Drone Performance Analysis Based on SNR Factor

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Abstract

In this paper, a depth analysis of a drone performance based on the signal to noise ratio (SNR), has been provided. The MATLAB software is used to simulate the effect of frequency, power and distance on the performance of drones. The SNR optimization has been proposed as well. The light has been shed on the drone performance in wildfire scenario.

Keywords: UAV, SNR, flying base station, cellular decomposition

1. Introduction

The human's craving to fly high in the sky developed as early as on time as its common sense. In any case, it took a long effort to make this fantasy real [1]. An enormous number of scientists had worked on this topic and it had requested such a significant number of courageous individuals, until at long last men could rise starting from the earliest stage. By that, people eagerness towards the aviation led success. From the start they conquered the air balloons, later by airships, lastly with planes. Meanwhile, the plan to use a machine that can fly without a person on board has consistently been in the scientists mind. This idea isn't unexpected in any way, because such systems advantages are obvious. We don't need to check with the death of the on-board personnel, if the airplane is destroyed for reasons unknown. Also, we can utilize them for such exhausting errands, similar to aerial surveillance. At last, their financial advantage position is unquestionable, because of the reality, that as a rule a UAV's first price is lower than the cost of a conventional aircraft. Like a great deal of objects that are used even in

civilian life, UAVs are the result of the improvements done during military conflicts. Despite the fact that there were some unmanned balloons used as early as the middle eighteenth century to destroy the enemy. These kind of airplane showed up in the First World War. As nowadays every nation has their own UAV research program [2].

The primary unnamed aerial vehicle UAV guideline was proposed in 1944, directly after the World War II. The principal globally perceived flight guideline, the Chicago Convention, brought up that the activity of UAVs ought to be approved to guarantee the wellbeing of kept an eye on common airplane [9]. Since 2000, because of the fast improvement of UAV and its expanding ubiquity, UAV guidelines have developed both broadly and globally. In 2002, the United Kingdom and Australia originally distributed their UAV guidelines. In 2006, the International Civil Aviation Organization (ICAO) reported that it was important to give a globally recognized enactment for common tasks of UAVs. Since 2012, an expanding number of nations have built up their own UAV guidelines [10].

5G or so called the fifth generation of wireless communication is the new revolution and evolution in a wireless field that speed up the advent of IoT. 5G is an essential infrastructure that allows all communications to be linked through the IoT at anytime and anywhere. The main advantages of 5G are providing larger capacity, higher data-rate, lower latency and higher application reliability. It is 1000 times more capacity, 100 times faster and 100 times more connectivity compared to 4G [1].

IoT has accelerated the development of many devices around us and has brought up possibility of many applications. Its vision is to build a fully connected environment to ensure more convenient and better human living by improving the issues like energy management, climate change, automation and transportation, healthcare and treatment, logistic management and other related fields [2].

Radio frequency identification (RFID) is a key technology for making the IoT to automatically detect objects by using wireless communication. In recent years, RFID has been widely used in many places, such as logistic management and production. RFID is one of the main IoT technologies and one of the ten most important technologies in the 21st century, as an automatic detection and data capture technology [3]. RFID uses frequency from 30 Hz to 5.8 GHz which depends on the applications [4].

According to the Federal Communications Commission (FCC) in February 2002, the specifications for UWB systems to use in the band of 3.1 GHz to 10.6 GHz and a large bandwidth of more than 500 MHz [5]. UWB provides higher data rates with very low radiation power. Hence, this technology is getting more significant and popular in wireless communication systems [6].

