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Research Article

Design and implementation of a novel seeding drone

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ABSTRACT

One of the most important environmental problems that the world facing is undoubtedly the deforestation problem, especially due to forest fires. Early detection and prevention of fires, extinguishing them before they grow, and reforestation in burned areas are widely studied solutions to deforestation. However, the number of technological studies related to reforestation is limited compared to the other fields. The main purpose of this study is to develop a 4-winged (Quadcopter) seeding Unmanned Aerial Vehicle (UAV) to be used in the reforestation of hard-to-reach areas. This tool can also be used in seeding agricultural lands. In the design of the drone, to achieve high-quality flight performance, engines with a thrust power that able to lift at least twice its own weight and the Pixhawk flight control card to ensure the autonomous tracking of routes are preferred. F450 drone frame with 9045 propellers is used in the study. Moreover, a completely unique seeding system and a suitable landing gear are designed and fabricated. Operation of the seeding system is realized using Arduino Nano and a step motor. In the tests, our UAV device and the seeding system operated smoothly, and it was indicated that drones could achieve reforestation in hard-to-reach areas to prevent deforestation. This research can be further developed for seed dispersal in other agricultural applications and for larger areas.

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INTRODUCTION

There are many reasons that are directly or indirectly related to each other, triggering environmental problems such as global warming and drought. The most important of these is undoubtedly the deforestation problem that the world is facing [1,2]. Deforestation is the process of destroying trees and forests that result in the permanent destruction of forest areas and causes significant environmental, ecological, and climatic impacts. Common causes of deforestation include improper agricultural practices, urbanization and other types of land development, climate change, natural disasters, mining, and excessive consumption of trees – especially through harvesting wood for fuel and export [3,4]. Forest fires are another severe reason for deforestation, which affects natural life, climate, and land cover [5,6].

According to the World Resources Institute, in 2023, the extent of forest fires has notably expanded, currently affecting approximately twice as much tree zone as they did two decades ago. The tree losses that have occurred in the last 20 years and the act of forest fires to this can be summarized

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as shown in Figure 1. As evident from the figure, forest fires account for an additional 3 million hectares of annual tree zone loss compared to the year 2001, making up more than 25% of all tree zone loss in the past two decades. In 2021, forest fires reached alarming levels, causing a staggering 9.3 million hectares of global tree zone loss. While the numbers decreased slightly in 2022, over 6.6 million hectares of tree zone were still lost to these fires. Moreover, 2023 has already witnessed increased fire activity across the world [7]. Currently obtained data points that this terrible increase in cover losses due to forest fires will continue in the future and the extent of deforestation will increase [7,8].

As a result of years of research and studies, a large number of methods have been developed to early-detect and prevent forest fires [9]. The prevalent methods for detecting and monitoring involve monitoring towers, aerial and satellite-based surveillance, wireless sensor networks and machine-learning models, optical camera sensors, as well as various types of detection sensors, either individually or in combination [10-14]. On the other hand, in addition to the classical methods of extinguishing forest fires, new strategies such as the use of drones have begun to be used with the developing technology to detect and extinguish [15-17].

UAVs have begun to be used in a wide range of areas in the last 20 years. UAVs, which first came into our lives with military defense, are now used in many civilian and military areas including delivery [18, 19], traffic monitoring systems [20], maintenance and repair applications [21], safety and security systems [22] and geological mapping [23]. Some special applications can be counted as ambulance drones and overhead power line inspection drones. Ambulance drones provide accurate and fast communication between the rescue unit and the patient in emergency situations [24]. For overhead power line inspection applications, the UAVs perform tasks in areas that are hazardous to humans [25]. Furthermore, UAVs are also used in forest fires (as early detection drones and extinguishing drones) and agricultural applications. In agricultural production, by using UAV technology the amount of fertilizer, chemicals and water needed is optimized, this results in an increase in both efficiency and profitability [26]. Other side in forest fires, early detection methods [27, 28] and drone-based extinguishing methods are getting common with single drones or swarms of drones [29, 30].

While it is important to detect, prevent and extinguish forest fires, restoring forests is also very important. Despite this, the number of technological studies on burned area reforestation is limited compared to the technological developments in the detection and prevention of forest fires [31, 32]. Reforestation is still carried out using traditional methods in many regions. Reforestation is the fastest way to regenerate forests, but doing this using conventional methods has some disadvantages that should be considered. Lack of workforce, insufficient transportation -especially to steep areas-, being very laborious and time-consuming -because vast areas are burned-, due to the dangerous nature of the burnt areas working is not safe enough, and the presence of harmful gasses can be considered as general problems. This research offers a solution to the above-mentioned problems

