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Cost-Effective Arduino-Based RFID Automated Cage Door and Pet Tagging with GPS Tracker using Peer-to-Peer LoRa WAN

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Abstract: In this modern era, there is a lot of technology improvement in pet cages and pet tagging. Manually operating a pet cage might not be really efficient for the modern world. Moreover, when the pets go missing it is always a hassle to know about their whereabouts. Hence, this cage is able to sense the pet when it is nearby by detecting the RFID embedded in the pet tag. If the pet goes missing or is outside the cage's vicinity, the owners should be able to obtain the pets location by using the GPS module with peer-to-peer LoRa WAN which is embedded in the pet tag. Previous research has primarily relied on either an automated pet cage or a GPS tracker with a short range. In this work, the RFID and GPS system implements peer-to-peer LoRa WAN in the pet tag which is able to unlock the pet cage and also help the owner to track the pet's location via a web-based maps by inserting the coordinates (latitude and longitude) obtained. The RFID RC522 is integrated with the Arduino UNO for the Arduino-based automatic pet cage. As for the peer-to-peer LoRa WAN GPS tracker, the RFM95W LoRa shield integrated with the Arduino UNO is used as the transmitter and receiver. The transmitter of LoRa WAN shield has a GPS tracker (NEO-6M) and the receiver LoRa WAN has an LCD display, so that the owner can obtain the coordinates of the pet. It is shown from this work that the LoRa WAN can transmit signals within a coverage area of up to 10 km.

Keywords: RFID, cage door, pet tagging, GPS tracker, Peer-to-Peer LoRa WAN

1. Introduction

Nowadays, balancing work life and personal life can be hard. It is particularly harder for those who owns a pet as it is a major responsibility. As pet owners might not be able to give full attention to their pets. It might be a hassle to constantly open the cage door for the pets whenever it wants to leave and enter the cage. Another scenario to consider is when a pet wanders around and gets lost. In this case, the owner will have a hard time locating the pet. It is common for pet owners to post about their missing pets on social media. When pets are found missing, pet owners usually need to physically search for their lost or missing pets. Most pet owners have been using microchips without knowing the disadvantages that come with it. The function of implanted chips, however, could not be guaranteed and might be compromised due to various factors affecting their functionality such as improper implant depth and location of the chip. In addition, the size of the implanted chip is too small and thus, fewer copper spirals can fit into the chip. Therefore, it will be harder for the RFID reader to detect the microchip which is implanted into the pet. In this work, the pet tag will

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also have a locator which is an Arduino-based GPS with peer-to-peer LoRa WAN, which is a tracking system that generates the coordinate from the transceiver and sends the coordinate (based on latitude and longitude) to the receiver which displays it on the LCD. When the GPS tracker gets activated, it immediately connects to the LoRa WAN and it sends the GPS data of the pet tag and to the receiver LoRa WAN [1]-[2]. An Arduino-based RFID automated cage door and pet tagging with GPS tracker is proposed. The proposed RFID pet tagging shall identify the pet with RFID as it is equipped with a unique serial code. Moreover, the RFID tag shall also track its location with GPS tracking embedded with the LoRa WAN [3]-[4]. The passive RFID system operates at high frequency (HF) is anticipated as being the most practical because it offers a good balance between range (typically up to a few meters) and the ability to read multiple tags at a greater speed [5].

2. Methodology

This section discusses the methodology applied in completing this work.

2.1 Arduino-based RFID Automated Cage Door

Fig. 1 shows the block diagram based on the Arduino-based automated cage door. The block diagram is divided into three sections. At the input section, there are the RFID tag, RFID module and a 12-V power supply. In the control section there is an Arduino Uno microprocessor board. Finally, the output section has a relay module and a solenoid. The workflow of this block diagram begins when the RFID tag which is placed on the dog collar is detected by the RFID reader and sends an input command to the Arduino Uno which then controls the relay to unlock the solenoid in order for the pet to enter its cage. The 12-V power supply is the input for the solenoid.

