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Unmanned Aerial Vehicle Design for Smart City Application

Birasalapati Doraswamy[1*], M. N. Giriprasad[1], K. Lokesh Krishna[2]
[1]Department of Electronics and Communications Engineering,
Jawaharlal Nehru Technological University Anantapur (JNTUA),
Ananthapuramu, Andhra Pradesh-515002, India
[*1]Email: dsbira@gmail.com, {[1]e-mail: giriprasadmn.ece@jntua.ac.in}
[2]Department of Electronics and Communications Engineering,
SV College of Engineering, Tirupati, Andhra Pradesh-517502, India
[2]e-mail: kayamlokesh78@gmail.com

Abstract- Nowadays, Unmanned Aerial Vehicles (UAVs) or drones are also one of the applications to provide the required services and to gather information from the target location. Because smart city applications effectively deal the drone interaction and enhance the human lifestyle with drones. Moreover, UAVs are generally utilized due to their privacy threats, lower cost, pose security, and versatility, which request dependable detection at lower altitudes. However, the less sensing module in the drone has earned the low sensing accuracy of location tracking. So, this paper aims to develop a novel Firefly-based Recurrent Neural Mechanism (FRNM) to enrich the sensing capacity of the drone vehicle. In addition, the sound of the research is medicine delivery through UAVs in emergencies. This UAV system is one of the most crucial features to delivering essential medical items aids by reaching properly correspondent patients. Moreover, the client's needs are stored in the FRNM cloud then that stored data is trained to the UAV machine. Hereafter, based on the trained details, the drone can reach the destination and has delivered the requested medicine to the specific clients. The planned design is drawn in Network Simulator (NS2) environment, and the robustness of the projected replica is valued by calculating the chief parameters. Hereafter, the improvement score was valued by the comparison assessment. Hence, the FRNM has reported the finest performance by earning less location finding duration, running period, and error rate.

Keywords*:* Medicine delivery; Sensing module; Client requests; Optimization; Recurrent neural deep learning.

I. INTRODUCTION

Nowadays, intelligent facilities are much-needed to get the daily need for survival [1]. Everyone can realize the need and advances of the smart city during this COVID pandemic [2]. So in these cases, several people are affected by living conditions, the economy and health [3]. In that situation, UAVs [4] have been used to supply food and medicine [5]. Hence, this technology was welcomed by many people to protect their lives from the COVID pandemic and to get the needed things at the required time [6]. On the other hand, to manage the public in an emergency or other pandemic situation [7], the governing and urban environment could be more suitable for rapid services [8]. So, the smart application is the needed framework for economic and lifestyle development [9].

In the COVID situation, the UAV application can be utilized a lot to reduce the COVID risk by avoiding crowds in public places [10]. So, the crowd was formed to get the needed thing for people's survival. The needed items are shared with specific users using drones, like door delivery [11]. For this drone application, the Internet of Things (IoT) [12] is the most required parameter to sense the public situation and to start the service policies [13]. Hence, many research works have proved that, without IoT, the smart city becomes a dream [14]. So, the IoT plays an essential role in all smart city applications, especially drone appliances, to collect data in the particular target cities and to send the data to the management [15]. Moreover, the drone's sensing function is based only on the updated deep or machine learning model. So to sense the needed data, the intelligent model should be designed with the required parameters [16, 17].

Here, the UAEs system constantly connects to the base station and receives updates on atmospheric conditions and weather data. This makes it sensible, and it decides to optimize the path dynamically [18, 19]. This is necessary to avoid aberrant atmospheric behavior and destructive potential by considering the real-time problem and needs, such as geographically challenging regions to trace and provide critical little things, medical kits, and so on [20, 21]. Although roads serve and justify the link to residential areas, severe weather conditions and some transportation challenges prevent medical products from being delivered on time. Many organizations have adopted drone technology to tackle such issues, which has developed as an innovation [22, 23].

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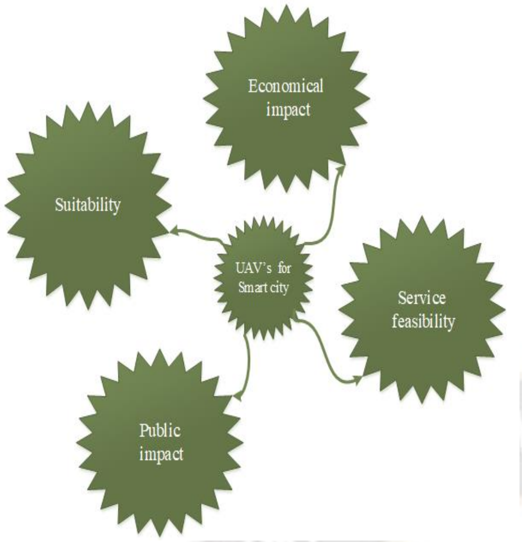

Figure 1. UAV for smart city

Several architectures, like automated decision [24], light polarization [25], etc., have been implemented in the past to train the UAVs with people addresses, but they gave inferior results because of the effective algorithm. Therefore, the present research has aimed to develop a novel optimized deep learning mechanism in the UAV application to improve the sensing function. The process of the current research article is described as follows,

- Initially, the user needs are trained to the system and stored in one specific folder
- Then the required number of UAV's was designed, then the address of each user is upgraded to the UAV memory
- Then a novel FRNM was designed to find that exact user location with the use of training data of UAV's
- Hereafter, the performance metrics are calculated based on location identification, energy usage, delay, Run time, mean square error

The sections of the discussed research work is described as follows, associated works related to drone appliance is exposed in section 2, System model with issues are explained in section 3, section 4 has detailed the planned novel concepts, the outcomes of the discussed procedures are drawn in section 5, then the research discussion is end in section 6.