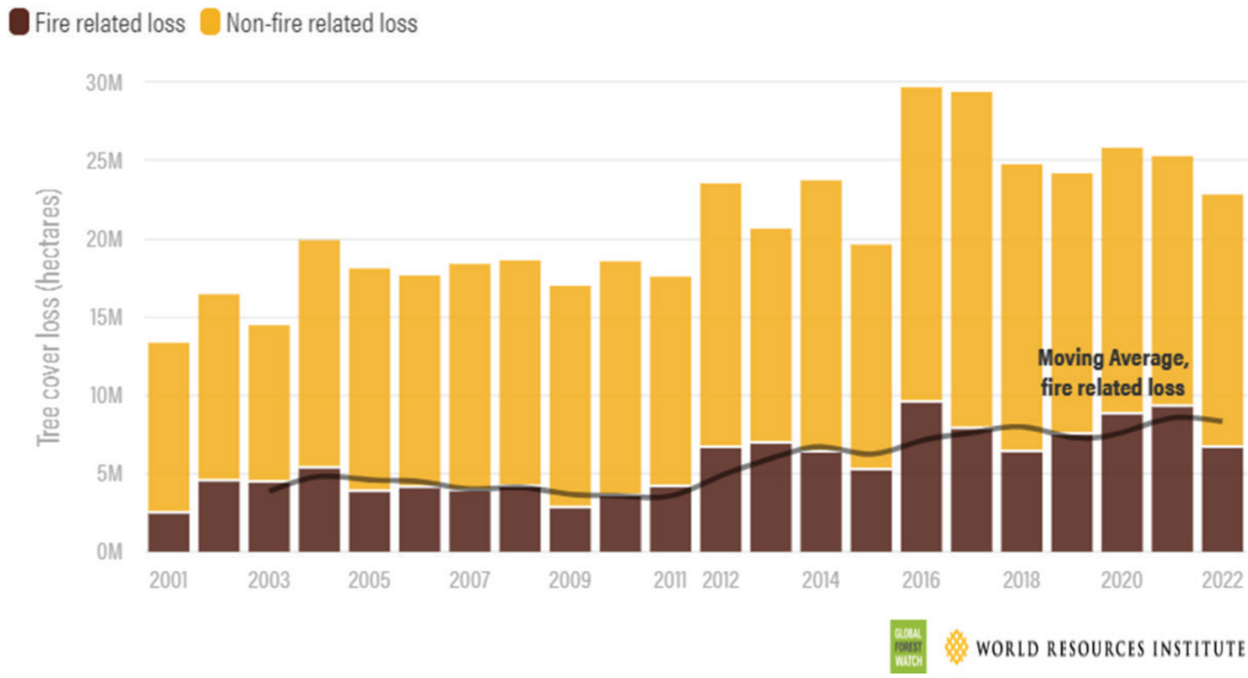
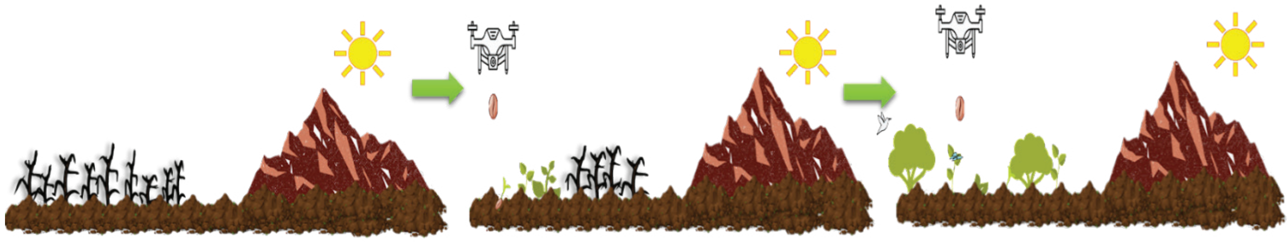


Figure 1. Comparison of tree zone loss caused by fires with losses due to other factors from 2001 to 2022 [From WRI's website [7] based on WRI's Open Data Commitment].



(a) (b) (c)

Figure 2. Realization of project; (a) Burned area after the forest fire, (b) Drone-based seed leaving, (c) Reforested area.

by designing an autonomously flying, drone-based seeding mechanism that leaves seeds in a burned area. This case is shown in Figure 2.

Whereas the main purpose of this study is to develop a 4-winged seeding aircraft to be used in the reforestation of hard-to-reach areas. This device will also be a tool that can be used in seeding agricultural lands. A special seeding unit and seeding mechanism are designed and mounted to the UAV. The mission of the designed seeding UAV consists of several stages. The quadcopter first takes off autonomously and moves towards the determined area where the coordinates are previously loaded. Then, it reaches its destination and hangs at a certain altitude. Afterward, it leaves the seed balls from the previously filled unit one by one towards the surface at a specified distance interval. In this way, seeds are left in the entire determined area. Finally, after the designed quadcopter completes the seed leaving process, it autonomously returns and lands at the starting point. The drone is also designed to be controlled manually in emergency situations.