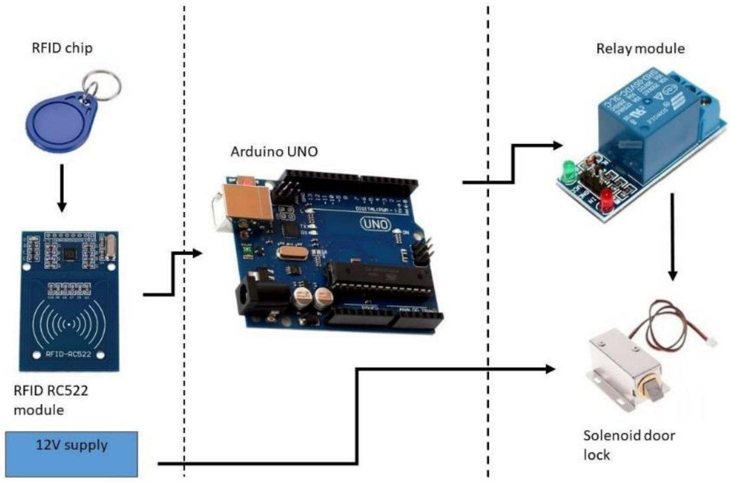


Fig. 1 - Block diagram of Arduino-based RFID automated cage door

2.2 Pet Tagging with GPS Tracker and LoRa WAN Peer-to-Peer

Fig. 2 shows the block diagram based on the pet tagging system with a GPS tracker. Similarly, this block diagram is divided into three sections to ease the understanding. The first component of the input is NEO-6M GPS module and a transceiver LoRa WAN shield. The second section is the control which is Arduino UNO. Finally, the third section is the output which are the Receiver LoRa WAN shield. The flow of the system is, once the GPS module is activated, it starts to tag the location of the pet. It then sends the information the Receiver LoRa WAN shield through peer to peer communication. Then the information is displayed by the LCD display on the receiver module. Once the coordinates are displayed in the LCD display the owner can then insert the received coordinates into any web-based maps to obtain the location of the pet.

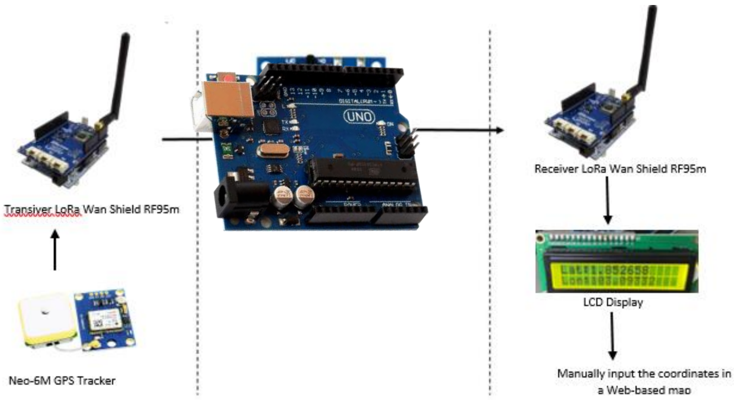


Fig. 2 - Block diagram of the pet tagging with GPS tracker

2.3 Web-Based Application

Web-based application is an IoT software that runs in a web browser. Unlike software programmes that operate locally and natively on the operating system of the device, web applications are application software that run on a web browser. Users with an active network connection can access web applications over the World Wide Web. In this work, the maps application is used as the web-based application. The coordinates of the pet location, in terms of latitude and longitude, will be displayed on the LCD display which is embedded on the receiver LoRa WAN shield. Once the pet owner receives the coordinates, it can be manually inserted into any maps application to obtain the direction to the location of the pet.

3. Results and Analysis

This section discusses the results obtained and analysis on the cost-effective Arduino-based RFID automated cage door and pet tagging with GPS tracker using peer-to-peer LoRa WAN. The structure of the work can be divided into two parts namely, Arduino-Based RFID and LoRa WAN Peer-to-Peer Communication with GPS Tracker.

