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Pet Tracking System Using Telegram Notification

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ABSTRACT

This research aims to design and implement a pet tracking system using GPS Neo-6M and LoRa SX1278 modules with Telegram integration for real-time location monitoring. The system consists of a transmitter unit using Arduino Nano, a GPS module, and a LoRa module to send coordinates. The receiver uses a LoRa module and an ESP8266 microcontroller connected to the internet, which forwards the GPS data to a Telegram bot. The test results show that the system successfully sends accurate location data from the pet's location to the owner via Telegram. This system is suitable for areas with limited internet coverage, offering low power consumption and long-range communication. It enhances the safety of pets through real-time monitoring and is highly applicable in various outdoor scenarios

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1. INTRODUCTION

In the early stages of human civilization, people adopted the practice of domesticating animals as an alternative to the physically demanding and uncertain hunting lifestyle. As humans began to care for and raise animals, they shifted toward a more sedentary lifestyle, establishing permanent settlements. Over time, the relationship between humans and animals deepened, with pets becoming an inseparable part of daily life. Today, domesticated animals range from common pets like cats, dogs, hamsters, and even snakes, to livestock such as goats, cows, buffaloes, and fish[1].

Monitoring pets in large numbers or allowing them to roam freely can be difficult due to the challenge of controlling these animals. This is especially true when animals are foraging or wandering around open fields or farm complexes. Examples of animals that are difficult to monitor include cats, goats, and cows[2].

Therefore, thanks to the significant advancements in technology, particularly in the field of communication and information, it is now much easier to access information and communicate using smart devices like smartphones. This development can be utilized to monitor the whereabouts of pets that are allowed to roam freely in open areas, as is often seen in some farming systems. Such open-grazing models benefit farmers by reducing the need to manage feed supplies. However, these systems carry risks, as animals can become lost or trapped. Hence, there is a need to implement a pet monitoring system that leverages modern telecommunications technology[3].

Currently, monitoring systems are widely based on the Internet of Things (IoT), utilizing the Global Positioning System (GPS) as a location-tracking tool through smartphones or other monitoring devices. IoT can be described as the capability of various devices to connect and share data over the internet. It represents a technological advancement that allows control, communication, and cooperation between hardware devices, as well as data exchange via the internet[4].

Thus, IoT occurs when objects or devices are connected to the internet without requiring direct human operation. GPS becomes very useful in monitoring moving objects, including humans, animals, and vehicles. GPS is used in various applications, including navigation, location tracking, and logistics management. By integrating GPS with IoT systems, users can monitor and track the locations of various objects effectively and

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efficiently[5]. This research aims to design and implement a pet tracking system using GPS Neo-6M and LoRa SX1278 modules with Telegram integration for real-time location monitoring. The system consists of a transmitter unit using Arduino Nano, a GPS module, and a LoRa module to send coordinates. The receiver uses a LoRa module and an ESP8266 microcontroller connected to the internet, which forwards the GPS data to a Telegram bot[6].

Although monitoring systems are available, most existing solutions rely on GSM, WiFi, or Bluetooth-based communications[18]. These methods have several drawbacks:

1. GSM-based systems require continuous network coverage and incur recurring subscription fees[19].
2. WiFi-based systems have limited communication range and are dependent on existing infrastructure[20].
3. Bluetooth-based trackers have limited range and are impractical for monitoring in open fields.

These limitations make them unsuitable for large farms, rural environments, or situations where network coverage is unreliable[21]. Therefore, a pet monitoring system is needed that is:

a. Low-cost (no recurring fees or additional application costs),
b. Energy-efficient[22],
c. Capable of long-distance communication,
d. Integrated with an easily accessible platform[23].

Therefore, the use of Lora SSX1278 and Telegram is very appropriate for this project.

2. METHOD

The research method involves hardware and software integration, consisting of two main units : Transmiter and Receiver.

Transmitter Unit :

1. Arduino nano is used as the main microcontroller[7].
2. GPS Neo-6M module is conected to Arduino to acquire the pet's real time location[8].
3. LoRa SX1278 module is used to transmit the data to Receiver[9].
4. The 433 Mhz U.fl spiral antenna is used to strengthen the signal[10].
5. AMS1117 3.3V used to reduce power because LoRa works at a voltage of 3.3 V[11].
6. Bateray Lippo 3.7V 1500mAh as a power source for the circuit[12].

Receiver Unit :

1. NODEMCU ESP 8266 microcontroller reads the GPS data and sends it via WiFi to a Telegram bot[13].
2. LoRa SX1278 receives data from Transmiter[14].
3. The 433 Mhz LoRa Antenna to strengthen the signal[15].
4. The bot sends meages to the owner's Telegram acccount containing the pet's location (latitude and longitude)[16].