Principle of Quadcopter Operation and System Architecture

A quadcopter is composed of four motors evenly spaced along its frame body. Each of these engines is used to control a propeller placed at its corners. Each propeller's speed and direction of rotation can be adjusted independently

to ensure balance and control of the drone's movement. To maintain equilibrium, generate the required lift and achieve flight, two of these propellers rotate clockwise while the remaining two rotate counterclockwise, as illustrated in Figure 3. When the quadcopter needs to ascend or hover in place, all propellers operate at high speeds. By varying the speeds of these propellers, the drone can be maneuvered in forward, backward, and lateral directions.

The major components that make up the quadcopter can be listed as a frame, propellers, motors, power distribution board (PDB), electronic speed controller (ESC), flight controller (FC), battery, transmitter, and receiver. In the proposed system, in addition to the basic components, a global positioning system (GPS), telemetry, and remote controller are used. Also, a stepper motor and Arduino nano microprocessors are used to operate the seeding unit. Detailed information about the components is given in

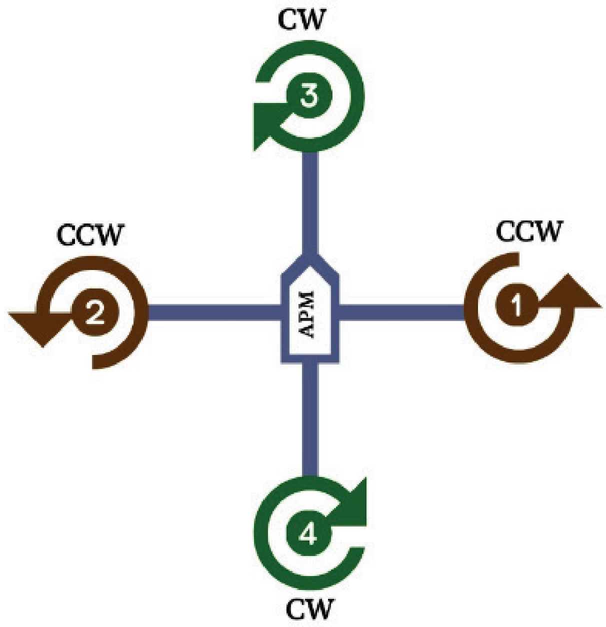


Figure 3. Quadcopter motor directions.

Table 1. The electronic components we used in the design and the connections between them are also summarized in Figure 4. Yellow, black, red, and blue lines represent information transfer, ground connection, 11.1V power connection, and 5V power connection, respectively. Also, green and pink dashed lines show communication connections for 433MHz and 2.4 GHz frequencies.

Our chosen flight controller is the Pixhawk 2.4.8, which incorporates high-quality sensors for precise navigation and stabilization. Specifically, it features the ST Micro L3GD20H 16-bit gyroscope and the ST Micro LSM303D 14-bit accelerometer/magnetometer sensors. The flight controller is the brain of the UAV, it has control over every component in the UAV including motors and ESCs.

SunnySky X2216-7 kV1400 brushless motors are used in the design. Numerous factors, with particular emphasis on the UAV's weight, are taken into account in the selection of the UAV engine. The choice of engine for a UAV necessitates