3.1 Arduino-Based RFID

In this section, the Arduino-based RFID, solenoid and relay circuits are combined and tested together. On the condition that the RFID tag is present near the RFID reader, the buzzer is switched on for 0.8 second. The buzzing indicates that the solenoid is unlocked. The lock of the solenoid latches down for 20 seconds and thus, giving the pet an access to enter its cage. After the access delay, the lock latches up. Figure 3 shows the circuit of Arduino-based RFID automated cage door. Fig. 4 and Fig. 5, on the other hand, show the solenoid when the latch is up and down.

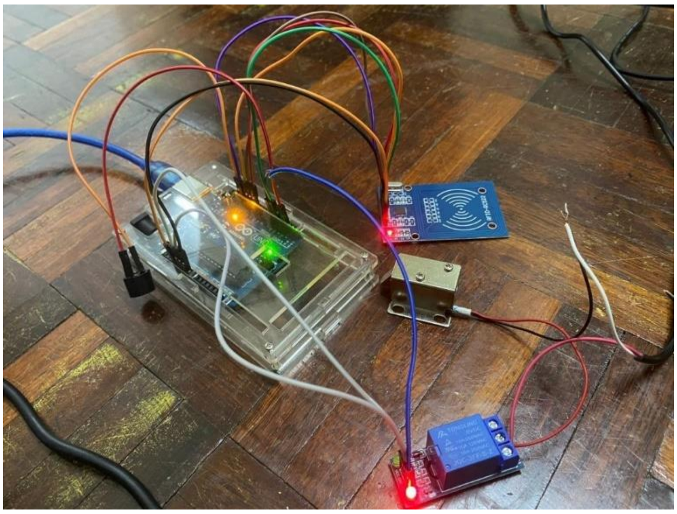


Fig. 3 - Circuit of Arduino-based RFID automated cage door

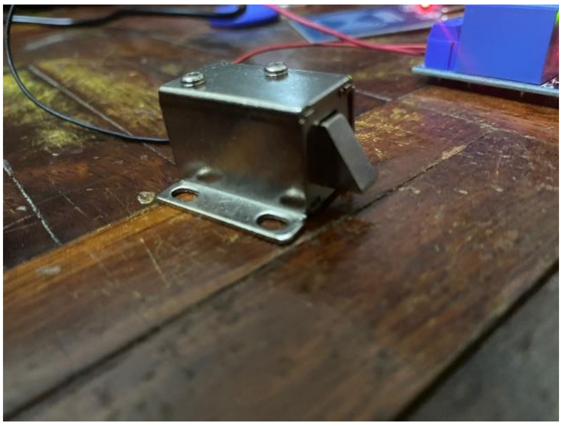


Fig. 4 - Solenoid latch is up

Fig. 5 - Solenoid latch is down

3.2 LoRa WAN Peer-to-Peer Communication with GPS Tracker

The peer-to-peer LoRa WAN-based GPS tracking system in this work consists of a transmitter that reads position data from the NEO-6M GPS module and transmits it wirelessly via LoRa WAN. The information received by the receiver will be displayed on a 16 × 2 LCD display. The received coordinates (latitude and longitude) by the receiver can then be inserted into any web-based maps to obtain the location. In this work Google maps is used to obtain the location. LoRa WAN gateway is not used in this work as it is expensive but instead, a more cost-effective peer-to-peer LoRa WAN communication is used between the transmitter and receiver. The LoRa WAN module with an unlicensed ISM band of 915 MHz is used. A LoRa WAN Arduino shield is constructed in this work to ease the communication between the transmitter and receiver of LoRa WAN. The RFM95W 915MHz is combined with a 3.3V regulator based on the LM317 Variable Regulator in this shield. The shield is mounted directly on top of the Arduino UNO and will provide LoRa connections. When the LoRa sensing nodes need to be deployed or established in a LoRa mesh network, this LoRa shield will then come in handy. The shield has no LoRa WAN stack. Hence, it needs to be downloaded in order to be compatible with the Arduino UNO. The shield has a 12 V socket that, when powered, will use the LM317 regulator to regulate 3.3 V for the LoRa module. It will also be used to power the Arduino UNO through the Vin pin and the LCD display on the shield is powered by the Arduino's regulated 5 V. The resistors R1 and R2 are used to set the output voltage of the LM317 to 3.3 V. As the LoRa module uses little power, it may be powered directly from the Arduino's 3.3 V port. However, an external regulator is utilized in the design because the LM317 is more dependable than the on-board voltage regulator. A potentiometer on the shield may be used to change the brightness of the LCD display. As shown in Fig. 6, only the LoRa Shield receiver (on the right) has an LCD display connected to it, while the transmitter (on the left) has a GPS tracker connected to it. The GPS module utilised here is the NEO-6M GPS module, which has a compact form factor and can run on extremely low power, making it ideal for tracking applications. The GPS module runs on 5 V and communicates via 9600 bauds serial connection. As a result, the Rx and Tx pins are linked to digital pins D4 and D3 on the Arduino UNO and power the module using the +5V. The D4 and D3 pins will be set up as software serial pins. When the NEO-6M GPS module is turned on, it will seek for a satellite connection and then output all of the data serially. The NMEA phrase format, which stands for National Marine Electronics Association and is the standard format for all GPS devices, will be used to produce the data. The LoRa WAN module is a transceiver, which means that it can both send and receive data. However, in this work, one module will act as a transmitter, transmits the GPS coordinates to the receiver module, while the other will act as a receiver, receiving GPS coordinates and displays them on the LCD. There are two separates programmes which are uploaded into the corresponding Arduino UNO modules to power them up using a 12 V converter or USB connection after the hardware and software are completed. When the transmitter is switched on, the blue LED on the GPS module blinks, indicating that the module is hunting for a satellite connection in order to get coordinates. Meanwhile, as soon as the coordinate is obtained by the receiver module it will then display the latitude and longitude on LCD as can be seen in Figure 6. From the figure the LCD display is enlarged for a better view of the latitude and longitude. The latitude and longitude data provided on the LCD display can then be entered into the Google maps, as seen in Table 1.