II. RELATED WORKS

This section provides a general examination of the proposed DL and UAV models and frameworks for medical networks and technology. This has been claimed in data collection jobs and secure remote access to social media platforms, among other things. The cumulative popularity of UAVs in mobile networks is the connectedness of various social networks, increasing data exchange across networks, and the empowerment of social robotics research. Recent Associated literatures are discussed below,

IoT has played an important role to enhance the smart city facilities by collecting the patient data through the specific sensors. Gera *et al*. [24] have designed an automated decision making scheme to diagnosis the disease from the gathered data. Hence, this system has attracted by many users. But in some time the data transmission delay has occurred.

Beg *et al*. [25] have presented the light polarization strategy in UAV system to identify the emergency cases and to consider it as the first priority of medical services. Hence, this model is useful to predict the emergency cases by traffic. Some of the emergency cases can easily be identified are violation, accident, etc. But this model has consumed more energy services.

Richards [26] has designed the fly high approach to afford the medicine door to door delivery by knowing the needs of people needs. Here, the importance of civil structure was highlighted, because based on the civil structures the user location was found. Moreover, the shareholder activities also combined in UAV's to offer the better delivery rate. But the trained structure details in UAV's might cause transmission delay.

The drone application was well utilized in COVID situation to reduce the disease spreading issues by delivering the people needs to door-to-door delivery system. So, Cheema *et al*. [27] have designed the drone system with the use of artificial intelligence strategies. Here, the drone application is framed with artificial intelligence strategy for making the appropriate decision to find the people needs. But, framing the design has taken more time.

To enable the security to the public and to know the user needs, Ullah *et al*. [27] have designed deep learning based UAV sensing module with 5G services. Moreover, the proposed system is checked with different intelligent models, still the finest results are only got for the security monitoring and capturing module. However, it has failed to predict the user needs in an accurate way. The process of the current research article is described as follows,

- Initially, the user needs are trained to the system and stored in one specific folder.
- Then the required number of UAV's was designed, then the address of each user is upgraded to the UAV memory.
- Then a novel FRNM was designed to find that exact user location with the use of training data of UAV's.
- Hereafter, the performance metrics are calculated based on location identification, energy usage, delay, Run time, mean square error.

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III. SYSTEM AND PROBLEM STATEMENT

Nowadays, the application drone became the most needed sector in this society to improve the people's life style and to reduce the human risk and effort. Also it is very useful in natural disaster situation. Nevertheless, the majority of current commercial UAV applications require an operator to pilot the vehicle using distant controller expedients [28]. Instead, the introduction of self-sufficient UAVs for the manipulation of processes that found dramatic variation in the dual comportments of cargo logistics and deliveries in smart cities has captivated the shipping logistics and delivery businesses [29]. As a result, it is critical to address the responsiveness on certain technological characteristics of UAVs, whose appreciation facilitates the appraisal of the actual potential of such vehicles [30].

However, designing the decision model in the drone is the most complicated task because of vast data. In many scenarios, it is utilized to deliver the things to the people but identifying the people location using the trained data is some more complex. Advances in technology cause an increase in the competences and effectiveness of UAVs, resulting in their rapid evolution or application in various areas such as medical, engineering, profitable, and entertainment applications, that is, the ability to gather real-time data at on-time delivery, cost-effectiveness and on-time payloads deliveries [31]. This issues have been motivated this present research work towards this drone application in smart city area. The system description with issues is explained in Figure 2.

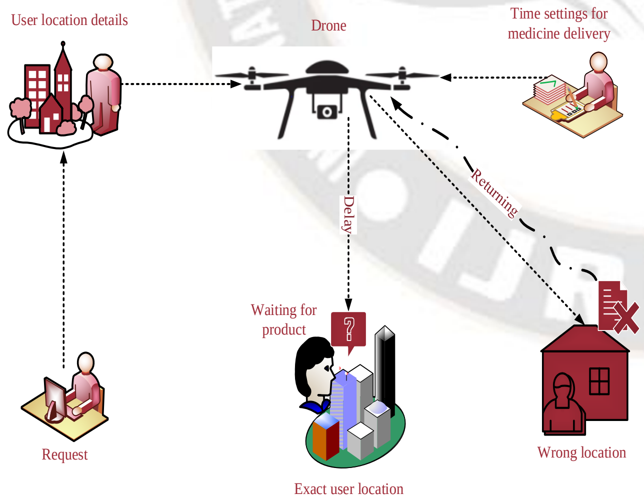

Figure 2. System model with identified issues

IV. PROPOSED METHODOLOGY

The present research work has focused to invent innovate drone application system for door-to-door medical supply system. Moreover, a novel Firefly based Recurrent Neural Mechanism (FRNM) was designed to sense the requested user location.

Initially, the needs of user related to medicine is stored in the cloud storage, by analysing the cloud data the location of users was identified. Then that address of the user is updated in drone memory then with the help of FRNM the location of user was found and medicine was supplied. Then, the optimization fitness function is updated to the classification layer or identification layer of the neural network. Based on this updated fitness module the correspondent user agents are sensed and medicines are supplied to the requested users with the help of UAVs. Hence, the planned model is described in Figure 3.

