Development Of An AI-Powered Biogas Production Prediction Model For Smart Gobar Gas Systems

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Abstract
The Smart Gobar gas or Biogas monitoring system is a gadget used to monitor Gobar gas or Biogas plants in rural areas. The device can monitor the plant's condition and nearby activities via a camera. The system is associated with the technology field of biogas plant autonomous monitoring, specifically a form of plant monitor and early warning system.
Biogas, generated by anaerobic digestion of organic material, provides a sustainable and renewable energy source in rural regions. The variable nature of biogas generation presents obstacles for its proper application. This study suggests creating an AI-driven model to forecast biogas production in intelligent biogas systems, facilitating better management and usage of this important resource.

Keywords: Gobar gas plant optimization, Sustainable rural energy, Biogas digester monitoring, AI in agriculture, Renewable energy prediction.

INTRODUCTION

Gobar gas, sometimes referred to as biogas, is an environmentally friendly fuel produced through the anaerobic breakdown of organic substances such as cattle manure. It provides a hopeful remedy for rural communities dealing with energy shortages and difficulties in managing garbage. The sporadic and unpredictable nature of biogas generation impedes its efficient use.
Intelligent biogas systems utilize sensors and monitoring technology to gather data on characteristics such as temperature, feedstock composition, and pressure inside the biogas digester. The data contains vital information about the biogas generation process and can be used to forecast future production.

1. Background of the Research

The system includes a wireless collection terminal 1 placed inside a biogas digester, a wireless collection terminal 2 placed outside the biogas digester, a wireless data transmission terminal, and a remote monitoring center. The wireless data transmission terminal, wireless collection terminal 1, and wireless collection terminal 2 create a star network structure and communicate wirelessly following ZigBee protocols. The wireless data transmission terminal and the remote monitoring center are linked through a GPRS network and the Internet, enabling wireless communication between them. The remote monitoring center consists of a computer and a data server. The system utilizes solar energy for electricity, is user-friendly, cost-effective, and enables both dispersed and centralized maintenance and control of rural methane digesters.

Gap of research:

- The current innovation does not utilize a humidity sensor to monitor plant humidity.
- In the current innovation, no camera is employed to capture images of surrounding activity.
- The plant monitoring gadget does not have a display screen.
- The current innovation lacks a web or mobile application.

2.1 Literature Review:

Various researchhas investigated the use of machine learning and artificial intelligence (AI) to predict biogas production. A support vector machine (SVM) model was used to estimate biogas yield from operational factors with an accuracy of 82.3%. utilized a deep learning technique with Long Short-Term Memory (LSTM) networks to predict biogas output. The results showed better accuracy than conventional machine learning models.

The research emphasizes the potential of AI-powered algorithms for predicting biogas output. Further study is necessary to:

Create models customized for intelligent biogas systems, considering their distinct data streams and operating features.

Examine how incorporating expertise in a specific field and information from sensors might enhance the precision and adaptability of AI models.

Examine the ethical implications and possible prejudices linked to utilizing AI in rural development initiatives.

2. Methodology

The study suggests creating an AI-driven model to forecast biogas production in intelligent biogas systems. The methodology will consist of the following steps:

3.1 Data Collection:

Data from smart biogas systems, such as temperature, pressure, feedstock composition, and biogas production volume, will be acquired in real-time from sensors.

Existing historical data on operating parameters and biogas production from gobar gas plants can enhance the dataset.

Data preprocessing at 3.2:

The gathered data will undergo a cleaning process to address missing numbers and outliers.

Feature engineering methods can be used to derive important characteristics from the original sensor data for training models.

3.3 Development and Training of the Model:

Several AI models, including LSTM networks, artificial neural networks (ANNs), and ensemble approaches, will be examined and contrasted based on their predictive capabilities for biogas production.

The selected model will undergo training using preprocessed data, with a focus on improving hyper parameters to maximize prediction accuracy.

3.4 Evaluation and Validation of the Model:

The model will be assessed using a distinct test dataset to determine its generalizability and performance on new data.

The model's prediction accuracy will be assessed using metrics such as mean squared error (MSE) and R-squared.

4. Anticipated Results

An AI model that is precise and dependable for forecasting biogas production in intelligent biogas systems.

Enhanced comprehension of the variables impacting biogas generation by examining the results of an artificial intelligence model.

Improved decision-making skills for operators of biogas plants, allowing them to enhance feedstock management, forecast energy availability, and enhance system efficiency.

3.2 DETAILED DESCRIPTION OF THE RESEARCH

The shown versions of the subject can be comprehended by referring to the drawings, where similar elements are identified by corresponding numerals consistently. This description provides examples of specific embodiments of devices, systems, and techniques that align with the subject matter described here.