In this paper, the study and design of an UWB microstrip patch antenna is presented. Microstrip patch antenna is chosen over other types due to its compact size, light weight, high bandwidth, multiband properties, low cost and high gain [7]. The proposed antenna needs to cover three of the applications as well as meeting the requirements of UWB. The rise of the IoT has accelerated the development of many devices around us and has opened the possibility of myriad applications. The IoT vision is to build a fully connected environment. This can be done by using smart objects and devices to produce data and transmit through the internet automatically for decision making purpose [7-9]. This is to ensure more convenient and better human living by improving the issues like energy management, climate change, automation and transportation, healthcare and treatment, logistic management, and other related fields. The IoT devices includes remote monitoring, tracking, collection of data, manufacturing and also for media applications. Nowadays, there are many IoT applications which are already identified globally i.e smart city, smart home, smart logistics, smart transportation, smart healthcare, and smart agriculture [8-10].

2. Background

The surveying of UAV based systems for traffic monitoring and management. Despite having a lot of research on the subject. Unmanned aerial vehicles (UAVs) are proven to be an applicable and less time-consuming alternative to real time traffic monitoring and management, providing the eye in the sky solution to the problem [1-3]. However, synthetic aperture radar (SAR) processing in general is not enough to detect and focus moving targets on the ground, therefore he described other techniques that are described and considered. Ideas for a long-track velocity were proposed but it was shown that clutter suppression and vehicle acceleration are

major challenges for a current estimation of the motion status of road vehicles.

Deployment problem as reducing the number of UAVs and maximizing the load balance among them, which is subject to two main constraints, UAVs should form a robust backbone network and they should keep connected with the fixed based stations.to solve this optimizing problem with low complexity, he proposed a hybrid algorithm to solve them stepwise [4]. . First, a centralized greedy search algorithm is used to heuristically obtain the minimum number of UAVs and their suboptimal positions in a dis-continuous space. Then, a distributed motion algorithm is adopted which enables each UAV to autonomously control its motion towards the optimal position in a continuous space. The proposed algorithm is applicable to various scenarios where UAVs are deployed alone or with fixed base stations regardless of the user equipment distribution. Extensive simulations validate the proposed algorithms despite everything discussed in the paper the main purpose was to make sure they deploy minimum UVAs to evenly serve as many user equipment as possible while guaranteeing a robust backbone network [5].
5G and beyond 5G will be more important for the upcoming wireless networks wireless networks that can potentially facilitate wireless broadcast and support high rate transmissions compared to the communication with fixed infrastructure and he provided the exhaustive review of various 5G techniques based on UAV platforms such as networks layer, joint communication and computing. However in this survey they provided a brief understanding of UAV communication in 5G and beyond 5G [6-8].wireless networks and providing an overview on recent research activities an UAV communication combining the 5G techniques from the viewpoint physical layer, joint communication and computing.

UAVs can be connected to cellular networks as new types of user's equipment and how UAV offer unprecedented opportunity dynamically repositioning themselves to boost coverage, spectral efficiency and user quality experience as well as the obstacles and opportunities for helping cellular communication with UAV based flying relay and based station. However with all that discussed the outcome of the studies show some major interferences issues arising from height of UAVs but most of them can be addressed with the current 4G system even though 5G will be better to deal with UAV related challenges as a proven fact.

The research in [3] mainly focused on the point on the present comprehensive Survey of the literature on the location optimization of the unmanned aerial vehicles mounted base station in new gerent on wireless networks and the generic problem on the finding of the location of the base station and some solution to solve the challenges that are covered in the literature review and later gave the form of the mathematical formulation of flying base station location problem. However, the future research awareness will be to ensure the reliability of the services provided by flying base station.

3. Methodology

The about the operation of drone according to its coverage area, and methods to improve the drove lasting time in the air and a practical scenario in which UAV can be implemented and operate has been introduced. Moreover, the effect of SNR on the operation of the UAV and the optimization techniques have been discussed in this section.