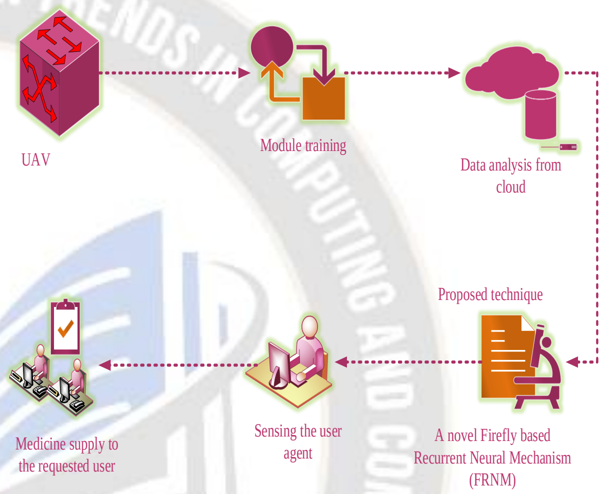

Figure 3. Proposed methodology

4.1 Process of FRNM methodology

The planned model is the combination of meta-heuristic and DL approaches. Here, the meta-heuristics as firefly algorithm [29] was utilized and the recurrent neural layer is used as DL model. Combination of these two strategies can provides finest results in terms of performance metrics. Several optimizations are utilized in different numerical solution; however, the reason of selecting this particular firefly algorithm is to find the target location with accurate measure. Usually, the fitness of the firefly is based on distance prediction between the partner fireflies. This reason has turned the interest to make use of firefly in this UAV application.

- FRNM Cloud constructer

The need of this frame is to receive the user needs and stored in the recurrent neural system memory. Several blocks are designed to save the user needs in day order, numerous things users can requests different items. But, the current research article has primarily focused the medicine supply in the emergency situation. So, from the set of requested data, medical data request are identified in the initial stage. The gathering process of the user's requests is exposed in eqn. (1).

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$$C_r = gather(n^*) \quad (1)$$

The FRNM cloud design is visualized in Figure 4, it contains totally four blocks like user needs, medicine requests, other requests and location saving blocks.

Here, the cloud side receiver is defined as C_r and the user requests or needs are defined as n^*. When, the user's needs are received then it has been stored in the memory layer, the detailed stored in the memory layer was users' needs and location address.

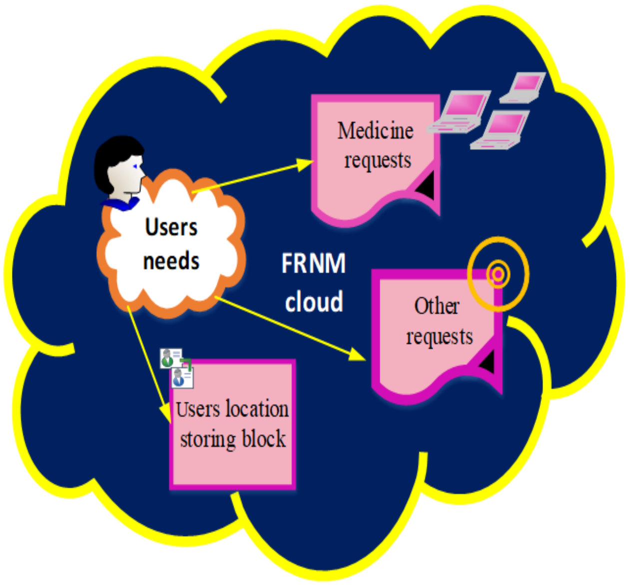

Figure 4. FRNM cloud design

4.2 UAV training phase

Users requests and location details are stored in the recurrent hidden frame, hence the activation of the hidden frame is described using eqn. (2),

$$f(h) = H_a(V_m p(h)) + V_n f(h-1) \quad (2)$$

where, the activation parameter of the hidden layer is denoted as $f(h)$, H_a is the hidden function variable and the hidden output metrics are denoted as H_o. Also, $p(h)$ and $q(h)$ are the input & output vector variables. Moreover, the 3 correlation matrices have been determined as V_m, V_n and V_o. The output vector variable is defined using eqn. (3),

$$q(h) = H_o(V_o\, f(h)) \quad (3)$$

Here, ua is the user address and uaN means n number of user address, these details were trained to the UAV's, which are ready to travel. Hence, FRNM layers are drawn in Figure 5.

After, the training phase, the time was set that has included start time P_Y and end time P_Z, also the error parameter is exposed as $pr_s(t)$.

$$\beta^s{}_{total}(P_Y, P_Z) = \sum_{t=P_Y}^{P_Z} pr_s(t) \quad (4)$$

Fe has denoted the firefly fitness, if the drone takes extra duration than the fixed end duration then the error value was reported. Here, $D_{Y,Z}$ is the distance amid starting and target.

$$P_{Y(t+1)} = P_Y + \beta^s(P_Y - P_Z) + R_d \quad (5)$$

The firefly best solution is upgraded to the classification layer of recurrent model to trance the requester destination. Hence, the parameter utilized to trace the right location is detailed as β^s, also, the reaching duration is represented as R_d. The designed FRNM procedure is exposed in Algorithm 1.

After specifying the time parameter, the path planning was designed in the sensing module that is explained using eqn. (6),

$$\beta^p = ap(P_Y - P_Z) \quad (6)$$

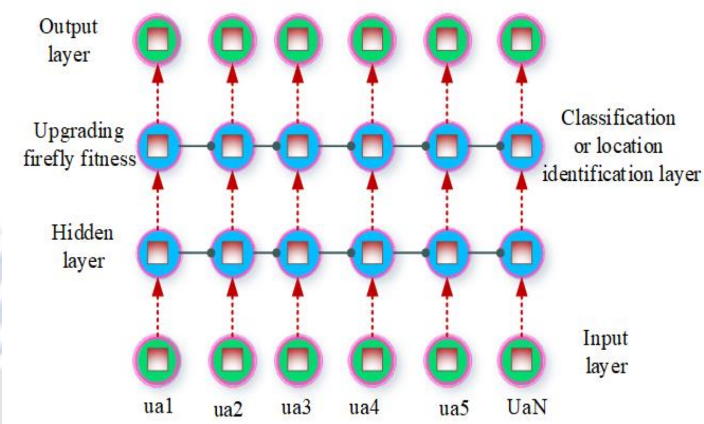

Figure 5. Proposed FRNM layers

Algorithm 1. FRNM

Start
{
Initialize *UAV's (g1,g2,g3)*
// Here, g1,g2,g3 are the utilized drones
User request storing ()
{
$$user \leftrightarrow needs + l^* \rightarrow m^*$$
// here, m^* *represents the memory layer and users location is denoted as* l^*
$$analyze = needs(subject)$$
// analysing the requested things
$$_{if}(subject = medicine)$$
{
Medicine requested user
}else (different things)
UAV training phase ()
{
$$_{Train}(n^* \& l^*) \rightarrow UAV$$