The entire system is powered by 2 lippo 3.7V 1500mAh Batteray. The firmware for each microccontroller i written uing the Arduino IDE. The Telegram bot is configured using the Botfather tool and Intregated through HTTP-based API calls.

Analysis Technique :

To obtain the desired data in this research, system analysis is required. This analysis is obtained from the results of the experiment by drawing conclusions as a reference.

Block Diagram :

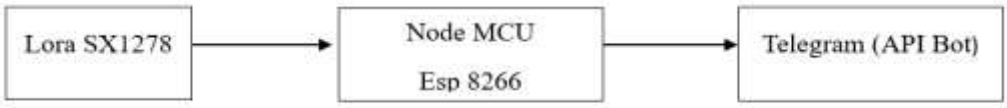

Figure 1. Block Diagram Receiver

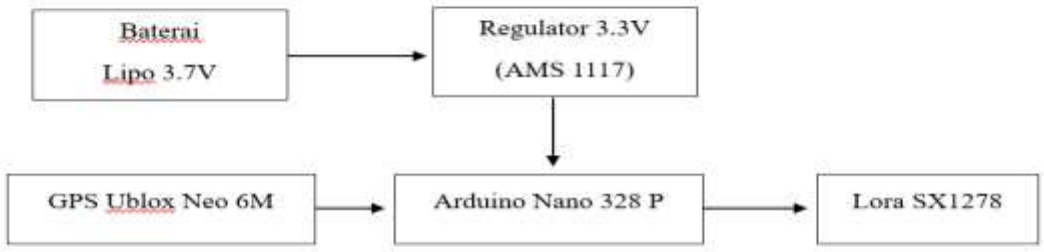

Figure 2. Block Diagram Transmitter

The following is a Block Diagram for the design of a Pet GPS Tracker Using a Telegram Bot. The sensor used to identify the position of a pet is a LoRa sensor supported by a GPS neo6M[10]. Lora uses a 3.3V regulator (AMS1117) and a power source from a 3.7V LiPo battery[7].

The collected data can be monitored via a cellphone. Information from the Ublox Neo 6M GPS will be sent to the Arduino, processed, and then sent via radio signals received and forwarded by Nodemcu to be displayed in location data on Telegram. Users of this device can see the location of pets directly.

The block diagram of the design of a pet monitoring tool using LoRa technology shows that the entire design of the Pet GPS Tracker Using a Telegram Bot produces output in the form of location data that can be accessed via the Telegram Application and Google Maps.[8] The input to the microcontroller comes from the GPS sensor to get the latest location information from the pet[17].

System Design

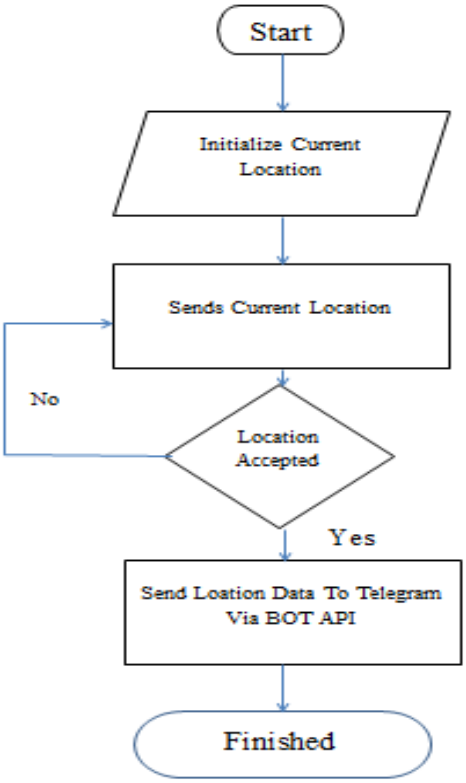

Figure 3. Flowchart Pet Tracking System Using Telegram Notification

Mechanical Design

Consist of Transmitter Design, Receiver Design, and Final Design of the tool.