3.1. *Coverage Path Planning*

Given an area of interest composed by the robot's free space and its limits, the coverage path planning (CPP) problem comprises of planning a path which covers the whole entire environment considering the vehicle's movement limitations and sensor's characteristics, while avoiding passing over obstacles [5]. In an aerial context, the workspace obstacles can represent no-flight zones (NFZ) that the UAV should not consider during the planning stage, e.g. areas close to air terminals or very tall buildings.
A few techniques can even deal with areas of interest containing NFZ which must be avoided from during coverage. These no-fly zones can represent areas where coverage is basically unnecessary or areas where the UAVs are not permitted to fly. Distinctive decompositions strategies are typically embraced to lessen the concavities of complex zones or to part the area into littler cells to facilitate the coverage task.

3.2. *Cellular Decomposition*

One of the major worries about the CPP problem is to ensure a total coverage of the scenario. This is generally accomplished by applying cellular decomposition in the area of interest, splitting the target free space into cells in order to simplify the coverage In literature there are different cellular decomposition methods and the most well-known used in CPP problem including UAVs is approximate cellular decomposition. The approximate cellular decomposition method approximates the area into a lot of regular cells. These regular cells for the most part expect a square structure, yet they can also be represented either in a triangle or hexagonal structure Grid based methods can be applied over approximate areas to generate coverage paths. The size of the cells for the most part fits the robots measurements while considering coverage using land robots. However, in aerial coverage the UAVs fly at a specific altitude from the ground carrying a camera as a sensor to perform the task. For this situation, the footprint of the camera in the UAV while it's flying is shown in Fig. 1 bellow.

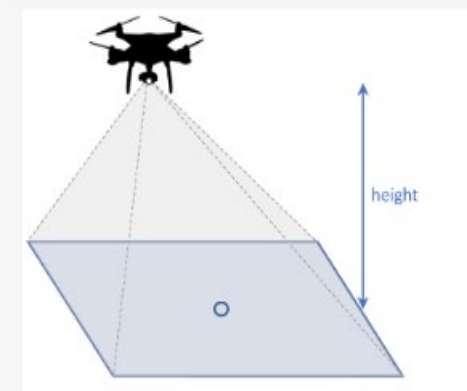

Fig. 1. Square area presentation overview of a flying drone.

3.3. *Drone Performance Matrics*

3.1.1. *Flying Altitude*

Every nation has their own laws of how high one can fly their drone. While it might have the option to fly a thousands of feet in the air [9]. There's a set law in Malaysia as indicated by Malaysia's national aviation authority, the civil aviation authority of Malaysia (CAAM) that permits drone owners to fly up to 400 feet high and you can't fly within 50 meters of any individual. In the European Union, you can fly an automaton up to 500 feet from the beginning. This is to prevent any interference with airplanes.

3.4. *Mission Completion Time*

For a drone to last long on its flight to complete its mission you need a long lasting battery that can at least last up to 25 minutes. Aside from the battery the weight can affect your drone flight time. Drone add-on also plat a major a major role of any extensions attached, one of the biggest interest of drone ad-on is the camera therefor the heavier the camera is the less time your drone flight will be and the weather matters too, you have in a calm weather and avoid strong winds, rains and any other unsuitable weather [8]. Strong wind can majorly affect your drone flight time because the battery works harder to power through it. Drone can be applied and be useful in different scenarios and the following is an example of a practical example of WILDFIRES in which a drone is being used.

3.5. *Wildfire*

A wildfire, Wild land fire or rural fire is an uncontrolled fire in a region of burnable vegetation happening in rural areas. Depending upon the sort of vegetation present, a rapidly spreading wildfire can likewise be grouped all as a wildfire, bushfire (in Australia), desert fire, forest fire, grass fire, hill fire, vegetation fire or veld fire. Numerous organization think about wildfire as unplanned and undesirable fire, while wild fire is a more extensive term that include prescribed fire just as Wild land fire use (WFU) these are additionally called response fires. Fossil charcoal demonstrates that wildfires started not long after the presence of terrestrial plants 420 million years prior. Wildfire's event since the commencement of terrestrial life welcomes conjecture that fire probably had pronounced developmental consequences on most ecosystem widely varied vegetation. Earth is a characteristically flammable planet attributable to its cover of carbon-rich vegetation, seasonally dry climate, atmospheric oxygen, and broad lightning and volcanic ignitions [8-10]. In the case of wildfire to monitor the situation on the ongoing fire a drone is used.in this disastrous situation we need a quad copter drone with