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// Here, n^* *is the user needs, the prepared UAV has been trained with users location and needs.*
}
UAV machine setting frame
{
$\text{int}\, Y, Z;$
//Here, Y is the travel initiating region of drone and Z is the target location

$$start(Y) \rightarrow end(Z)$$

$$endZ = user(l^*)$$

$$start(Y) \cap end(Z) \rightarrow np$$

// Here, np *is the nearest path, the UAV was moved by finding the nearest path*

$$UAV \leftrightarrow user = inital \leftrightarrow arival\ time$$

// By defining the users location to the drone, starting and ending time was fixed

Return $\rightarrow starting\ \ place$
}
Parameter estimation
}
stop

The available path identification between the source and target is values using eqn. (6), here, available path is depicted as ap and the path searching is determined by β^p Once, the available ways are found then the minimum way distance were found using the travelling time parameter.

$$\beta^p = time\_estimation(ap) = \min\_dis\tan ce \quad (7)$$

Hence, the travelling time of the available distance was measured by eqn. (7), finally, the minimum travelling time path was identified.

Moreover, the acceleration of the drone is depending on the weather condition, if the atmosphere has contained high rage of moisture and humidity then the acceleration of drone became slow. Also, it has required more duration to reach the end point. The UAV's functions and regulation process are detailed in Figure 6.

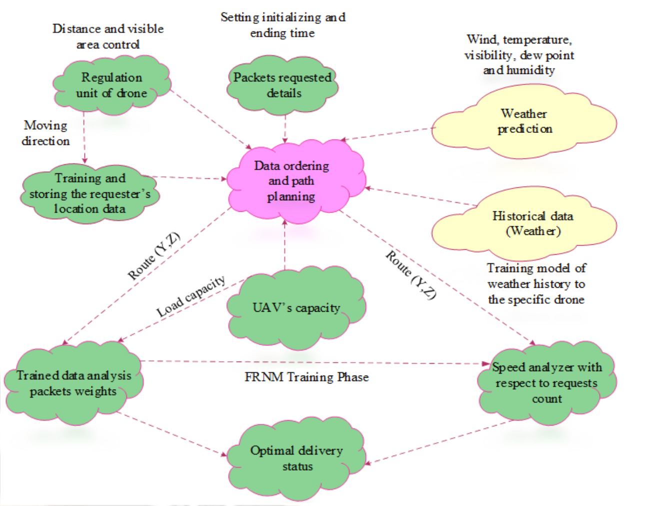

Figure 6. Internal process of UAV

V. RESULTS AND DISCUSSION

The discussed research work is executed in NS2 platform, and also running in UBUNTU platform. Initially, the require mount of nodes are designed with the appropriate lables, in those nodes some are medicine requested nodes (clients), UAV's, drone management and normal nodes (casual users). In the initial phase, the requester can send the needed medicine report to the FRNM cloud memory. In the NS2 platform, the FRNM cloud memory is named as drone management. Moreover, the clouds has included the descriptions abut users need and location. Hereafter, those stored data is trained to the UAV machine, the sensing module of the UAV was updated by the FRNM model.

Several optimizations are utilized in different numerical solution; however, the reason of selecting this particular firefly algorithm is to find the target location with accurate measure. Usually, the fitness of the firefly is based on distance prediction between the partner fireflies. This reason has turned the interest to make use of firefly in this UAV application.

5.1. Case study

To value the robustness rate of the constructed paradigm, initially 120 nodes are designed in the NS2 environment. According to this current research, the 120 nodes are considered as users or clients. The client's needs are saved in the cloud memory that hub is coloured as blue. Drones location sensing module is upgraded with the FRNM module.

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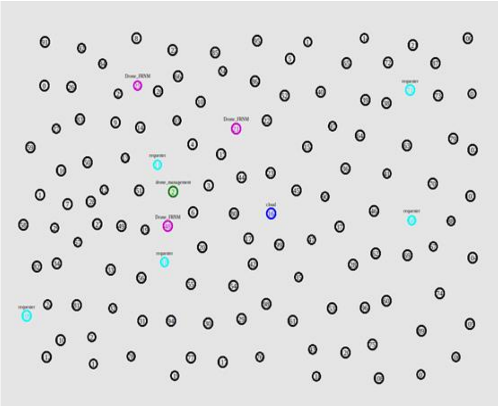