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Transmitter Design

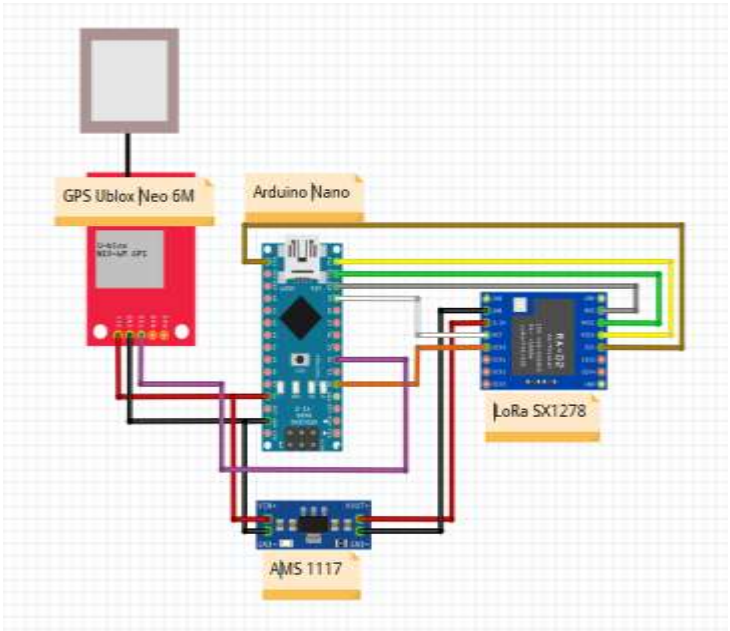

Figure 4. Transmitter Design Arduino Nano, LoRa SX1278, AMS1117 and GPS Ublox Neo-6M

Transmitter hardware pin addressing :

NO	GPS NEO 6-M	ARDUINO NANO
1	VCC	5V
2	GND	GND
3	TX	Pin 4
	LORA SX1278	**ARDUINO NANO**
1	VCC	Output 3.3v dari AMS1117
2	GND	GND
3	SCK	Pin 13
4	MISO	Pin 12
5	MOSI	Pin 11
6	NSS (CS)	Pin 10
7	RST	Pin 9
8	DIO0	Pin 2
	AMS1117	
1	IN	5V Arduino
2	OUT	3.3V untuk VCC Lora
3	GND	GND

Receiver Design

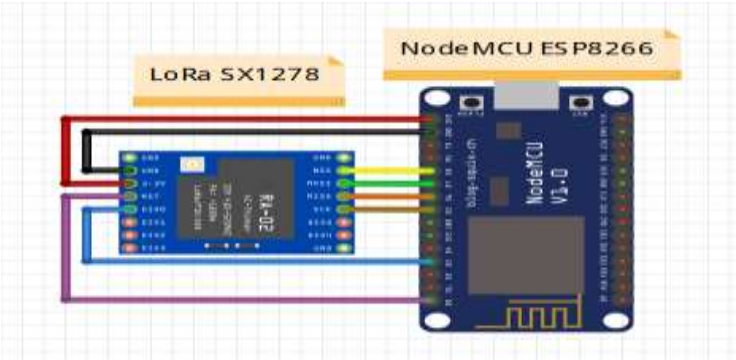

Figure 5. Receiver Design LoRa SX1278 and NodeMCU ESP 8266

Receiver hardware pin addressing :

LORA SX1278	NODEMCU ESP8266
VCC	3.3V
GND	GND
SCK	D5 (GPIO14)
MISO	D6 (GPIO12)
MOSI	D7 (GPIO13)
NSS (CS)	D8 (GPIO15)
RST	D0 (GPIO16)
DIO0	D1 (GPIO5)

Final Design Tool

The final design aims to protect the components used and provide a more orderly arrangement for the assembled circuit.

