Communication-based Intelligent Unmanned Vehicle Module for BVLOS Operations

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Abstract

A smart city is characterized by the concept of an integrated metropolis consisting of infrastructure, services, and people. Unmanned ground vehicles and intelligent drones are among the most intriguing possibilities for developing smart cities. Drones can be used for various tasks, ranging from plantation monitoring to goods delivery in difficult-to-reach places. Moreover, the smart city concept necessitates that a variety of devices connect with one another over an Internet protocol known as the Internet of Things (IoT). 4G/Long Term Evolution (LTE) UAV/UGV Enabled is a research topic addressing the Internet of Things expansion. Beyond Visual Line of Sight (BVLOS) is a technique for remote control of the UAV/UGV mode. This paper aims to design on a modest scale the development of the Intelligent Transportation System (ITS), which is packaged in an LTE-based smart drone module.

Ⅰ. Introduction

The smart city idea allows numerous sorts of items to connect with one another using various internet protocols, often known as the Internet of Things. So far, drones/unmanned vehicles have only been restricted by the control range of the vehicle controllers. The kind of frequency and signal intensity limits this distance or range. As a result, a sophisticated communication protocol that can overcome these limitations is required. Fortunately, the majority of Indonesia has acquired the 4G LTE network. This opens the door to developing a regulated communication protocol across the internet [1].

The objective of this study is to implement a small-scale Intelligent Transportation System advancement (ITS). This demonstration employs a quadcopter drone to represent unmanned aircraft later on. Additionally, this knowledge can be used to unmanned ground vehicles (UGV). For this reason, it is used to compare future vehicles, such as integrated electric buses, to intelligent algorithm-based delivery services.

We utilized the Ardupilot software package to assistance with this research. Ardupilot offers software like Mission Planner for displaying vehicle data for land and air using the MAVlink connection. The driving brain of the test car is a Pixhawk module based on the ARM architecture. Pixhawk contains many sensors, including a gyroscope, barometer, and compass. In addition, numerous sensor modules, such as GPS or others, can be added so long as they support UART, IIC, CAN, or SPI communication protocols. Pixhawk will be outfitted with Copter or Rover firmware in the future to facilitate this study.

Ⅱ. Method

1. Beyond Visual Line of Sight (BVLOS)

BVLOS is one of three types of methods for controlling unmanned vehicles. BVLOS is an event where observers and pilots cannot see the presence of unmanned vehicles, so a tool is needed to help the pilot control the movement of the unmanned vehicle. Usually, BVLOS uses a Ground Control Station (GCS) instrument to see the condition of the unmanned vehicle. BVLOS operations are often used in surveying, inspection and freight forwarding applications. However, BVLOS operations require approval from the regulatory authorities and must meet stringent safety requirements to prevent accidents [2].

The BVLOS method may vary depending on the type and size of the drone and the application used (as shown in Fig. 1). However, some of the methods commonly used include the following: Autopilot: Drones can be controlled automatically through an autopilot system programmed to follow a specified flight route. Radar monitoring: Drones can be equipped with a radar that can be used to detect nearby objects and avoid collisions. Remote control: The operator can control the drone via a remote control connected to the drone via a wireless connection. Camera monitoring: Drones can be equipped with cameras that can monitor conditions around the drone and provide video feeds to the operator. Telemetry system: This system transmits data from the drone to the operator, such as position, speed and weather conditions. Monitoring system: This system is used to monitor weather conditions and determine whether BVLOS operations are safe.

All these methods must be used together and meet the safety requirements specified by the authorities to ensure the safe operation of BVLOS.