savor motors, battery, pay load of 6kg and a thermal camera sensor. The UAV is fitted with an integrated thermal camera sensor for monitoring a controlled burn and use during post fire cleanup for hot spots detection from above. The following parameters must be considered in order for UAV to work to its maximum potential: frame, transmitter, receiver, power, propellers, motors, ESCs (electrical speed controller) [9].

4. Signal to Noise Ratio

Signal-to-noise ratio (abbreviated SNR or S/N) is a measure used in science and engineering that compares the level of a desired signal to the level of background noise. SNR is defined as the ratio of signal power to the noise power, often expressed in decibels. A ratio higher than 1:1 (greater than 0 dB) indicates more signal than noise.

The transmission of information from one point to another is called data link. When this transition is accomplished using wireless means the data link is now called radio link or radio modem

In unmanned aviation, the data link permits the transmission and gathering of information between the autopilot in the aircraft and the Ground Control Station (GCS).in order to transmit information we have two links called uplink and downlink. SNR is considered when receiving information using data links, SNR compares the level of a desired signal to the level of background noise. The higher the SNR the better signal quality.it is given by the formula below [10]. When measuring signal-to-noise-ratio there are two basic elements to the measurement, one is noise level and the other is the signal. The signal often includes noise due to the way measurements are made in which the signal level is assumed to be much larger than the noise hence it is considered signal plus noise.

5. Results and discussion

In this paper, the main objective is to analyse the drone performance based on signal to noise ratio. Therefore a parametric study on the effects of changing distance, frequency and transmit power of the UAV are analysed and these are the only parameters that we are focused on in this paper.

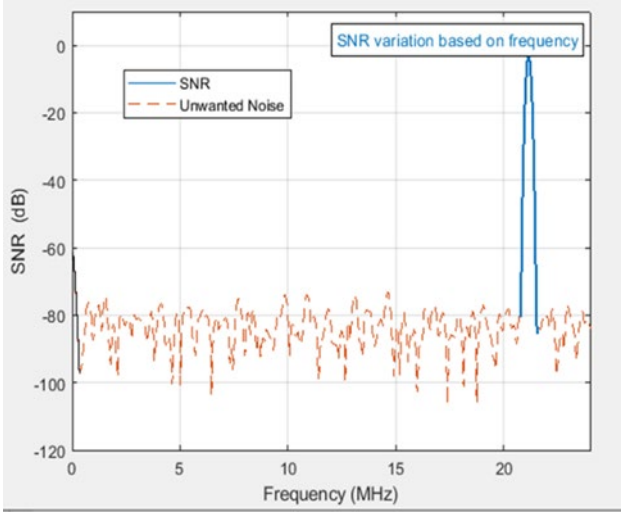

Fig. 2. SNR Variation in relation to frequency

Fig. 2 shows the SNR variation in subject to frequency, the graph also shows the noise within space and signal strength closer to the transmitter. The SNR to a given frequency band is sensitive as different frequency band will vary causing the SNR to be affected. Typically, the input voltage for SNR threshold level of 10dB is stated and the noise level threshold of -90dBm is being used. Based on the SNR the transmitter and the receiver will negotiate a data rate with which to communicate. In a free world propagation where there is nothing blocking SNR the frequency plays a major role in communication system. While the transmit power and the distance is maintained the frequency is affected where we have buildings and trees, the signal wave is affected hence causing the SNR to be affected so if we are going to a lower frequency the SNR is reduced and If we going to a higher frequency the SNR increases hence making the connection strong. Therefore, every move away we lose the frequency and the higher the SNR the better because higher data rate can be used to increase the communication.