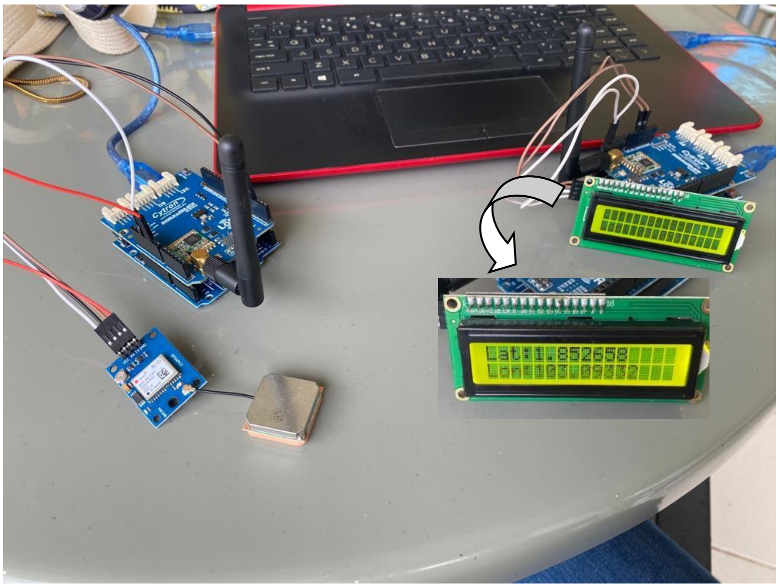
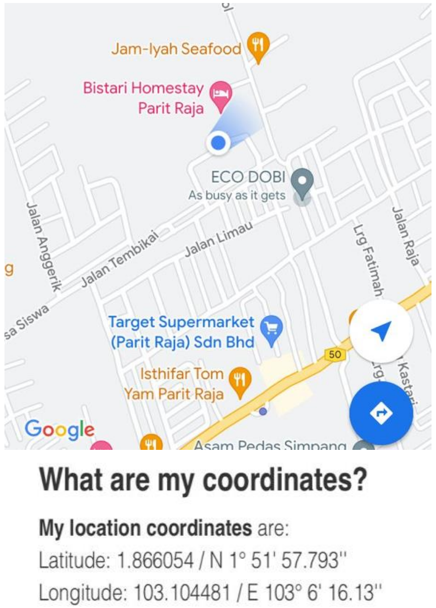
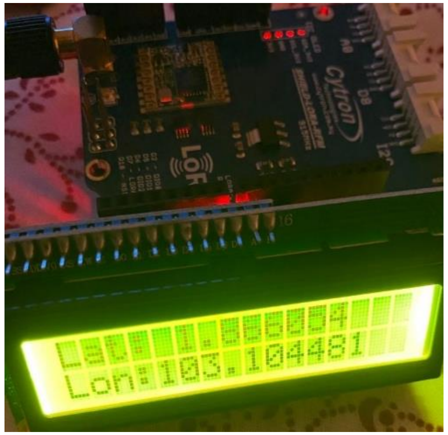
