial neural network model used is the Backpropagation network

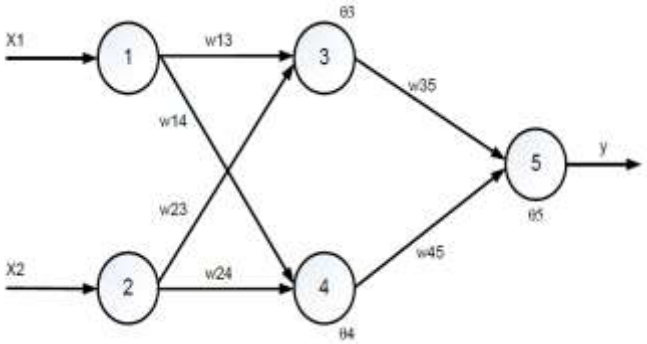

Figure 1. Artificial Neural Network Model

Hardware design

The device chosen for measuring temperature, humidity and room brightness is the DHT22, while the light sensor is the Light Dependent Resistor (LDR). While the input control device for light brightness, temperature and humidity data input, it takes a board called Arduino UNO that uses a microcontroller called ATMega328. The circuit of the Arduino UNO board with LDR and DHT11 sensors can be shown in a schematic form in Figure 2

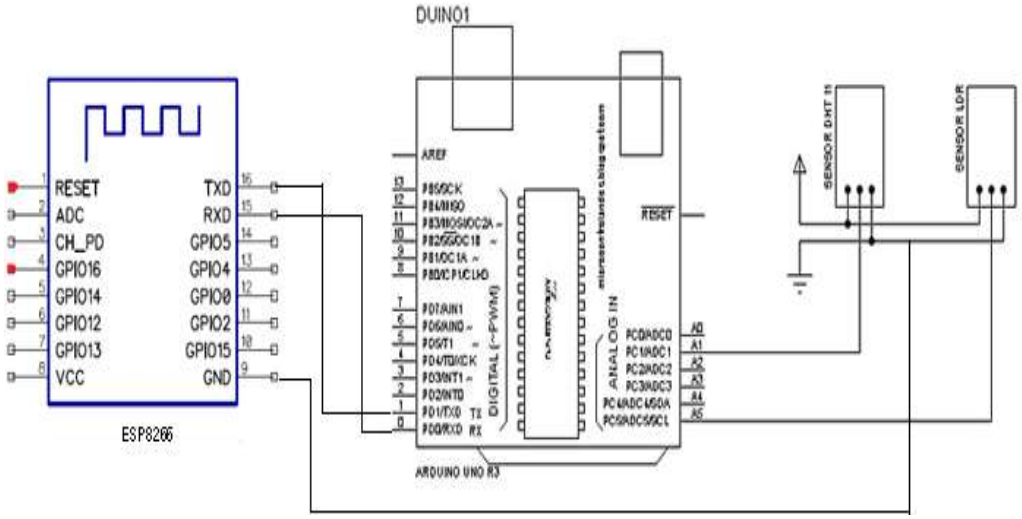

Figure 2. Schematic

Software Design

Software design for this measuring instrument consists of:

- Microcontroller activation software placed inside the Arduino UNO . microcontroller
- Data reading software placed on a laptop or PC.

RESULTS AND DISCUSSION

In testing the system, three components are needed, namely hardware (PC, Arduino UNO Microcontroller, DHT11 Sensor, LDR), software (Windows 10, Sublimetext, WindIDE, Python, Arduino IDE) and - brainware (System analysis, Programmer, Public)

Neural Network Modeling in Python

The initial stage is reading the data and then storing the data in array and table format. The data will be used as training data and testing data on the Neural Network model based on data criteria (input variables) and models (structure and parameters) to obtain optimal results (MSE value < 10% and correlation value > 80%) in predicting the Occupancy value.

Based on the stages of data preparation, determining the type of model, the structure of the Neural Network model and its parameters, the modeling will be formed with the following conditions:

- Entering data
- Creating Neural Network models
- Doing training
- Doing testing
- Application development
- Final application

The following is a view of the implementation through a finished application that has a window component, each of which has its own function.

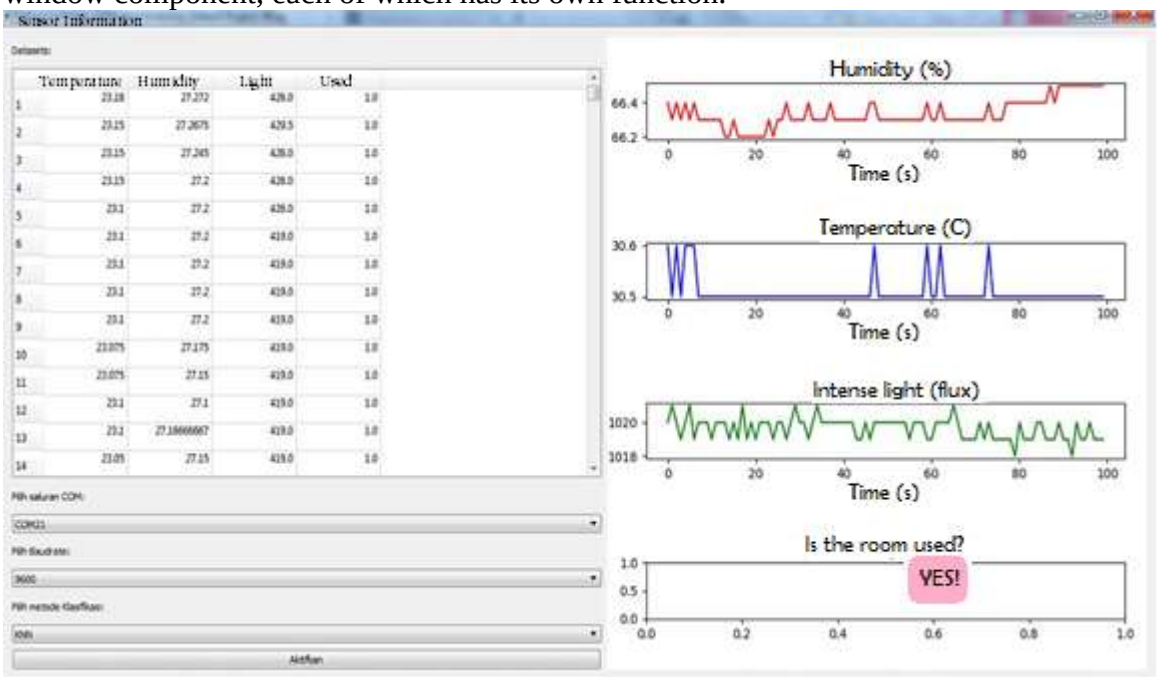

Figure 3. Application monitoring display

The monitoring image on the left shows the training data in the form of tables of temperature, humidity, light and room conditions. While on the right of the image there is data on temperature, humidity, light in the form of a graphic display based on the DHT11 sensor, humidity and graphs of the presence of people in a room.

CONCLUSION

From a series of tests carried out, it can be concluded that to predict the occupancy value of a person in a room, the use of the Neural Network method is good enough to use, through a

sensor device that can display a fairly precise prediction accuracy, even though the data is quite long and based on the local environment. different. Thus, these sensor methods and tools can be used as an alternative to help represent security activities such as remote monitoring in residential areas, schools, offices and factories and storage of goods.

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