Internet of Things (IoT) for Urban Detailed Spatial Plan with Zoning Map

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Abstract. The purpose of this research is to create a system consisting of hardware and software for measuring area, circumference and other environmental parameters such as altitude above sea level, temperature, humidity, slope, soil pH and soil water content. Data measurement results cannot only be stored on the device but can be forwarded to the web server to be processed into a zoning map. The method used is to obtain GPS coordinate data from the smartphone to determine the location of the land, calculation of area and circumference and altitude above sea level. Meanwhile, to measure soil pH, the water content in the soil, slope, temperature, humidity used several sensors. All this data is sampled by the microcontroller and transmitted serially to the smartphone. Furthermore, all this data is sent to the web server and processed using the web service to generate zonation maps. The results of this study provide an ease impact for surveyors and help the city government to determine the function of land to be effective and can be monitored properly.

1. Introduction

Internet of Things (IoT) is the concept by which the device can communicate with the internet, either to send data or to receive data. Many areas are supported by the internet of these things, for example for the field of transportation, agriculture, health and smart city. Especially for mapping the land in order to support the detailed urban planning plan, the internet of things has a role ranging from measuring the area and circumference of the land, the measurement of environmental parameters, accepting the proposal of the citizens to make it a zoning map that becomes information for the government or citizens [1,2]. City spatial planning is important to determine the direction of land functions in the area. This can be started by conducting land surveys and creating zoning maps. There are many benefits of zoning maps such as:

- Improved mapping – better access to maps, improved map currency, more effective thematic mapping, and reduced storage cost.
- Greater efficiency in retrieval of information.
- Faster and more extensive access to the types of geographical information important to planning and the ability to explore a wider range of ‘what if’ scenarios.
- Improved analysis.
- Better communication to the public and staff.
• Improved quality of services, for example speedier access to information for planning application processing.

To conduct a spatial survey is usually done by surveyors using measuring tools, recording and making zoning maps, which means there are several stages of work and requires a relatively long time. Previously there has been a measurement of land and environment based on smartphones, but not yet complete with some environmental parameters required and the absence of automatic zoning map creation [3]. In this study, the new thing to do is to create a spatial survey system that not only measures the area and circumference of the land, but is already equipped with some environmental parameter data that is, the temperature and humidity, soil pH, soil water content, the slope of the land, the height above the sea level. In addition, the measurement data can be stored in 2 modes, both offline on smartphone and online, where data is forwarded to the web server for the process of making zoning maps based on GPS data and comes with environmental parameter data.

The method used is to take the GPS data from the smartphone to calculate the area and circumference of land with haversine equation. Then the data read temperature sensor data and humidity, soil pH sensor, water content in the soil sensor and land slope sensors. This data is then combined in the form of array data and sent to the web server. On the web server is equipped with a web service to process the data, so it becomes a zoning map that contains extensive information and circumference of land, altitude above sea level, temperature and humidity, soil pH, soil water content and slope of land. Based on this information, the government can map the land and utilize the land properly.

The purpose of this research is to create a system consisting of hardware and software for measuring area, circumference and other environmental parameters such as altitude above sea level, temperature, humidity, slope, soil pH and soil water content.

2. Methods

Each field of land has a function according to its designation as set forth in Republic Indonesia Act No. 26 of 2007 on Spatial Planning. In addition to the functions attached to the land there is an area that is generally characterized by physical boundaries on the land. Since the change in function in the area of land is very drastic as the impact of rising urban population growth and the process of transformation of economic structure from the former based on the primary sector (agriculture) to the secondary and tertiary sectors (industry, services and trade) to meet basic human needs in the form of development of facilities and infrastructure of the city that practically can not be avoided anymore. Therefore, in order to control and controlled land area, the technical aspect must be monitored periodically and rapidly so that the information of the change of the land function can be known by overlaying the current function of the observed land to the data of land function in year previously stored in the data base [4]. Based on the data of land change, the government can monitor the land use change and can take follow up to support the development.

2.1. Global Positioning System (GPS)

GPS stands for Global Positioning System which is a system for determining position and navigation globally by using satellite. The system first developed by the US Department of Defense was used for both military and civilian use (surveying and mapping). The GPS system, whose real name is NAVSTAR GPS (Navigation Satellite Timing and Ranging Global Positioning System), has three segments: satellite, controller and receiver / user. GPS satellites orbiting the earth with orbits and fixed positions (the exact coordinates) [4-6].

2.2. Microcontroller

The Nano dreamer is the microcontroller board of the newest Arduino and is an embedded microcontroller of Atmega 32U4. This nano dreamer has a direct USB as a media upload program. The nano dreamer specifications as follows [7, 8]:

• Based on ATmega32u4
• Operating Voltage:5V
- Input Voltage (recommended): 6.5-12V (VIN) / 5V (Micro USB)
- Input Voltage (limits): 6.5-12V

**Figure 1.** Microcontroller arduino nano.

2.3. *Temperature and humidity sensor*
DHT 22 is a digital sensor that can measure the temperature and humidity of the surrounding air. It has a good level of stability and highly accurate calibration features. This sensor will receive the response of temperature and humidity from outside then stored in OTP program memory. Pin from VCC, Gnd, Data and one pin unused. The required working voltage of this sensor is 3.5-5V [8-10].

**Figure 2.** DHT 22 sensor.

2.4. *pH meter sensor*
The pH Meter Sensor is used to measure the pH (acidity or alkalinity) of a liquid or solution, but it can also measure the acidity of the soil and can be used to pH semi-solid matter pH. The pH meter sensor measures the difference in electrical potential between the pH electrode and the reference electrode. Usually has a glass electrode with plus a reference electrode column Figure 3, Figure 4, and Table 1 [10, 11].

**Figure 3.** pH meter sensor.
3. Results and discussion
In order to test the functionality and performance of the system, we have been done several indoor and outdoor test. A lot of data was collected such as position based on GPS, altitude, temperature and humidity and another information about locations. All of the data are sent to the cloud and was calculated and stored in cloud storage. Based on those data, zoning map was created as shown below. (Figure 5, 6, 7)
Figure 5. Testing result (Purwakarta).

Figure 6. Testing result (Lembang).
Figure 7. Testing result (Batu Nunggal).

According to the results above, the system was able to build a mapping zone based on GPS data from devices. There a various geometry form based on a various testing area, as well as shown with zoning map. For GPS Data there is a little bit different with manual measurement result due to GPS accuracy. All zoning map gives the information about area and circumference of the land, altitude sea above level, slope, temperature and humidity and soil pH.

4. Conclusion
To establish a zoning map required land measurement, and one of its methods uses GPS. The system has been created, not just measuring the area and circumference of a land but already equipped with the measurement of the land parameters. All these data are subsequently successfully sent to the web server and processed to become a zoning map. The information presented is a land zoning map with support information, which can be used as a reference for the government in determining the function and managing the land.

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