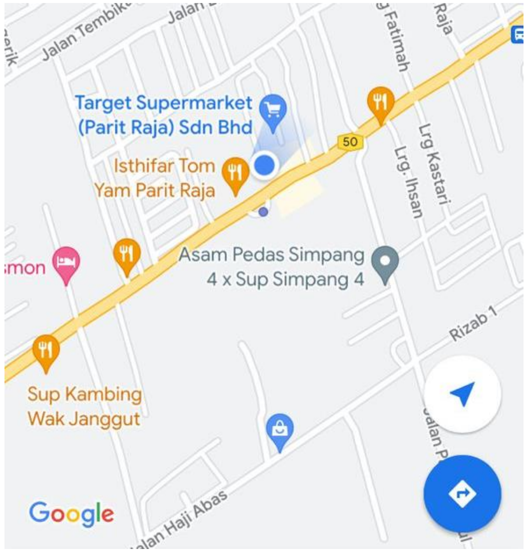
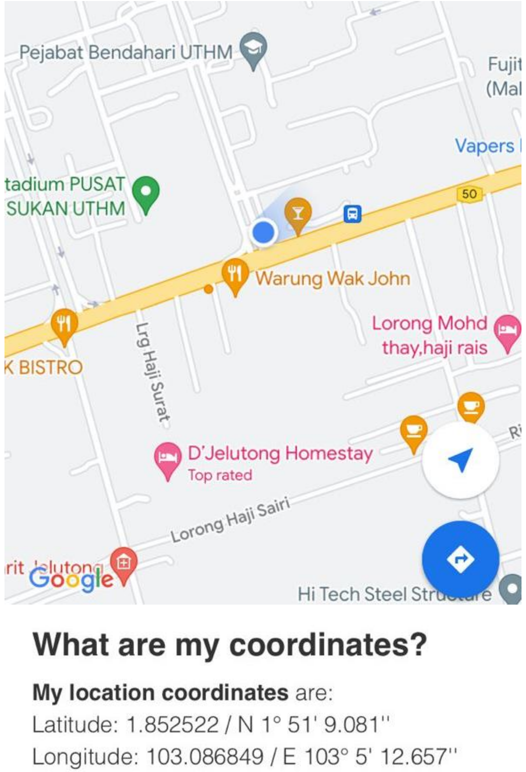
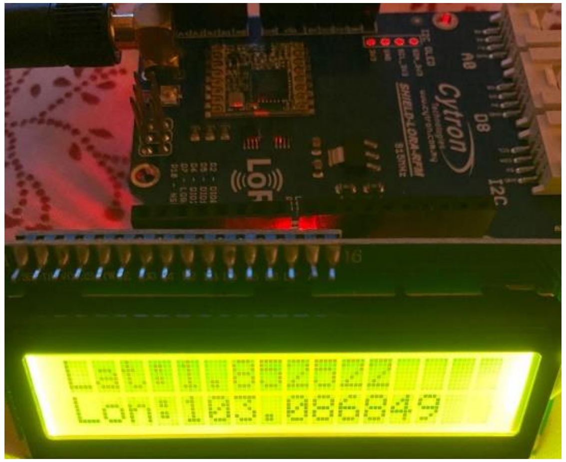