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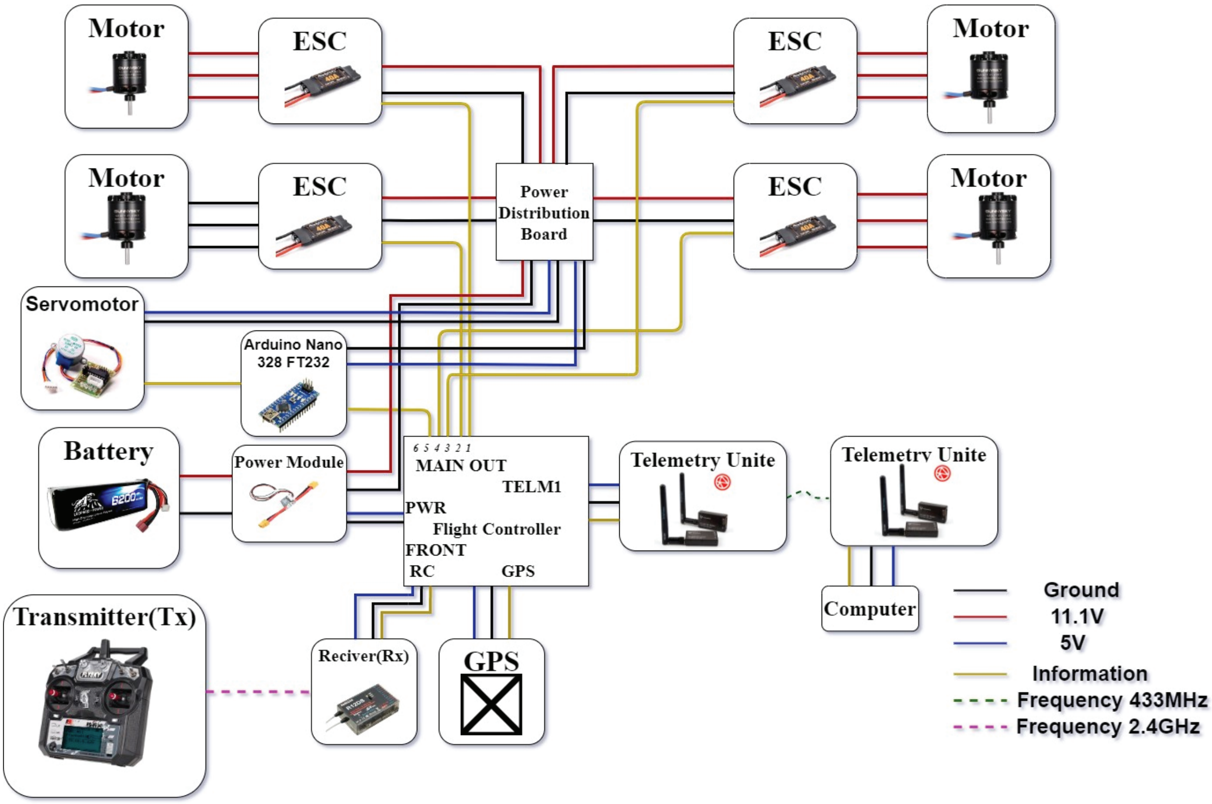


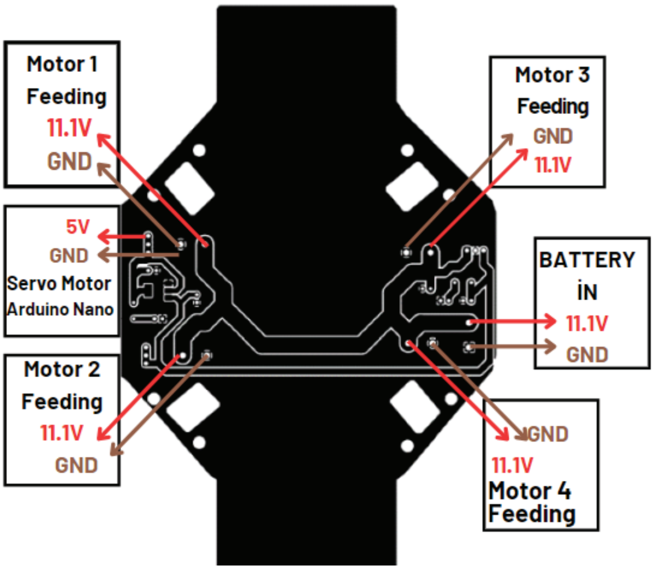
Figure 4. Information and electronic connections scheme.

Table 1. Electronic and mechanic components

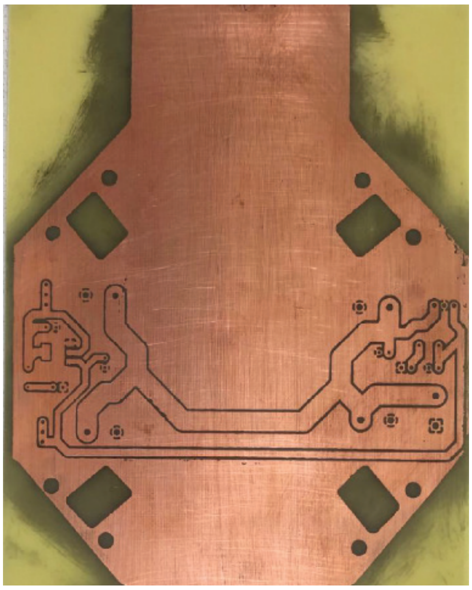
	Component Name	Model Description
Major Components	Motor	SunnySky X2216-7 kV1400 Brushless Motors
	Flight Controller	Pixhawk 2.4.8 Flight Controller
	ESC	40A Brushless ESC
	Battery	Leopard Power 6200 mAh 11.1V 3S 40C Lipo Battery
	Frame	F450 drone frame
	Propellers	9045 SF Propellers
Additional Components	Telemetry	3DR Radio Telemetry 433MHz
	Remote Control	FS-i6X RC Radio Transmitter, Irfora FS-i6X 2.4GHz
	GPS	Ublox Neo-M8N GPS Modül
Seeding Unit	Stepper Motor	28 BYJ-48 Geared Stepper Motor
Components	Arduino	Arduino Nano

the provision of adequate thrust to counteract the UAV's weight and facilitate take-off. As such, meticulous attention is devoted to assessing the torque characteristics of the engine to be employed. During the engine selection phase, priority is given to opting for an engine characterized by its lightweight construction, capable of furnishing the requisite thrust force to sustain the UAV in a suspended state within the air at a specified altitude. Furthermore, the chosen engines, brushless motors, are relatively cost-effective and they require minimal maintenance.