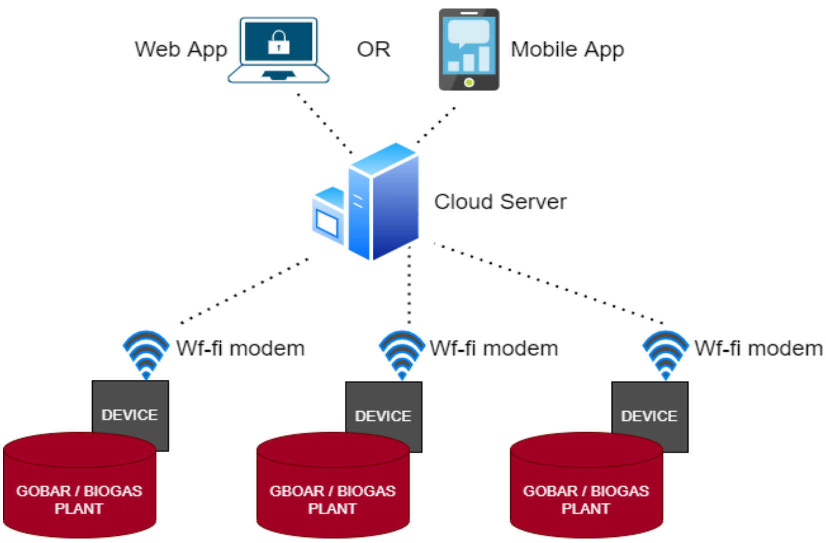

Figure 1 illustrates the fundamental setup of a smart device within a Gobar gas or Biogas plant.

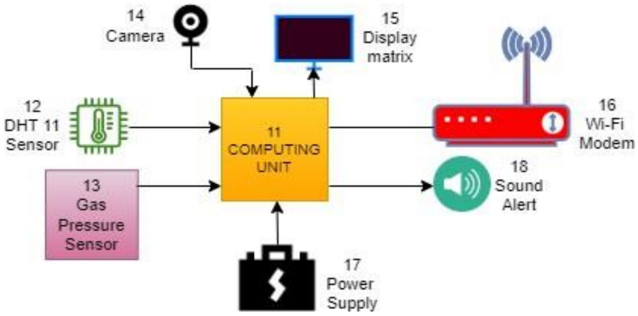

Figure 2 displays the inside structure of a smart device.

The figures show examples of the current topic matter for illustrative purposes only. Someone with expertise in the field will readily identify from the description that there are other versions of the structures.
The methods demonstrated here can be used without deviating from the principles of the described disclosure.

3. BEST METHOD OF WORKING:

Figure-1 illustrates the fundamental setup of a device in a gobar gas or biogas plant. A gadget is installed in a specific plant equipped with a Wi-Fi modem. The device regularly checks the plant and sends the data to a cloud server via a wi-fi modem. Data from the cloud server can be accessed via a mobile application or a web application. Every gadget is given a distinct ID that allows us to pinpoint the plant's position. We can create a sound alert through an application to protect the plant from dangerous behaviors.

Figure-2 illustrates the internal mechanisms of the smart device. This monitoring and alert device includes a central computing unit connected to a DHT 11 sensor for temperature and humidity detection, a gas pressure sensor, a camera for visual monitoring, a display screen, a Wi-Fi modem for data transfer, a sound speaker for alerts, and a power supply battery.
The intelligent device is installed at the biogas facility. The processing unit collects temperature and humidity data from the DHT 11 sensor, gas pressure data from the gas pressure sensor, and visual information from the integrated camera to display these inputs.
Utilize an integrated display unit to transport data inputs to the cloud server using a Wi-Fi modem. After data is stored or uploaded to the cloud server, a mobile or web application is utilized to access the data for monitoring purposes. We can create a sound alert using online or mobile applications to safeguard the plant from dangerous actions. We may assess the plant monitoring record on a weekly and monthly basis using mobile or web applications.
Once the temperature exceeds its upper limit, the smart device will send an SMS or popup alert to the application, allowing the owner to take appropriate action.

4.1ADVANTAGES

- Biogas is designed to monitor gas pressure in gobar gas or biogas plants in rural areas.
- It can also monitor the temperature and humidity of gobar gas or biogas plants in rural areas.
- The current research also offers alerts regarding dangerous actions in the vicinity of a gobar gas or biogas plant in rural areas.
- The owner can manually operate it using a mobile or online application.

4. Conclusion

This overview introduces key principles in a simplified manner, which are elaborated on in the complete description of the innovation.
This overview does not aim to pinpoint crucial or fundamental innovative ideas of the research, nor does it aim to establish the extent of the innovation.
To provide a clearer explanation of the benefits and characteristics of the current research, a detailed description will be given by referring to specific embodiments shown in the accompanying drawings. The drawings show typical embodiments of the research and should not be seen as restricting its breadth. The innovation will be discussed in detail along with accompanying drawings.
Biogas, also known as gobar gas, is a clean, non-polluting, and cost-effective energy source commonly used in rural areas. The substance consists of methane that is highly flammable, with a composition ranging from 60 to 75 percent. A biogas plant, sometimes referred to as a gobar gas plant, utilizes a digestion process to produce biogas from cattle manure. A smart monitoring system capable of monitoring temperature, humidity, and gas pressure needs to be deployed. An additional camera should be connected to this gadget to observe the surrounding activity.
The computing unit collects temperature and humidity data from the DHT 11 sensor, gas pressure data from the gas pressure sensor, and visual information from the integrated camera. It then displays these inputs on an integrated display unit and sends the data to a cloud server using a Wi-Fi modem.

After data is stored or uploaded to the cloud server, a mobile or web application is utilized to access the data for monitoring purposes. An audible alert is triggered via online or mobile applications to safeguard the plant from dangerous actions. The plant monitoring record is analyzed weekly and monthly using mobile or web applications. Once the temperature exceeds its upper limit, the system will send an SMS or popup notice to the application for the user to respond accordingly.

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