Figure 7. Node designed frame

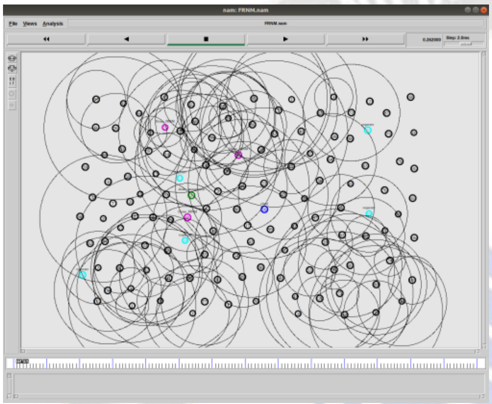

Figure 8. Data broadcasting and location searching frame

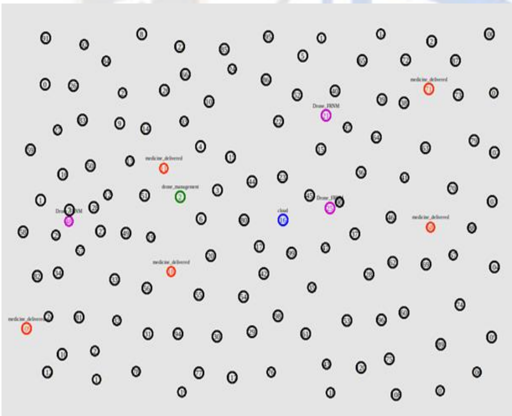

Figure 9. Request delivered

Here, totally 3 drones were utilized that is mentioned in the rose colour. To train the user requested details to the specific drone, drone management is needed that is denoted in the green colour. Also, the medicine requesters are represented in sky blue colour, the node designed frame in NS2 is explicated in Figure 7.

After training the user requests and their location to the drone, then it has initiated the location finding process that is depicted in Figure 8. For the drone application, the location was identified by the help of GPS. After the identification of all available paths, medicine is transferred to the requester.

Finally, the initiated drones have reached to the destination and the medicine was delivered that is viewed in Figure 9. When, the things were delivered then the drone return to the drone management location, in where it has been initiated. The red colour node has denoted the medicine delivered to the particular client.

5.2 Performance assessment

In any system validating the function is the crucial task to value the proficient score of the specific paradigm. Considering that, this performance assessment section is discussed broadly to justify the successive measure of the planned design. Hence, to estimate the planned design**,** 120 nodes are designed in the NS2 platform in that 3 Drones are set.

5.2.1 Travelling distance and duration

The travelling distance and travelling duration of the UAVs are important parameters to prove the proposed model efficiency. Here, three UAVs are taken as travelling distance and travelling duration with number instances, which are estimated that is drawn in fig.10.

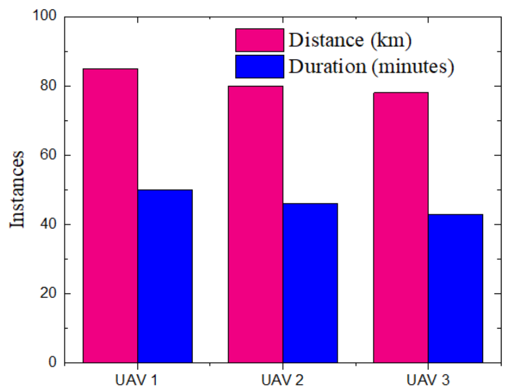

Figure 10. UAV's travelling distance and time

5.2.2 Error rate

After initiating the drone, based on the travelling and sensing process the error was measured. The measure of flaw was calculated in three phases that are duration error, distance error, and data training flaw in drone applications. The three states error estimation is tabulated in table.1 and fig.11.

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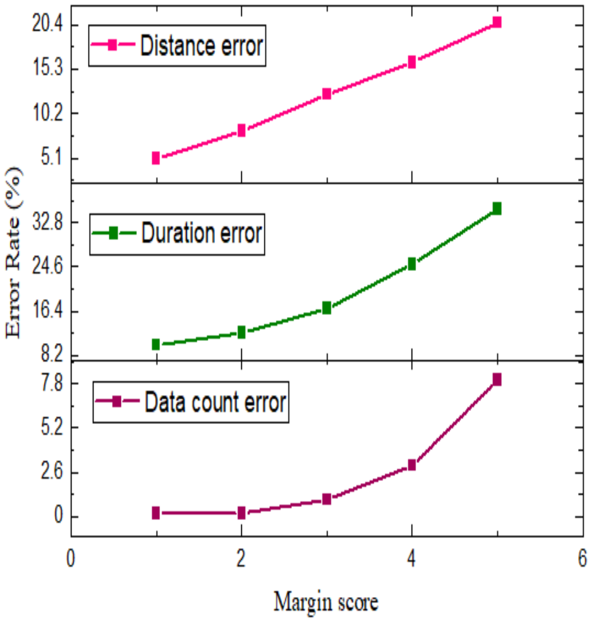


Figure 11. Error assessment

Moreover, error rate validation of the proposed module is calculated based on three error factors such as data count error, duration error and distance error.

TABLE 1 ERROR ANALYSIS

Margin score	Error validation		
	Data count error	Duration error	Distance error
1	0.2	10	5
2	0.2	12.3	8.2
3	1	16.8	12.4
4	3	25.1	16.1
5	8	35.3	20.6
6	16.2	30.5	2
7	14	39	27
8	20	44.9	24

As discussed in the proposed section, the rapidity of the vehicle is based on weather conditions. If, the weather atmosphere is clear then the UAV has the finest rapidity score.

5.2.3 Speed analysis

The speed of the drone is the crucial factor to maximize the robustness score because the drone system is enabled for emergency cases. So, the rapidity measure of the UAV application is the significant metric to maximize the drone system. Here, the acceleration of the drone is valued on the basis of the amount of packet delivery requests. The measured acceleration of the UAV is exposed in fig.12.