The proposed UAV requires two different voltage levels (11.1 V and 5 V). But only one voltage regulator is needed. Because the voltage level that supplies the ESCs is the same as the voltage of the battery. Therefore, it can be used directly on the card without being regulated. The regulated voltage is used to feed the servo motor and Arduino card that operates the seeding system. Both operate in the



(a)



(b)

Figure 5. The designed (a) and printed (b) power distributed PCB.

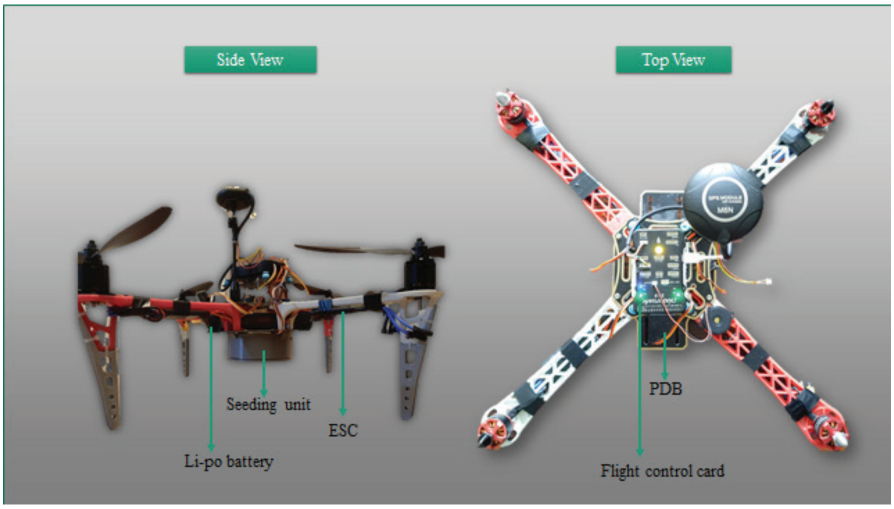


Figure 6. The side view and top view of the designed seeding-drone.

voltage range of 4.8V-6.8V. So, it reduces the 11.1V (battery voltage) to a 4.8V-6.8V range. In addition, since the servo motor draws a current of 550mA, the voltage regulator also provides this. A power distribution circuit designed and printed for this purpose is shown in Figure 5. 6200 mAh 11.1V 3S 40C Lipo Battery is used as the power source and battery connections are organized by the designed PDB.

To control the speed of the electric motor, regulate the current coming from the battery, reverse the motor, and perform dynamic braking 40A brushless ESC; for communication, 3DR Radio Telemetry 433MHz 500mW(X6) telemetry module, which is the most common and stable communication method in UAV, are used. The drone is designed to be controlled manually in emergency situations and a simple remote controller is used for this purpose.

F450 drone frame is used as a body. It is made of ultra-durable material that could better adapt to crashes and provide plenty of space for wiring and installation of additional elements. The drone is equipped with four 9045 propellers with a diameter of 23cm. These are light, powerful, and compatible with selected engines. A landing gear is designed and printed to enable the drone to take off and land easily even on rough terrain. The landing gear is printed using 3D printing techniques and is made of lightweight and durable materials. A novel seeding system that can hold the seeds and leave them to the desired points is

