IoT-driven Environmental Support System for Smart Cities

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Abstract— Smart city is a concept of urban development that integrates information and communication technology (ICT) to enhance efficiency, quality of life, and environmental sustainability. The implementation of smart city has become increasingly popular in the last five years, with many countries developing smart city initiatives, such as the "Smart City Pilot" program in China and the development of smart city applications and platforms in the United States. In Indonesia, several major cities have started developing various digital applications and platforms to improve public service efficiency and encourage economic growth. However, there are still some challenges that need to be addressed, such as inadequate ICT infrastructure, lack of supportive regulations and policies, and insufficient active participation from the community. The use of IoT in smart city plays an important role in collecting real-time data from various connected sensors and devices, allowing for more accurate and timely decision-making. In the long term, this can help improve the overall quality of life of the community. In Indonesia the smart city movement is being intensively implemented by the government with the aim of creating 100 smart cities, so there needs to be efforts made to increase the development of smart cities in Indonesia.

Keyword: arduino, energy, environmental, iot, smart city

I. INTRODUCTION

Smart city is a concept of urban development that integrates information and communication technology (ICT) to enhance efficiency, quality of life, and environmental sustainability. In the past five years, this concept has become increasingly popular, and many countries are developing smart city initiatives. In China, the central government established the "Smart City Pilot" from 2013, and there are currently more than 2.080 cities participating in the program [1]. In the United States, several cities such as New York and San Francisco have developed smart city applications and platforms to improve public services and the comfort of citizens. In Indonesia, the central government and several cities are also beginning to develop the smart city concept as an effort to improve the quality of life and public services.

The implementation of smart city in Indonesia is being applied to improve the quality of life and public services for the people. Several major cities in Indonesia, such as Jakarta, Bandung, Makasar, Surabaya, Semarang, Yogyakarta, Denpasar and Banyuwangi, have begun to develop various digital applications and platforms to improve public service efficiency, enhance the quality of life of citizens, and encourage economic growth [2]. However, despite the development of smart city implementation in Indonesia, there are still some challenges to be addressed, such as inadequate ICT infrastructure, lack of supportive regulations and policies, and a lack of active participation from the community. Therefore, collaboration between the government, community, and private sectors is crucial in realizing the smart city concept in Indonesia.

One important aspect of smart city development is a strong and reliable ICT infrastructure, including fast internet networks, sensor technology, and software to collect and analyze data. The Internet of Things (IoT) plays a vital role in smart city utilization [3]. IoT allows for real-time data collection from various connected sensors

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and devices, enabling more accurate and timely decision-making. With the use of IoT in smart city, more accurate and real-time data collection can help the government make better decisions and optimize the use of city resources. In the long run, this can help improve the overall quality of life for the community.

IoT is a technology concept that connects various electronic devices and sensors to the internet, allowing these devices to communicate and exchange data automatically. With internet connectivity, IoT devices can be accessed and controlled remotely through digital applications or platforms, providing convenience and comfort for users.

One aspect of smart city is smart environment, which is a focus on the use of ICT to improve environmental sustainability and the quality of life of the community. Smart environment includes the use of sensor technology, data analysis, and artificial intelligence to monitor and manage various environmental aspects such as air, water, and soil quality, as well as waste, energy, and transportation management [4].

Sustainable energy management with IoT is the use of IoT technology to optimize the efficient and sustainable use of energy. IoT enables real-time data collection and monitoring from connected devices, allowing for more accurate decision-making in energy management [5].

In Indonesia the smart city movement is being intensively implemented by the government with the aim of creating 100 smart cities [6], so there needs to be efforts made to increase the development of smart cities in Indonesia.

II. METHOD

The methods used in this research are:

Literature review: Conduct a literature review to study the technology and equipment needed to develop Automation using IoT sensors. Additionally, study the methods for developing sensors and using IoT in smart cities.

Sensor design: Create a design for LDR and IoT sensors that meets the requirements. Determine the type of hardware to be used, such as microcontrollers, LDR sensors, and other electronic components. Additionally, create the necessary software, such as an application that can process and display data from the sensor. Sensor design is carried out in the form of a prototype.

Evaluation: Evaluate the development of LDR and IoT sensors. Measure sensor performance, analyze data, and assess the effectiveness of using sensors in smart city development.

III. RESULTS AND DISCUSSION

The implementation of the Internet of Things (IoT) in the field of environment can be realized through the use of the Arduino electronic platform.

A. RESULT

Arduino can serve as the core of an IoT system that connects various environmental sensors, such as temperature, humidity, and air quality sensors, to the internet. By using Arduino as the controller and connector, data collected by these sensors can be processed and analyzed in real-time, providing valuable information for environmental monitoring and management. Through creativity and innovation in the development of Arduino-based projects, we can enhance our understanding of the environment and drive more effective efforts towards environmental conservation and sustainability.

