A Review Over Existing Handover Decision Systems For Drones In Wireless Network

Sonika Singh, Dr. Mandeep Kaur Sandhu

Abstract— The advancement in technologies has increased the customer's demands to meet various services. Moreover, in the wireless networks, unmanned aerial vehicles/ drones are experiencing prominent growth due to its various advantages. Drones are capable of providing a network area when the existing infrastructure is not enough to provide different services to the users. Besides, various benefits of drone network, handover is one of the major concerns which are needed to be resolved. A significant number of researches have been performed. This paper presented a survey that is conducted to understand the handover techniques designed for wireless networks in two dimensional and three-dimensional spaces. Through this survey, various major factors that affect the handover decision are observed. This paper illustrates the role of drones in the network and the issues faced by these devices to provide the network. This paper gives an overview of handovers in drones and different approaches designed to make effective decisions about the handover.

Index Terms— Unmanned aerial vehicles, Wireless network, Handover, Fuzzy inference system.

1 INTRODUCTION

THE advancement in wireless technology has a great impact on the day to day lives of the people. Specifically, the Internet of things (IoT) is emerged rapidly as a promising future technology [1-3]. With the help of IoT, it becomes possible to connect different devices present at different location together which eventually change the lifestyle. As a result, the demand for such ubiquitous communication is increasing in different areas, particularly in the areas where more activities are involved [4].Therefore, the demand for bandwidth has been growing in the current internet architecture. Thus, to resolve the issue of bandwidth, aerial networks are introduced by exploiting or drones unmanned aerial vehicles (UAV) [5,6] which are demonstrated in fig. 1.

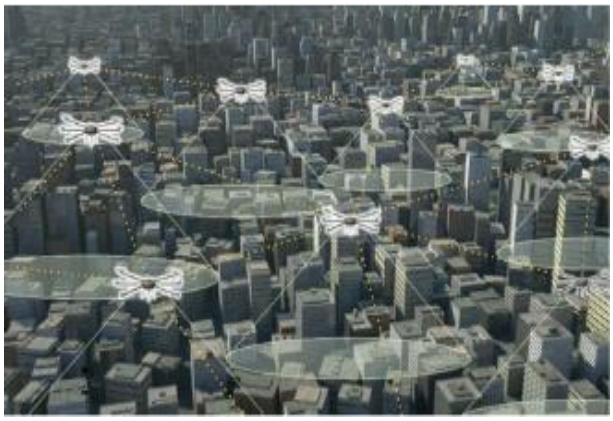

Fig. 1. Illustration of drones [7]

With the deployment of such a network from the sky, it is possible to use an idle wireless medium. It has high mobility due to the absence of ground obstacles. These networks are utilized when there is an urgency of setting up the network in the areas suffering from the disasters or where the more cost and time is consumed for establishing an additional infrastructure of the network.UAVs are referred to the aircraft that can fly without a pilot and passengers. The drone is controlled with the help of radio waves. It is also controlled by setting a predefined route for the drone. In general, there is no particular size or type of drive. Drones are mostly equipped with the important accessories which are required for monitoring and surveillance, through the optoelectronic heads. Drones have many benefits; one of them is that there is no requirement of any additional infrastructure for rapid registration and monitoring of the designated object or the area. Another significant benefit is attained during commissioning and preparing the unit for a flight that it experience extremely short reaction. Basically, these drones are originated from the aircraft which are utilized in the uniformed services such as the police and the army. UAVs were first researched by several countries - the United Kingdom, the United States, Germany, Russia, and Israel. In August 1849, the first unmanned flying vehicle was utilized by the Austrians. During that period, balloons filled with explosives were used to fly the object. This technique has been known for nearly 150 years.With various benefits of the drones, still there is need to resolve some technical issues of drones. Existing drones can be utilized as a Wi-Fi access point (AP) because of limited payload which is due to the lightweight of the hardware for Wi-Fi than that for LTE [8]. The main concern on which this paper is focused is the handover (HO). It is a bit complex to perform an efficient seamless handover in traditional wireless networks it has narrow communication coverage as compared to a cellular network and it take more time to complete a handover procedure. [9]. In addition, the decisions of HO basically assume the same coverage for every access point which is not applicable for UAVs at different height s and elevation [10].In a dynamic drone network such as providing information to the users under special conditions which involves replacement of the drones or the movement of the drones in a specific form (according to the status of the user or the drone), it is not possible to perform handover with existing HO technology.