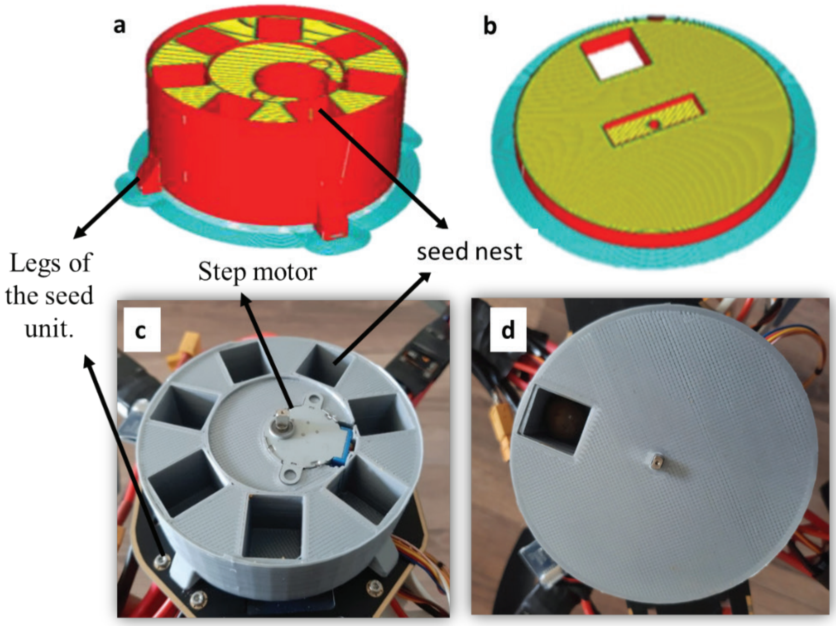


Figure 7. (a) Side and (b) top view of simulated seed unit, (c) side and (d) top view of manufactured seed unit.

designed and printed by using 3D printer techniques. This system is mounted on the bottom side of the drone. The side view and top view of the designed seeding drone are shown in Figure 6.

Design and Implementation of the Seeding Unit

Within the scope of this study, a novel seeding unit is designed and produced. Instead of a complex and heavy system, a lighter and simpler system that can be mounted on the frame is designed. The design is made of durable and lightweight PLA materials using a 3D printer. The seed unit consists of two interlocking cylindrical structures and separated chamber-shaped structures between them. A stepper motor is placed in the center of the planting unit. The rotor of the stepper motor is integrated into the bottom cover of the seeding unit. In this way, the cover can rotate 360° and the drone can drop the seeds out one by one. The draw form and fabricated view of the seeding unit are shown in Figure 7.

PERFORMANCE ANALYSIS

A SunnySky X2216-7 kV1400 engine can carry 1190 grams with 9045 propellers at maximum power. There are 4 engines in the UAV, so it can carry 4760 grams as shown in Eq. (1). For stable and performance flight, the UAV (Total weight) should weigh half the carrying capacity of the engine [33]. Therefore, the total weight of the UAV is determined as approximately 2380 grams as defined in Eq. (2). That's why the UAV is designed to weigh less than 2380 grams. The total weight of the UAV is expected to be approximately 1800 grams as calculated in Table 2.

$$Tt = 4 * Et = 4 * 1190\ gr = 4760\ gr \tag{1}$$

$$Ht = \frac{Tt}{2} = \frac{4760\ gr}{2} = 2380\ gr \tag{2}$$

Table 2. The total weight of the drone materials and body

Component name	Number	Weight (g)
Motor	4	4*72
Flight controller	1	60
ESC	4	4*30
Battery	1	450
Propellers	4	4*10
Transmitter/receiver	1	20
Stepper motor	1	30
Remote control	1	25
Body and seeding unit	1	600
Other electrical equipment	1	135
		Total: 1800

By doing reverse engineering, the total thrust required by motors can be calculated as 3600g by using the Eq. (3). Since it is a quadcopter (4 motors), the thrust force required by each motor is 900g as shown in Eq. (4). According to the technical properties of the selected engines as given in Table 3, 900g thrust force means, the engines work with a ~4.8 g/W efficiency and draw 16.9 A current.

$$Tr = W * 2 = 1800\ gr * 2 = 3600\ gr \tag{3}$$

$$Er = \frac{Tr}{4} = \frac{3600\ gr}{4} = 900\ gr \tag{4}$$

Table 3. Technical properties of SunnySky X2216-7 kV1400 engine [34]

Prop(inch)	Voltage(V)	Amps(A)	Thrust(gf)	Watts(W)	Efficiency(g/W)	Load temperature in 100% throttle
		0.8	100	8.88	11.26126126	
		2.1	200	23.31	8.58000858	
		3.7	300	41.07	7.304601899	
		5.4	400	59.94	6.673340007	
		7.5	500	83.25	6.006006006	
APC9045	11.1	9.4	600	104.34	5.750431282	44°
		11.8	700	130.98	5.344327378	
		13.9	800	154.29	5.185041156	
		16.9	900	187.59	4.797697105	
		19	1000	210.9	4.741583689	
		23.9	1190	265.29	4.485657205	

Battery capacity, the total weight of the drone, and the currents drawn by the drone materials are the most important factors affecting the flight time of the drone, and in order for our drone to perform the desired task, it must remain in the air for a certain period of time, depending on the location of the target area. Here, the necessary calculations are made for a certain of flight time, and as a result, it is seen that a Lipo battery with a capacity of 6200mAh is sufficient. Calculations can be redone for different batteries [35]. However, the weight of the battery and the maximum load that the motors can carry must be considered.