Arduino is an open-source electronics platform based on easy-to-use hardware and software, designed for both beginners and professionals. According to the official Arduino website, "Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online." Arduino is widely popular among makers, hobbyists, and educators, due to its accessibility and versatility in creating a variety of projects. As the website further states, "Arduino is an open-source hardware, software, and content platform with a global community." The

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availability of resources, tutorials, and community support has made Arduino a leading platform in the maker movement [7].
LDR (Light-Dependent Resistor) sensor is an electronic component that can detect the intensity of light and convert it into different resistance values. This sensor works based on the principle that the brighter the received light, the smaller the resistance value, and conversely, the darker the received light, the larger the resistance value. LDR sensors are widely used in various applications, such as in automatic lighting systems, room temperature regulation based on light intensity, agricultural system control, and so on. LDR sensors are often also called photoresistor sensors [8] .
Ultrasonic sensor is a sensor that uses ultrasonic sound waves to detect distance and obtain information about the surrounding environment. This sensor uses the same principle as sonar used in submarines and ships to detect sea depth. Ultrasonic sensors send ultrasonic sound waves to the target and then measure the time it takes for the wave to return to the sensor. From this time measurement, the sensor can calculate the distance to the target [9].
Servo is one type of motor designed to produce precise motion. This motor is different from ordinary DC motors because it has the ability to control very accurate position or rotation angle. The servo consists of a motor, gearbox, controller, and potentiometer. The motor is used to move the shaft in and out, which can be rotated up to 180 degrees, while the gearbox functions to slow down the motor's rotation speed. The controller is used to adjust the shaft position based on the received signal, and the potentiometer functions to measure the position or rotation angle of the motor [10].

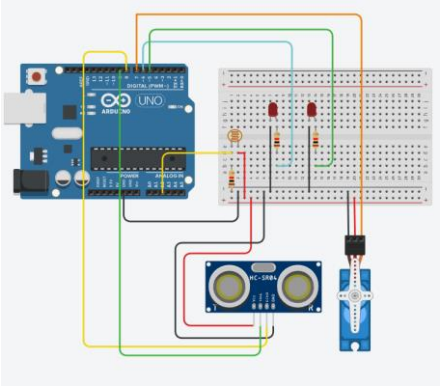

Figure 1. Example of Schematic for Smart City

The code below is an example to control garden lights so they will turn on automatically when the light intensity is low using the light sensor.

LDR §

```
const int pinSensor = A2;
const int pinLed = 6;
int data;

void setup() {
  pinMode(pinSensor, INPUT);
  pinMode(pinLed, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  data = analogRead(pinSensor);
  Serial.println(data);
  if(data >= 100)
  {
    digitalWrite(pinLed, LOW);
  }
  else
  {
    digitalWrite(pinLed, HIGH);
  }
}
```

Figure 2. Example of Code for Smart City

B. DISCUSSION

The result of this prototype design uses several sensors for automation to support the concept of a smart city. The sensors used are LDR, ultrasonic, and servo sensors. The LDR sensor in this prototype is used as one of the sensors that detects light. If the intensity of the received light is low, the existing lights will be turned on automatically, while if the intensity of the light is high, the lights will turn off automatically, thus supporting the smart city concept of a smart environment

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where energy usage is more efficient compared to not using sensors.

In addition, there is an ultrasonic sensor installed in the parking area to detect the number of parked vehicles. With the ultrasonic sensor, the maximum capacity of the parking area can be determined. If the parking area is already full, it will send a signal to the drivers to find another location to park, thus avoiding congestion. This is one implementation of smart mobility that allows residents to easily move to different locations. Finally, the last sensor used in the prototype design is the servo, which is used as an automatic gate that can be used in housing complexes. The gate will automatically open if the person recognized is allowed, thus increasing the security within the residential complex.

Figure 3. Example Smart City Design

From the results of making these miniatures, it can be seen that it will increase interest in student interest in developing smart cities using IoT devices.

IV. CONCLUSION

From various explanations above, it can be concluded that the use of IoT or Internet of Things in the concept of smart city is very important to improve efficiency, quality of life, and environmental sustainability. By utilizing sensor technology and IoT devices, various data and information can be collected and analyzed in real-time, allowing for more accurate and timely decision-making by governments and communities. In addition, IoT also enables various devices and sensors to communicate and exchange data automatically, thus improving efficiency and productivity in various sectors such as transportation, energy, and the environment. However, the use of IoT in smart cities also needs to be balanced with strong and reliable ICT infrastructure and supportive policies, so that the concept of smart city can be implemented well and provide benefits to the entire community.

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