2 DRONES

In general, drones or unmanned aerial vehicles are introduced to set up the network where more cost and time are consumed or in the regions where it is not possible to set up the

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infrastructure. The fig. 2 illustrates an extended coverage with the utilization of UAVs.

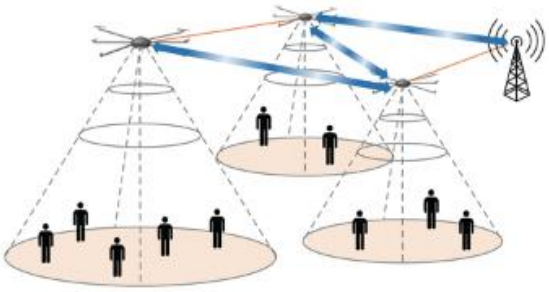

Fig. 2. Net drones covering extended area [7]

Thus, it is possible to increase the degraded performance of original infrastructure due to unexpected disaster or increase in the population. Drones provide an emergency network infrastructure which is capable of offering on-demand services from the sky to the users.

IEEE 802.11 WLAN (Wireless Local Area Network) technology and proprietary radio technologies are employed in most of the commercial drone systems for sensor data and command and control operations respectively. However, IEEE 802.11 is not capable of providing strict service requirements of predicted applications of drones due to high relative speeds, mobility and varying altitude. For instance, if the operation is performed in an unlicensed spectrum, it would raise the issues regarding security and reliability. Therefore, cellular network is taken as an alternative solution for drone communications. From the current architecture of network, there are several benefits o drones in terms of reliability, security and coverage at suitable or appropriate data rates several applications. But cellular networks were not developed for flying devices. Although, different standardization activities are being initiated [11], but still, there is need to resolve the issue of radio coverage and interference [12] cellular connectivity can be the better alternative for drones [13]. When the drones are integrated with the cellular network, there are different roles that can be played by drones [14] such as they can act as relays or mobile base stations [15]. The main purpose of this role is to enhance the coverage, connectivity, and capacity. Also, in the area with no fixed network architecture, radio access networks can be easily deployed. In [16, 17], authors have discussed about the drones that carry small base stations. Furthermore, drones as relays are presented in [18] [19].it is a type of setup which can be implemented in the disastrous situation to provide relief from investing time and cost on new infrastructure and also helpful in offering extra capacity and coverage during large, temporary gatherings of people like concerts and sport events. To understand the working of drones, it can be considered as the user equipment (UE) which acts like a mobile phone flying in the air. The downlink from the drone can be used for steering and controlling during the flight of the drone and uplink from a drone to a base station can be utilized for transmission of the data to the ground for processing.

3 HANDOVER IN DRONES

This section explains how conventional handover for drones takes place in a three-dimensional space

3.1 Net-Drones in the Three-Dimensional Spac

The drones are present in 3D space whereas the conventional network has its infrastructure in the two-dimensional area. The drone coverage in 3D space is represented in fig. 3.

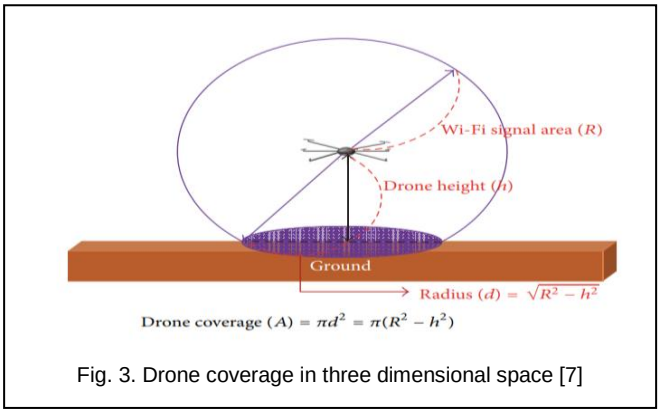

Fig. 3. Drone coverage in three dimensional space [7]

Basically, the coverage area of a UAV is computed by using the following equation:

$$A = \pi d^2 = \pi (R^2 - h^2) \quad (1)$$

Where h is the height of the drone, R is the radius of the transmission range of drones, and d is the radius of the coverage performed by the drones for the ground users.