Overview of Operation

In the study, the Pixhawk flight control card directs the UAV's flight through the program installed "Mission Planner". The drone's route map is created by using the Mission Planner interface. In this way, the exact locations where to leave the seeds are determined. Telemetry is utilized to transmit the required information, such as the route map and flight details, to the Pixhawk. Afterward, the planned route is achieved by directing the engines through Pixhawk and ESCs. Real-time location control is done via GPS, and when the drone reaches the planned location, Pixhawk signals the Arduino microprocessor, and the seeding process begins. After seeding is completed at all planned points, the drone returns to the starting point.

To enable the seeding unit's operation, precise information needs to be transmitted to the stepper motor at the appropriate moment. This precise timing is set on the flight control board. Once the flight control board attains the designated position, it issues a commencement signal to the motor, facilitated by an Arduino Nano. Consequently, the stepper motor initiates a gradual movement, the seeds are released from the planting unit in a controlled manner at certain intervals. The flowchart of the seeding operation is shown in Figure 8.

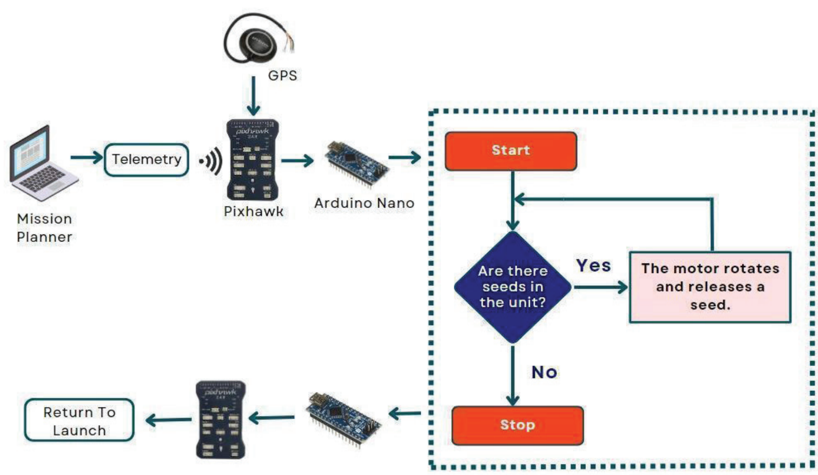


Figure 8. Seeding operation flowchart.

Figure 9. An image from the test flight.

RESULTS AND DISCUSSION

This paper proposes a novel seeding drone as a solution for afforestation. Unlike the existing studies in the literature, in this study a unique seeding system is designed, 3D printed and mounted to the proposed device. Although the proposed system is designed to lift up to 4490 grams at maximum power, the total thrust force required by the engines is calculated as 3600 grams and the weight of the designed system is set as 1180 grams. Taking into account the net weight of the system and the characteristics of the engines, the flight time required for the planned mission is calculated and a battery with a capacity of 6200 mAh is used. While the system flight is controlled with Pixhawk 2.4.8 and the motor drivers are controlled via this card, to operate the seeding system Arduino-nano is used. To leave the seeds to the desired points, communication and simultaneous operation of these two systems are ensured. To evaluate the drone's performance, a flight test was conducted outdoors in an open field successfully; the proposed system executed an autonomous flight and left the seeds to the desired points. The drone is also designed to be remotely controlled from the ground in case of emergency. An image from the test flight is shown in Figure 9.

CONCLUSION

In conclusion, this study addresses the global problem of deforestation, with a particular focus on forest fires. While early detection and fire prevention have been extensively studied, reforestation efforts, particularly through technological means, have received limited attention. The development of a seeding drone for reforestation in hard-to-reach areas represents a significant contribution to this under-researched field. This innovative tool, featuring a unique seeding system, performed successfully in the tests. The outdoor flight tests show that drones can provide a good way to fight deforestation in challenging areas. Furthermore, this device may offer possibilities for planting large areas in agricultural applications. The proposed system within the scope of this study can be improved to increase flight time and according to the requirements of the area to be applied the seed capacity can be increased. We strongly believe that, with the widespread use of this system, natural vegetation will regenerate rapidly in the destroyed areas.

NOMENCLATURE

Et	Engine thrust
W	Weight of UAV
Tt	Total thrust
Ht	Half of the thrust
Tr	Thrust required
Er	Required thrust for one engine

AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The authors confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

ETHICS

There are no ethical issues with the publication of this manuscript.

REFERENCES

[1] Trigueiro WR, Nabout JC, Tessarolo G. Uncovering the spatial variability of recent deforestation drivers in the Brazilian Cerrado. J Environ Manag 2020;275:111243. [CrossRef]

[2] Semper-Pascual A, Decarre J, Baumann M, Busso JM, Camino M, Gomez-Valencia B, et al. Biodiversity loss in deforestation frontiers: linking occupancy modelling and physiological stress indicators to understand local extinctions. Biol Conserv 2019;236:281–288. [CrossRef]

[3] Fearnside PM. Consequencias do desmatamento da Amazionia. Scientific American 2010;3:54–59.