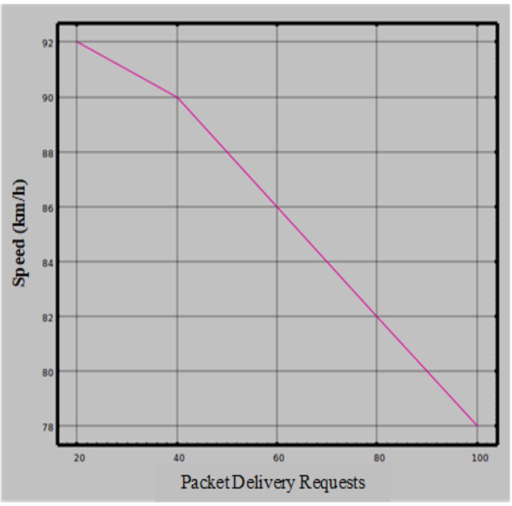
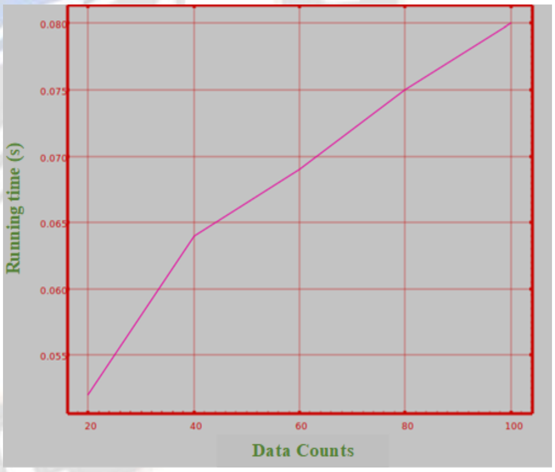


Figure 12. Assessment of speed

TABLE 2 TIME MEASUREMENT

Data counts	Running time	Location searching time
20	0.052	0.048
40	0.064	0.056
60	0.069	0.06
80	0.075	0.064
100	0.08	0.069



(a)

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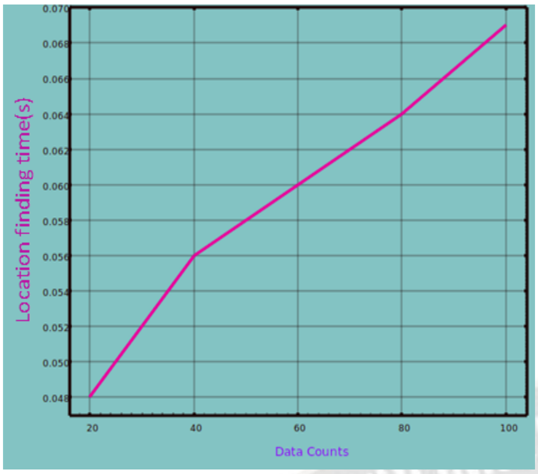

(b)

Figure 13. Time estimation: a) running time, b) location finding time

The requester addresses are stored in the server cloud, while initiating the drone system; the saved info is forwarded to the drone management. Then, the UAV's are trained with the gathered requester details. Based on that, the drone has travelled to reach the specific spot to deliver the requested items.

The time measurement was taken in dual phases that are location finding and execution duration, which is sketched in Table 2.

5.3 Comparative analysis

In this UAV application, the metrics error was calculated by analysing the duration and distance error. Here, the error that raised by the drones travelling long distance is compared with other schemes like Drone services (DS) [28], Self Adaptive Model (SAM) [20] and Optimized Drone [22].

This kind of error is often raised by selecting farthest path instead of shortest path. Hence, the error in path selection has tended to achieve the wide range of distance error. The earned error measure by DS is 41%, SAM 50%, but the designed FRNM has yield the less error measure as 27%. These exact statistics are exposed in Figure 14.

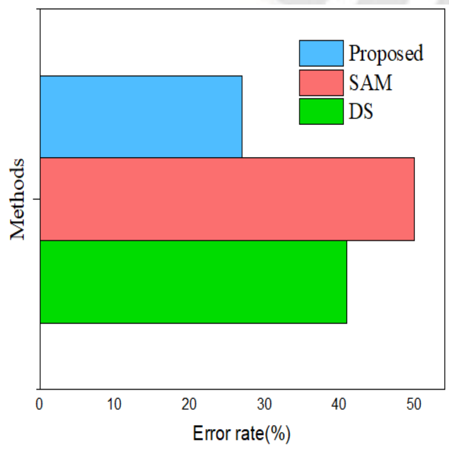

Figure 14. Measure of error

The execution duration of the simulation environment is based on the location identification time. If the drone has taken more duration to find the location then it has needed more period to complete the execution. Hence, the execution duration of the DS is 0.1s, OD 0.07s, also the designed FRNM has required less execution period as 0.05s. These detailed validations are exposed in Figure 15.

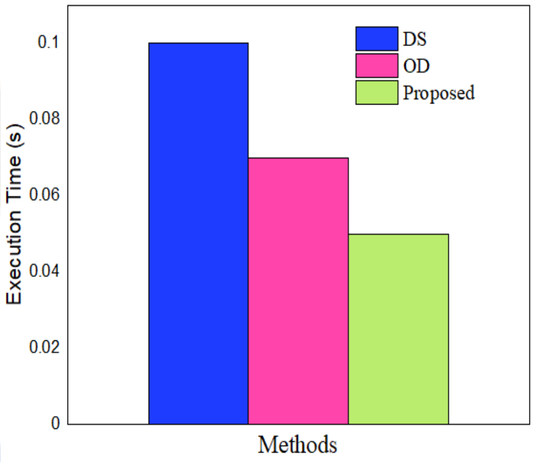

Figure 15. Execution time assessment

5.4 Discussion

The outcome of the discussed model has gained the fair results in all key metrics; this shows the flexibility of the created module in the drone cells.

Also, the plan of this present research method will help to maximize the advances in the smart city application. To prove the achieved outcomes three schemes are obtained and compared with one another, those details are shown in Table 3.