Various studies have been performed for handover decisions using different approaches and algorithms [20]. It is countered that optimal coverage decision relies on the received signal strength (RSS). Following equation can be used to compute the strength:

$$RSS_{cur} = RSS_{\min} - 10\,\beta \log(d) + \varepsilon \quad (2)$$

In the above equation, the minimum level of the RSS needed for the mobile terminal with a distance of 1meter between the sender and the receiver is denoted by $RSS_{\min}$. Further, path loss exponent is presented by β presents the β and distance between receiver and sender is denoted by d. the distance is computed in meters. At last, ϵ symbolizes the zero-mean Gaussian random variable with a standard deviation. It demonstrates the statistical variation in the RSS caused by shadowing in dB. In fig. 4, L3 handover is triggered when the received signal strength is the same for the adjacent drones [20, 21] i.e. denoted by the middle point in fig. 4.

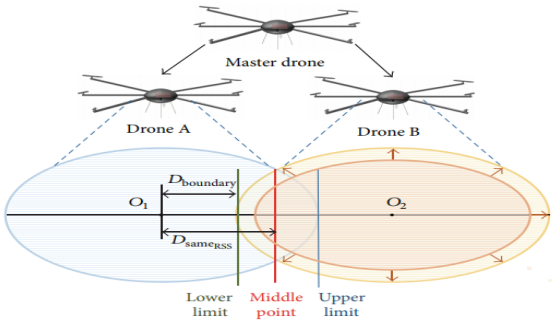

Fig. 4. Distance from drone A to B in handover procedure. The coverage of drone varies according to its height [7]

4 HANDOVER TECHNIQUES

This section presented the survey taken into account to analyze the different techniques used for handover decisions in aerial networks for drones.

Kyung-Nam Park, et al. [7] presented the handover technique

for 3D space-based aerial network. It makes it different from traditional two-dimensional schemes. In this method, the altitude of the drones and their distance with each other is adjusted. The probability of seamless handover success and the false handover initiation is determined for the evaluation of the optimal coverage decision algorithm. This technique is proved efficient in performing seamless handover in 3D space.

Manoj Sharma et al, [22] proposed a handoff decision scheme in order to select an appropriate network. Moreover, a fuzzy logic approach has applied in order to cope up with the inaccurate information of certain criteria as well as user preferences. The introduction of fuzzy logic concluded that the performance of the fuzzy in terms of selecting an appropriate network was effective. From the result analysis, it has been concluded that fuzzy performed appropriately in making multi-criteria decision.

Presila Israt et al, [23] developed a fuzzy logic system based novel and adaptive handoff management mechanism collaborated with existing cross-layer handoff protocol. The performance comparison between existing and proposed techniques had taken place which concluded that the proposed protocol outperformed the traditional protocols with the perspective of intra-system and inter-system handoffs.

Harvinder Gill et al, [24] designed a vertical handoff scheme by using the Fuzzy logic toolbox in MATLAB as a platform and the developed technique was most suitable to the WWAN and cellular network. There was a total of eight parameters that were involved in the system formation termed as FQDA i.e. fuzzy logic Quantitative Decision Algorithm. This technique has used 81 rules as compared to the 6561 rules required for 8 attributes. Few of the handoffs had been attained using a modified fuzzy method in comparison with the traditional method.