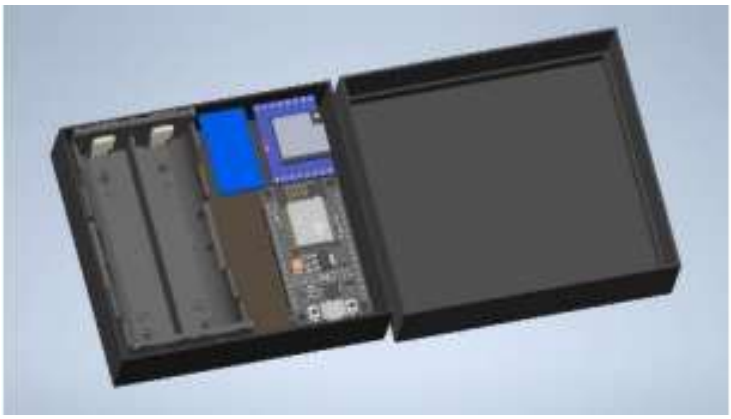

Figure 6. Receiver Box Design

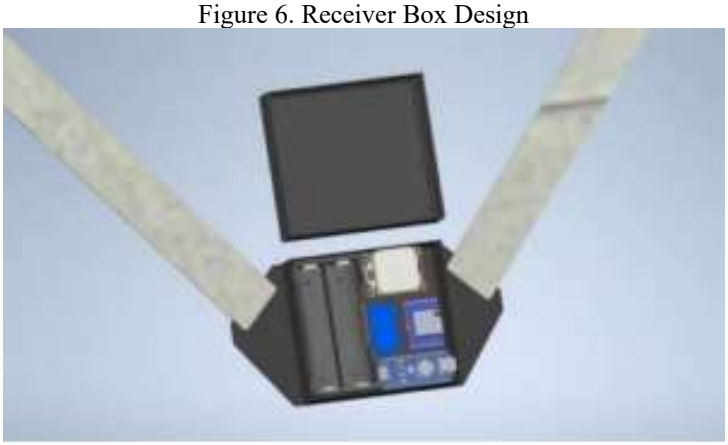

Figure 7. Transmitter Box Design

3. RESULTS AND DISCUSSION

The developed system was tested in an open environment to evaluate its functionality and communication range. The transmitter was attached to a simulated pet object, and the receiver was placed at various distances. The GPS data captured by the Neo-6M module was successfully transmitted over LoRa and received by the ESP8266. The ESP8266 was able to parse the data and deliver it to the owner's Telegram account with a 10 seconds delay.

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Figure 8. Receiver Box

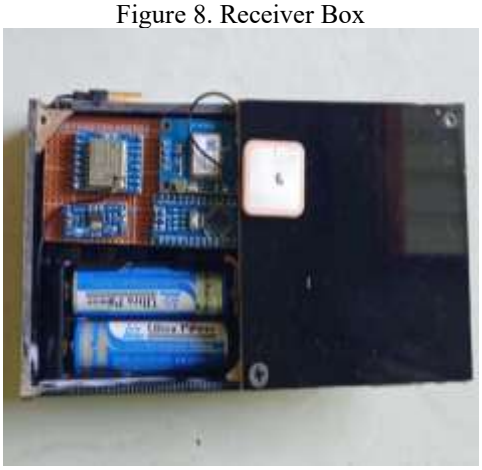

Figure 9. Transmitter box

3.1. Data Results

The data obtained from Telegram was opened in Google Maps.

Figure 10. The Results came out on Telegram

The Results of Data obtained :

1. Received coordinates : -7.387137,112.702110
   Distance : 10m

2. Received coordinates : -7.387143,112.702170
   Distance : 15m

3. Received coordinates : -7.387402,112.702450
   Distance : 50m

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4. Received coordinates : : -7.387402,112.702740
   Distance :80m

5. Received coordinates : -7.387402,112.702850
   Distance : 90m

6. Received coordinates : -7.387402,112.702950
   Distance :100m

3.2. Analysis Results

The analysis of the above experiments yielded the following findings:

- The system is capable of providing real-time and accurate location information for pets, especially in open areas. Interference occurs in enclosed spaces or densely built environments.
- LoRa communication demonstrated good performance for wide coverage, making it suitable for use in parks, villages, plantations, or livestock farms. The signal range of LoRa is influenced by the type of antenna used. In this experiment, a 433 MHz U.fl spiral antenna was implemented on the transmitter to ensure a more compact design that does not interfere when attached to the pet.
- Data transmission to Telegram was relatively fast, depending on the WiFi quality at the receiver side. A stable WiFi connection is required to ensure that data is sent to Telegram in real time.
- The system proved to be reliable and efficient, making it suitable for real-world implementation.

- Operating costs are lower since there is no need for a GSM subscription. It is easy to install and monitor remotely; however, it cannot track pets when they are outside the coverage area of either the GPS or LoRa signal.

4. CONCLUSION

The pet GPS tracker system integrating Arduino/ESP-based microcontrollers, the NEO-6M GPS module, LoRa SX1278 communication, and Telegram notification has been successfully developed and tested.

From the experimental evaluation, several important findings were obtained:

1. **Communication Range** – The effective transmission distance of the LoRa modules in the tested environment was approximately **100 meters**, which is sufficient for short-range tracking applications but requires optimization for longer distances.
2. **Notification Delay** – The average time required for location data to be delivered to the user via Telegram was about **10 seconds**, ensuring near real-time monitoring.
3. **Power Consumption and Battery Life** –
   - The **transmitter** (Arduino + GPS + LoRa) powered by a 5600 mAh Li-ion battery achieved an operating time of around **46 hours**.
   - The **receiver** (Wemos D1 Mini + LoRa + Wi-Fi to Telegram) consumed about 80–87 mA on average, resulting in an operating time of **2.5–3 days** with the same battery capacity.
4. **System Reliability** – Despite the limited range, the system consistently transmitted GPS data and successfully delivered it to the user through Telegram. This demonstrates the feasibility of integrating LoRa and Telegram for pet tracking applications.

Overall, the system is effective for real-time pet tracking with acceptable accuracy, stable data delivery, and long operating time supported by a 5600 mAh battery**.** Future improvements may include the use of higher-gain LoRa antennas, optimization of transmission intervals, or integration with solar charging to further extend system performance and applicability and improving the user interface for easier access to tracking history.

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