TABLE 3 ROBUSTNESS ASSESSMENT

Robustness Evaluation			
Methods	DS[28]	SAM[27]	proposed
Error (%)	41	50	27
Methods	DS	OD[26]	proposed
Execution time (s)	0.1	0.07	0.05

VI. CONCLUSION

The present research has implemented for medicine transferring system using the drone application. For that, a novel FRNM was designed with suitable parameters to train the UAV's sensing module. Initially, a set of user nodes are created in the NS2 environment then the requester nodes are set. Hereafter, the requester has asked the needed resources then it is stored to the cloud. Moreover, the UAV's are trained with the medicine details and their location address. Once, the training is completed then it has started travelling to reach the destination, based on the minimum distance, it will choose the shortest path. After delivering the medicine, it has returned to the initialize position. Hereafter, the robustness score of the designed FRNM was estimated with some metrics like error, running and location searching time. The designed approach has earned the finest outcome by earning the reduce error values as 27% and less running duration in 0.05s, hence the gained scores are much better than the compared techniques. Also comparing the earliest scheme, the presented novel FRNM has minimized error measure up to 20% and the execution duration up to 2%. Hence, the presented FRNM scheme is suitable for drone application to upgrade the sensing module by offering better location tracing report. In future, designing the security based system in the cloud architecture will gain the best confidential report.

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None.

REFERENCES

[1] M. Ouiss, A. Ettaoufik, A. Marzak, and A. Tragha, "A Parallel Genetic Algorithm for Solving the Vehicle Routing Problem with Drone Medication Delivery," In: F. Saeed, T. Al-Hadhrami, E. Mohammed, and M. Al-Sarem, eds, Advances on Smart and Soft Computing, Singapore: Springer, 2022, pp. 225-233. https://doi.org/10.1007/978-981-16-5559-3_19

[2] A. C. de Araujo and A. Etemad, "End-to-End Prediction of Parcel Delivery Time with Deep Learning for Smart-City Applications," IEEE Internet Things J. Vol. 8(23), 2021, pp. 17043-17056. DOI: 10.1109/JIOT.2021.3077007

[3] S. M. S. M. Daud, M. Y. P. M. Yusof, C. C. Heo, L. S. Khoo, M. K. C. Singh, M. S. Mahmood, and H. Nawawi, "Applications of drone in disaster management: A scoping review," Sci Justice, Vol. 62(1), 2022, pp. 30-42. https://doi.org/10.1016/j.scijus.2021.11.002

[4] N. Thakur, P. Nagrath, R. Jain, D. Saini, N. Sharma, D. J, "Hemanth. Artificial Intelligence Techniques in Smart Cities Surveillance Using UAVs: A Survey," In: U. Ghosh, Y. Maleh, M. Alazab, A. S. K. Pathan eds," Machine Intelligence and Data Analytics for Sustainable Future Smart Cities, Cham: Springer, 2021, pp. 329-353. https://doi.org/10.1007/978-3-030-72065-0_18

[5] R. Gupta, A. Kumari, and S. Tanwar, "Fusion of blockchain and artificial intelligence for secure drone networking underlying 5G communications," Trans Emerg Telecommun Technol, Vol. 32(1), 2021, pp. e4176. https://doi.org/10.1002/ett.4176

[6] M. P.Nisingizwe, P. Ndishimye, K. Swaibu, L. Nshimiyimana, P. Karame, V. Dushimiyimana, J. P. Musabyimana, C. Musanabaganwa, and S. Nsanzimana, "Effect of unmanned aerial vehicle (drone) delivery on blood product delivery time and wastage in Rwanda: a retrospective, cross-sectional study and time series analysis," Lancet Glob Health, Vol. 10(4), 2022, pp. e564-e569. https://doi.org/10.1016/S2214-109X(22)00048-1

[7] M. Patchou, B. Sliwa, and C. Wietfeld, "Flying Robots for Safe and Efficient Parcel Delivery Within the COVID-19 Pandemic," 2021 IEEE International Systems Conference (SysCon), IEEE, 2021. DOI: 10.1109/SysCon48628.2021.9447142

[8] M. Kalinin, M. Krundyshev and D. Zegzhda, "AI Methods for Neutralizing Cyber Threats at Unmanned Vehicular Ecosystem of Smart City, In: T. Devezas, J. Leitão, A. Sarygulov, eds, The Economics of Digital Transformation: Approaching Non-stable and Uncertain Digitalized Production Systems, Cham: Springer, 2021, pp. 157-171. https://doi.org/10.1007/978-3-030-59959-1_10.

[9] P. L. Mehta, R. Kalra, and R. Prasad, "A Backdrop Case Study of AI-Drones in Indian Demographic Characteristics Emphasizing the Role of AI in Global Cities Digitalization," Wirel Pers Commun, Vol. 118(1), 2021, pp. 301-321. https://doi.org/10.1007/s11277-020-08014-6

[10] R. Anand, M. S. Muneshwara, T. Shivakumara, M. S. Swetha, and G. N. Anil, "Emergency Medical Services Using Drone Operations in Natural Disaster and Pandemics," In: G. Ranganathan, X. Fernando, F. Shi, eds, Inventive Communication and Computational Technologies, Singapore: Springer, 2022, pp. 227-239. https://doi.org/10.1007/978-981-16-5529-6_19

[11] M. A. Rahman, M. S. Hossain, A. J. Showail, N. A. Alrajeh, and M. F. Alhamid, "A Secure, Private, and Explainable IoHT Framework to Support Sustainable Health Monitoring in a Smart City," Sustain Cities Soc, Vol. 72, 2021, pp. 103-083. https://doi.org/10.1016/j.scs.2021.103083

[12] M. Ouiss, A. Ettaoufik, A. Marzak and A. Tragha, "A Parallel Genetic Algorithm for Solving the Vehicle Routing Problem with Drone Medication Delivery," In: F. Saeed, T. Al-Hadhrami, E. Mohammed and M. Al-Sarem, eds. Advances on Smart and Soft Computing, Singapore: Springer, 2022, pp. 225-233. https://doi.org/10.1007/978-981-16-5559-3_19