Yaw Nkansah et al, 2006 [25] considered multiple criteria based vertical handoff decision making algorithms models along with their implementation. These vertical handoff decision algorithms exemplified in heterogeneous wireless wide area network i.e. WWAN and wireless local area network (WLAN) environment. This technique was based on the workforce automation field based on IP that provided free movement while connected with IP mode between networks and the use of a single device on multiple networks. This paper utilized a fuzzy logic inference system for processing the multi-criteria vertical handoff decision metrics.

Yashi Agarwal et al, [26] proposed a novel vertical handoff technique used for the integration of Wi-Fi (IEEE 802.11) as well as WiMAX i.e. IEEE 802.1M6 wireless network which was based upon fuzzy comprehensive. This paper considered several factors such as signal to noise ratio, moving speed of the terminal and strength of signal. The network Simulator NS2 and NS3 had used in this paper for the purpose of simulation.

Peng Yang et al, [27], introduced a novel speed adaptive system knowledge scheme in order to improve or update the rate of the candidate network set. Then, the author had modeled a decision algorithm for vertical handoff collaborated with fuzzy logic and pre-handoff decision method for making effective and efficient decisions. A comparison analysis had been done to analyze the performance level of the proposed work in comparison to the traditional RSS work. The results acquired from the simulation concluded that the proposed algorithm improved the performance in view of reducing unnecessary handoffs while balancing the resources of network as well as decreasing the rate of call blocking and dropping.

K.Bhagya Lakshmi et al, [28] surveyed several handoff algorithms used for the purpose of reducing handoff in the network. From the survey conducted, it has been concluded that most of the existing algorithms were designed to rendezvous individual desires which is not a good presentation scheme.

Wenhui Zhang, [29] developed a novel handoff decision-making approach by defining novel handover criteria. Furthermore, a handover decision had been taken by using a fuzzy inference system that supports the multiple attributes for handoff decision-making problems along with it deals with the issue of imprecise information. This paper has analyzed fuzzy MADM methods and based on this a feasible approach has been shown. Finally, several proposed methods on the basis of these approaches have been presented and their sensitivity has also analyzed.

Vikas.M.N et al, [30] presented a handoff mechanism in cellular networks based upon optimization algorithms. The proposed method was collaborated with the fuzzy logic approach and simulated annealing algorithm in view of automating the tuning process. The inference option performed in fuzzy logic was done at high speed, on the counterpart, tuning performed at a lower rate. The proposed fuzzy controller took two inputs and produced one output. There were seven membership functions defined for both input and output on an 8-bit resolution. In the fuzzy controller, two levels of pipeline have defined in which arithmetic, as well as inference options, were overlapped with each other. The simulated annealing mechanism was used to adjust the membership functions of triangular and singleton in view of reducing the cost function. The Xilinx SPARTAN3XC3S200 series FPGA device had been used to implement a self-tuned fuzzy inference engine.

Ali Safa Sadiq et al, [31] experimented a new fuzzy logic system based handoff decision-taking scheme for wireless network communication. The proposed system has taken two inputs parameters such as received signal strength indicator and second one was relative direction of a mobile node. These inputs were forwarded to the fuzzy logic system to facilitate the process of handover decision and evaluated the best preferable access point near the mobile network. This proposed technique had been implemented in Omnet to make comparison with the conventional handover procedure in fast mobile IPv6 and RSSI threshold approach.

Md. Tajul Islam, et al. [32] developed two approaches of vertical handover in heterogeneous environment in which fuzzy interference system and subtracting clustering method had been utilized. It is observed from the simulation that the technique make the HO procedure easy fast between different protocol users. Moreover, it used the concept of priority.

Thiago Coqueiro et al.[33] proposed a method in which fuzzy logic is used. This technique saves the energy of mobile devices within an integrated LTE and Wi-Fi network. This technique provides effective handover by utilizing QoE metrics.