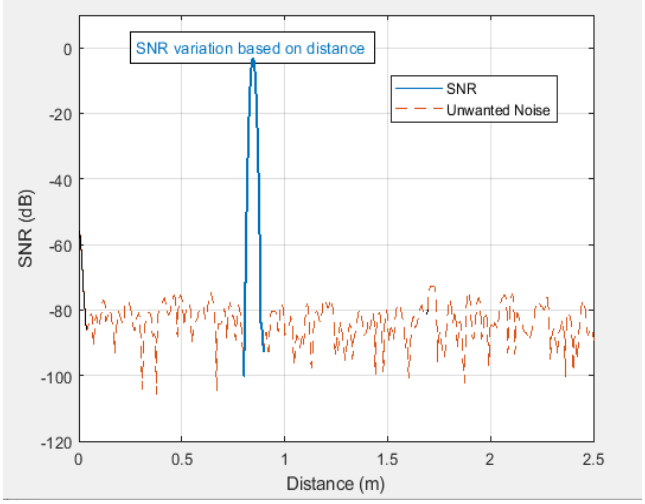

Fig. 3. SNR variation subjected to distance

Fig.3 shows the SNR as function to distance, the graph also shows noise within space and signal strength over a distance as a curve that has the best signal strength closer to the transmitter, the SNR threshold level is 10 dB however for a good performance SNR must be greater than 20 dB, to analyze the performance the frequency threshold of 2.4GHz and power threshold of 1W are maintained and the distance is changed, the SNR is affected as we move away from the signal. When we are at a distance of 1m and frequency of 10MHz with a transmit power of 1W, we have a stronger signal due to less noise that come around the receiver but as we move further away we get lower SNR caused by noise that can come from the remote control, phone, Bluetooth, trees and building distracting the signal more, hence the SNR is affected by distance. Therefore, SNR at a larger distance will require a higher frequency and power.

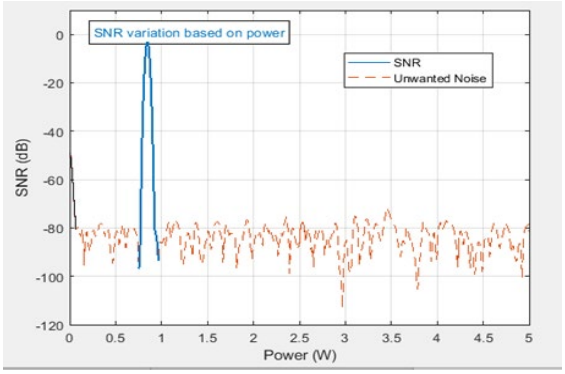

Fig. 4. Effect of power on SNR variation

Figure 4 shows the SNR variation with power, the noise and signal level strength. The noise reduce the distance that the transmitted signal can travel the main concern here is to make sure the transmitted power is high enough to overcome thermal noise that is contributed by the communication system. The transmitted power decreases over distance in watts/m2 and density hence the power received is already lower than that which was transmitted. Transmit power must increase to ensure high SNR, therefore, to overcome covering a larger distance of SNR we increase our power or amplify the noise.

6. Conclusion

The importance of a UAV operation in recent years have been shown in this paper. It can be very useful for temporal communication in disastrous scenario. However issues with UAV application and factors affecting them must be addressed and where they can fly according to the rule and regulation for UAV according to the region and country. On the other hand wireless network communication is one of the key points that make unnamed air vehicles more useful other than other methods of commutations that are currently used. This paper describes the effects of distance, frequency and power on signal to noise ratio. As depicted in results, the larger the distance the more they affect the signal and the more frequency results to the better SNR. The result also proved the same effect from increment in power however, more power is required to overcome thermal noise in transmission.

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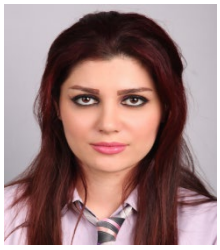

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