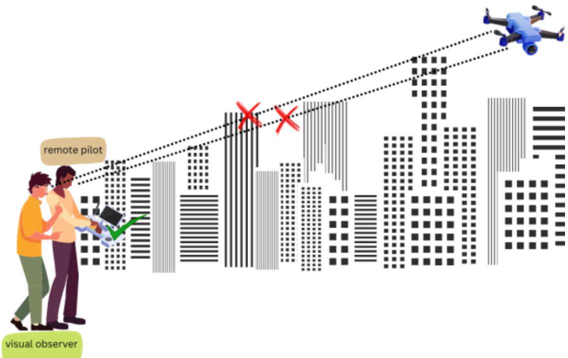

Fig 1. Beyond Visual Line of Sight Concept

2. Communication Module

The development of 4G LTE in drones is an exciting technological advancement that has the potential to revolutionize the way we use drones. This technology allows drones to communicate with each other and with the ground station, allowing for greater control and increased safety [3].

The use of 4G LTE in drones has a number of advantages. It provides a reliable connection, allowing for better communication between the drone and the ground station. This connection also allows for more accurate navigation, as the drone can receive real-time updates on its location. Additionally, the use of 4G LTE in drones can increase the range of the drone, allowing it to fly farther and for longer periods of time.

Overall, the development of 4G LTE in drones is an exciting advancement that has the potential to revolutionize the way we use drones. This technology will allow for greater control and increased safety, as well as improved communication and navigation.

3. Experiment

After the drone can carry out commands correctly and safely for testing, it enters into testing with the internet module. Using the AWS cloud service, the vehicle is expected to be able to communicate with the Ground Control Station by obtaining a ping signal (Fig. 2). This test is also carried out using internet service providers, available in the research area that has been running to determine the performance of internet services on the UAV being tested as depicted in Fig. 3.

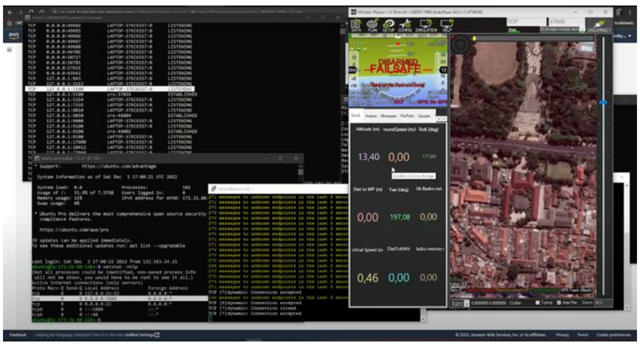

Fig 2. Ardupilot Settings for Communication Module

Fig 3. View of the GCS Mission Planner

Ⅲ. Conclusion

Due to the increase in UAV-equipped intelligent systems, there is a growing demand for 4G-based UAV communication systems that are easily accessible. This study presents a 4G communication module that synergizes with cloud services and has low internet and power consumption. Utilizing low-cost components and selecting a virtual network service with available credit enables the cloud services in use (AWS) portion of the communication system. The module is guaranteed to maintain the vehicle's security if the network is disconnected and to have sufficient information when the vehicle loses network connectivity. Implementation and outcomes demonstrate that the proposed module operates as anticipated.

ACKNOWLEDGMENT

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REFERENCES

[1] P. J. Burke, "A Safe, Open Source, 4G Connected Self-Flying Plane With 1 Hour Flight Time and All Up Weight (AUW) <300 g: Towards a New Class of Internet Enabled UAVs," in IEEE Access, vol. 7, pp. 67833-67855, 2019, doi: 10.1109/ACCESS.2019.2917851.

[2] K. H. Terkildsen, U. P. Schultz and K. Jensen, "Safely Flying BVLOS in the EU With an Unreliable UAS," 2021 International Conference on Unmanned Aircraft Systems (ICUAS), Athens, Greece, 2021, pp. 591-601.

[3] F. Ronaldo, D. Pramadihanto and A. Sudarsono, "Secure Communication System of Drone Service using Hybrid Cryptography over 4G/LTE Network," 2020 International Electronics Symposium (IES), Surabaya, Indonesia, 2020, pp. 116-122, doi: 10.1109/IES50839.2020.9231951.