[13] H. Khan, K. K. Kushwah, S. Singh, H. Urkude, M. R. Maurya, and K. K. Sadasivuni, "Smart technologies driven approaches to tackle COVID-19 pandemic: a review," 3 Biotech, Vol. 11(2), 2021, pp. 1-22. https://doi.org/10.1007/s13205-020-02581-y

[14] T. Subha, R. Ranjana, D. Kailash and S. Abisha, "Drone Usage in Delivery of Vaccines in Indian Scenario," In: J. C. Bansal, A. Engelbrecht, P. K. Shukla, eds, Computer Vision and Robotics, Singapore: Springer, 2022, pp. 141-153. https://doi.org/10.1007/978-981-16-8225-4_11

[15] S. H. Alsamhi, F. Afghah, R. Sahal, A. Hawbani, M. A. A. Al-qaness, B. Lee and M. Guizani, "Green internet of things using UAVs in B5G networks: A review of applications and strategies," Ad Hoc Netw, Vol. 117, 2021, pp. 102-505. https://doi.org/10.1016/j.adhoc.2021.102505

[16] U. Ukaegbu, L. Tartibu and M. Okwu, "Unmanned Aerial Vehicles for the Future: Classification, Challenges, and Opportunities," 2021 International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems (icABCD), IEEE, 2021. DOI: 10.1109/icABCD51485.2021.9519367

[17] Z. Ullah, F. Al-Turjman, L. Mostarda, and R. Gagliardi, "Applications of artificial intelligence and machine learning in smart cities," Comput Commun, Vol. 154, 2020, pp. 313-323. https://doi.org/10.1016/j.comcom.2020.02.069

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[18] S. A. Mohsan, N. Q. Othman, Y. Li, M. H. Alsharif, and M. A. Khan, "Unmanned aerial vehicles (UAVs): practical aspects, applications, open challenges, security issues, and future trends," Intelligent Service Robotics, 2023, pp. 1-29.

[19] S. I. Khan, Z. Qadir, H. S. Munawar, S. R. Nayak, A. K. Budati, K. D. Verma, and D. Prakash, "UAVs path planning architecture for effective medical emergency response in future networks," Phys Commun, Vol. 47, 2021, pp. 101-337. https://doi.org/10.1016/j.phycom.2021.101337

[20] N. B. Roberts, E. Ager, T. Leith, I. Lott, M. Mason-Maready, T. Nix, A. Gottula, N. Hunt, and C. Brent, "Current summary of the evidence in drone-based emergency medical services care," Resuscitation Plus, Vol. 13, 2023, pp. 100-347.

[21] A. Hamdi, F. D. Salim, D. Y. Kim, A. G. Neiat, and A. Bouguettaya, "Drone-as-a-service composition under uncertainty," IEEE Trans Serv Comput. 2021. DOI: 10.1109/TSC.2021.3066006

[22] T. Swain, M. Rath, J. Mishra, S. Banerjee, and T. Samant, "Deep Reinforcement Learning based Target Detection for Unmanned Aerial Vehicle," In2022 IEEE India Council International Subsections Conference (INDISCON) 2022 (pp. 1-5). IEEE.

[23] R. Yesodha, and T. Amudha, "A bio-inspired approach: Firefly algorithm for Multi-Depot Vehicle Routing Problem with Time Windows," Comput Commun, Vol. 190, 2022, pp. 48-56. https://doi.org/10.1016/j.comcom.2022.04.005

[24] S. Gera, M. Mridul, and S. Sharma, "IoT based Automated Health Care Monitoring System for Smart City," 2021 5th International Conference on Computing Methodologies and Communication (ICCMC), IEEE, 2021. DOI: 10.1109/ICCMC51019.2021.9418487

[25] A. Beg, A. R. Qureshi, T. Sheltami, and A. Yasar, "UAV-enabled intelligent traffic policing and emergency response handling system for the smart city," Pers Ubiquitous Comput, Vol. 25(1), 2021, pp. 33-50. https://doi.org/10.1007/s00779-019-01297-y

[26] D. Richards, "Flying high: a human perspective of unmanned aerial systems in future cities," Theor Issues Ergon Sci. 2021, pp. 1-16. https://doi.org/10.1080/1463922X.2021.1957517

[27] M. A. Cheema, R. I. Ansari, N. Ashraf, S. A. Hassan, H. K. Qureshi, A. K. Bashir, and C Politis, "Blockchain-based secure delivery of medical supplies using drones," Comput Netw, Vol. 204, 2022, pp. 108-706. https://doi.org/10.1016/j.comnet.2021.108706

[28] E. H. Abualsauod, "A hybrid blockchain method in internet of things for privacy and security in unmanned aerial vehicles network," Computers and Electrical Engineering. Vol. 99, 2022, pp. 107-847.

[29] B. Jacob, A. Kaushik, P. Velavan, and M. Sharma, "Autonomous drones for medical assistance using reinforcement learning," Advances in Augmented Reality and Virtual Reality, 2022, pp. 133-56.

[30] C. Zhang, Y. Qiu, J. Chen, Y. Li, Z. Liu, Y. Liu, J. Zhang, C. S. Hwa, "A comprehensive review of electrochemical hybrid power supply systems and intelligent energy managements for unmanned aerial vehicles in public services," Energy and AI, 2022, pp. 100-175.

[31] N. Nasser, Z. M. Fadlullah, M. M. Fouda, A. Ali, M. Imran, "A lightweight federated learning based privacy preserving B5G pandemic response network using unmanned aerial vehicles: A proof-of-concept," Computer Networks, Vol. 205, 2022, pp. 108-672.