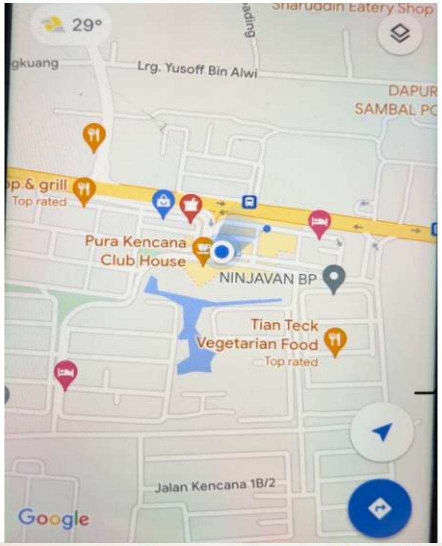
Fig. 6 - The circuit connection of LoRa WAN peer- to-peer communication with GPS tracker

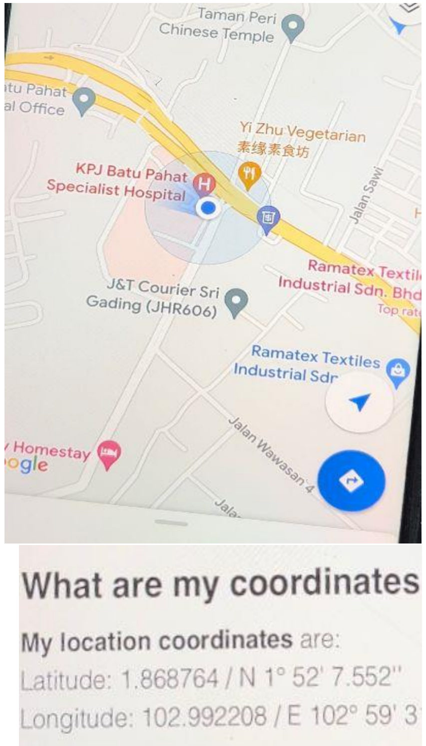
Table 1 - Results obtained from the transmitter and receiver of LoRa WAN

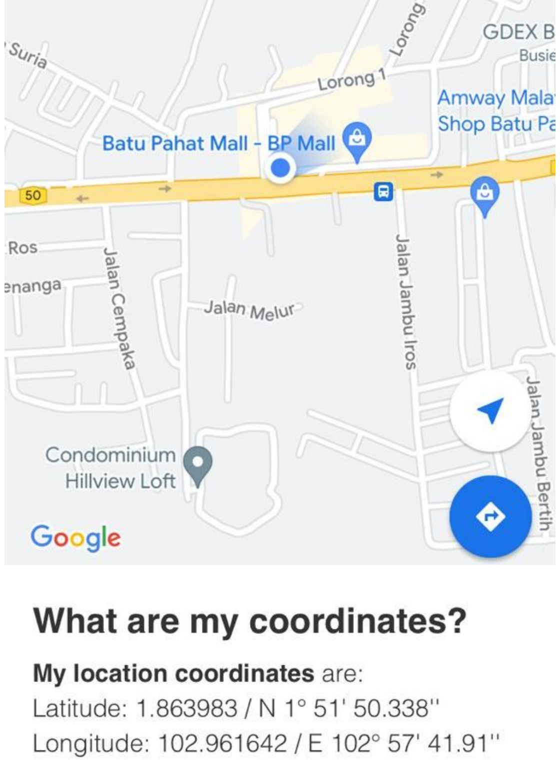
Distance of location from Bestari Hostel	Coordinate of Location	Coordinate Display at Receiver Lora	Transmitter availability
Bestari Hostel as the reference point: 0 km		 From the LCD display; Latitude: 1.866054 Longitude:103.104481	Available

Target Supermarket 1 km	 **What are my coordinates?** **My location coordinates** are: Latitude: 1.861775 / N 1° 51' 42.39'' Longitude: 103.105342 / E 103° 6' 19.232''	 From the LCD display; Latitude: 1.861775 Longitude:103.105342	Available

UTHM **5 km**	 	 From the LCD display; Latitude: 1.852522 Longitude:103.086849	Available

Sri Gading **10 km**		 From the LCD display; Latitude: 1.853477 Longitude:103.024788	Available

KPJ Batu Pahat Specialist Hospital 15 km		 From the LCD display; LoRa WAN Failed	Not Available