E. Lee, et al. [34] developed a scheme in which speed limit and coverage are taken into consideration as the parameters to perform handover in 3 D space. A fuzzy inference system was designed for the HO decision which comprised four steps. The steps include the analysis of the terminal-related information for selection of the factors affecting the Handover

TABLE 1
TECHNIQUES DESIGNED FOR EFFECTIVE HANDOVER DECISION

Author name	Parameters and technology	Outcome
Kyung-Nam Park, et al. [7]	Altitude of drones and distance of drones from each other.	It performs efficient and seamless handover in three dimensional spaces.
Manoj Sharma, et al, [22]	Fuzzy logic approach	This model is capable of selecting the appropriate model and making better handover decisions.
Presila Israt, et al, [23]	Collaboration of Fuzzy logic approach and cross layer handoff protocol	It efficiently performs intra-system and intersystem handovers.
Harvinder Gill, et al, [24]	Fuzzy logic Quantitative Decision Algorithm	It reduced the number of rules use for fuzzy model and reduced the handoffs.
Yaw Nkansah, et al, [25]	Fuzzy inference system	It utilized multiple criteria for taking handoff decision.
Yashi Agarwal, et al, [26]	Signal to noise ratio, moving speed of the terminal and strength of signal	The connectivity strength was increased and the ping pong effect was also reduced.
Peng Yang, et al, [27]	Fuzzy logic and pre-handoff decision method	Unnecessary HOs are reduced. The resources are balanced in the network. The rate of call blocking and dropping was reduced.
K.Bhagya Lakshmi et al, [28]	Fuzzy reasoning approach	It chose the best network to perform handover.
Wenhui Zhang, [29]	Fuzzy inference system	It is observed to be better approach in terms of carrying out any handover in the network
Vikas.M.N, et al, [30]	Fuzzy inference system	Handover in cellular networks is performed efficiently. The cost function was also reduced
Ali Safa Sadiq, et al, [31]	Fuzzy logic system Received signal strength indicator and Relative direction of a mobile node	Handover latency is reduced which in turn enhances the performance and wireless access media delay was also reduced.
Md. Tajul Islam, et al. [32]	Fuzzy interference system and subtracting clustering method	It makes the handover process feast and easy to implement.
Thiago Coqueiro, et al.[33]	Fuzzy logic in an integrated LTE and Wi-Fi network	It provides effective handover by utilizing QoE metrics
E. Lee, et al. [34]	Fuzzy inference system by utilizing speed limit and coverage	consideration of terminal-related parameters and the network-related parameters had shown a positive impact in the enhancement of the handover decision
Vishal Sharma, et al [35]	Handover latency, signaling overheads and E2E delay are considered.	Fast handovers and efficient management was performed. The combination of UAVs and small cells gives effective performance.
K. Park, et al. [36]	Probability of success and false handover initiation	Seamless handover was achieved in aerial network

decision for drone. Membership functions and rules were generated. Eventually, the decision regarding the handover is taken by using the current status of the drone. It is observed from this research that consideration of terminal-related parameters and the network-related parameters had shown a positive impact in the enhancement of the handover decision.

Vishal Sharma, et al [35] designed a mechanism to attain fast handovers and efficient management. In the research handover latency, signaling overheads and E2E delay are taken into consideration for taking handover decision. This scenario was helpful in understanding the impact of existing handover approaches in the upcoming 5G. The results of the study delineate that among only small cells and a combination of UAVs and small cells, the latter has better performance.

K. Park, et al. [36] designed an effective coverage decision algorithm to attain seamless handover in a wholly connected aerial network. The probability of success and false handover initiation of the seamless handover was computed. From the analysis, the projected scheme was countered as a better solution for handovers in an aerial network.

The overall summary of this survey is represented in the following table 1.

5 CONCLUSION

Handover is the major concern in the aerial network as these networks are not similar to that of cellular networks. Thus different researches have been carried out to understand the handovers decisions for unmanned aerial vehicles. This paper reviewed a significant number of researches to analyze the work that has been performed to this end. Drones are becoming very popular and a promising solution is required to take HO decision. From the survey, it is concluded that a fuzzy inference system has given a better and promising solution till now. Also, received signal strength plays an important role in taking the decision. Besides this, there is a scope of enhancement in the existing techniques which can be done by introducing novel technologies

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