Batu Pahat Mall **20 km**		 From the LCD display; LoRa WAN Failed	Not Available

4. Conclusion

In conclusion, a cost-effective Arduino-based RFID automated cage door and pet tagging with GPS tracker using peer-to-peer LoRa WAN is successfully developed and built in this work. An Arduino-Based RFID automated cage door circuit is designed and developed successfully in this work. The Arduino-based RFID (input), solenoid (output) and relay (output) are tested individually before integrating them together with the Arduino UNO as control unit to ensure each circuitry is working well. Next, the coding is produced and uploaded to the Arduino. The input and output combination with the Arduino are then tested again to obtain the desired output. In this case, once the RFID tag is read by the RFID reader, the solenoid latches down with the sound of a buzzer for a duration of 20 seconds. After that duration, the solenoid latches back to the lock position. As for the GPS tagging it is designed and developed successfully in this work. The LoRa WAN shield is used as it is a cheaper option rather than the LoRa gateway. The Arduino-based GPS NEO-6M which is on the transmitter of LoRa WAN is the input, peer-to-peer LoRa WAN Shield is the serial communication and the LCD with I2C on the receiver LoRa WAN is the output. Each component was tested individually before integrating them together with the Arduino UNO as the control unit to ensure good circuit connectivity. Then, the coding was produced and uploaded into the Arduino. The input and output combination with the Arduino UNO are then tested again to obtain the desired output. In this case, once the GPS stabilises and detects the location of the pet, the LoRa WAN shield transmits the latitude and longitude to the receiver LoRa WAN shield which is then displayed on the LCD attached to the receiver. With the received coordinates, the owner can insert it into any web-based maps application and obtain the location of the pet. The LoRa WAN uses 915 MHz as the frequency band, which is the unlicensed ISM band in Malaysia. The LoRa WAN peer-to-peer communication in this work can transmit signals that covers an area up to 10 km.

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References

[1] M. M. Rahman, J. R. Mou, K. Tara and M. I. Sarkar, "Real Time Google map and Arduino-based Vehicle Tracking System," 2nd International Conference on Electrical, Computer & Telecommunication Engineering (ICECTE),pp. 1- 4,2016.

[2] V. S. Rama Krishna Sighakolli, B. Siddineni, T. J. Satyanarayana and R. Nanditha, "Emergency Locket for Women using Blynk and IFTTT based on the Internet of Things," 12th International Conference on Computing Communication and Networking Technologies (ICCCNT), pp. 1-6, 2021.

[3] S. Kim, D. Kim and H. Park, "Animal Situation Tracking Service Using RFID, GPS, and Sensors,"Second International Conference on Computer and Network Technology, pp. 153-156, 2010.

[4] W. N. W. Muhamad, S. A. b. Razali, N. A. Wahab, M. M. Azreen, S. S. Sarnin and N. F. Naim, "Smart Bike Monitoring System for Cyclist via Internet of Things (IoT)," IEEE 5th International Symposium on Telecommunication Technologies (ISTT), pp. 168-173, 2020.

[5] J. Li, Y. Huang, G. Wen, R. Xu and L. Ma, "Compact UHF RFID Tag Antenna for Application of Domestic Animals Management," Cross Strait Quad-Regional Radio Science and Wireless Technology Conference (CSQRWC), pp. 1-2, 2018.

[6] S. Sivaraman, A. A. Zainuddin and K. Subramaniam, "Advances in Technology for Pet Tracker Sensing Systems," International Conference on Green Energy, Computing and Sustainable Technology (GECOST), pp. 1-4, 2021.

[7] J. Helminski, B. Caldwell, J. Marcum and N. Hall, “Smart Doggy Door,” The University of Akron, 2021.

[8] E. Williams, Z. Cleghern, M. Foster, T. Holder, D. Roberts and A. Bozkurt, "A Smart Collar for Assessment of Activity Levels and Environmental Conditions for Guide Dogs," 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), pp. 4628-4631, 2020.

[9] G. T. Woodling, S. Moran, J. Bischoff and J. Sindelar, “Smart Collar,” The University of Akron, 2020.