[4] Silva RM, Lopes AG, Santos CAG. Deforestation and fires in the Brazilian Amazon from 2001 to 2020: Impacts on rainfall variability and land surface temperature. J Environ Manag 2023;326:116664. [CrossRef]

[5] Amigo I. When will the Amazon hit a tipping point? Nature 2020;578:505–507. [CrossRef]

[6] Allen JC, Barnes DF. The causes of deforestation in developing countries. Ann Assoc Am Geogr 1985;75:163–184. [CrossRef]

[7] MacCarthy J, Tyukavina S, Weisse M, Harris N. New Data Confirms: Forest Fires Are Getting Worse. 2022; https://www.wri.org/insights/global-trends-forest-fires Accessed on Jan 27, 2025.

[8] Mataveli GAV, Chaves MED, Brunsell NA, Aragão LEOC. The emergence of a new deforestation hotspot in Amazonia. Perspect Ecol Conserv 2021;19:33–36. [CrossRef]

[9] Alkhatib AA, A review on forest fire detection techniques. Intl J Distrib Sensor Netw 2014;10:597368. [CrossRef]

[10] Rathee M, Dahiya J. Detection techniques of forest fire: Using WSNs. World J Adv Eng Technol Sci 2023;9:387–390. [CrossRef]

[11] Aslan YE, Korpeoglu I, Ulusoy Ö. A framework for use of wireless sensor networks in forest fire detection and monitoring. Comput Environ Urban Syst 2012;36:614–625. [CrossRef]

[12] Abdusalomov AB, Islam BM, Nasimov R, Mukhiddinov M, Whangbo TK. An improved forest fire detection method based on the detectron2 model and a deep learning approach, Sensors 2023;23:1512. [CrossRef]

[13] Kalaivani V, Chanthiya P. A novel custom optimized convolutional neural network for a satellite image by using forest fire detection. Earth Sci Inform 2022;15:1285–1295. [CrossRef]

[14] Dampage U, Bandaranayake L, Wanasinghe R, Kottahachchi K, Jayasanka B. Forest fire detection system using wireless sensor networks and machine learning. Sci Rep 2022;12:46. [CrossRef]

[15] Mahmudnia D, Arashpour M, Bai Y, Feng H. Drones and blockchain integration to manage forest fires in remote regions. Drones 2022;6:331. [CrossRef]

[16] Lawrence ID, Agnishwar J, Vijayakumar R. Revolutionizing firefighting: An experimental journal on the design and performance of drones in fire suppression. Eur Chem Bull 2023;12(Suppl 12):1238–1252.

[17] Innocente MS, Grasso P. Self-organising swarms of firefighting drones: Harnessing the power of collective intelligence in decentralised multi-robot systems. J Comput Sci 2019;34:80–101. [CrossRef]

[18] Miranda VRF, Rezende AMC, Rocha TL. Autonomous navigation system for a delivery drone. J Control Autom Electr Syst 2022;33:141–155. [CrossRef]

[19] Albayrak E, Vural H, Ekici M, Ekici S. TRIZ approach to the relevant problem for the transport of assay tubes: A case study on family health centers in Amasya. Sigma J Eng Nat Sci 2023;41:900–906. [CrossRef]

[20] Bisio I, Garibotto C, Haleem H, Lavagetto F, Sciarrone A. A systematic review of drone based road traffic monitoring system. IEEE Access 2022;10:101537–101555. [CrossRef]

[21] Choi HW, Kim HJ, Kim SK, Na WS. An overview of drone applications in the construction industry. Drones 2023;7:515. [CrossRef]

[22] Shvetsova SV, Shvetsov AV. Ensuring safety and security in employing drones at airports. J Transport Secur 2021;14:41–53. [CrossRef]

[23] Honarmand M, Shahriari H. Geological mapping using drone-based photogrammetry: An application for exploration of vein-type Cu mineralization. Minerals 2021;11:585. [CrossRef]

[24] Janney JB, Premkumar J, Krishnakumar S, Shivani SA, Atchaya E, Kanmani PG, Air ambulance drone for medical surveillance. J Phys Conf Ser 2022;2318:012023. IOP Publishing. [CrossRef]

[25] Ahmed MF, Mohanta JC, Zafar MN. Development of smart quadcopter for autonomous overhead power transmission line inspections. Mater Today Proceed 2022;51:261–268. [CrossRef]

[26] Türkseven S, Kizmaz MZ, Tekin AB, Urkan E, Serim AT. Tarımda dijital dönüşüm; insansız hava araçları kullanımı. Tarım Makinaları Bilim Derg 2016;12:267–271.

[27] Düzyol K, Budak S, Kurnaz E, Durdu A. Autonomous fire fighting mission using unmanned aerial vehicle image processing. J New Results Eng Nat Sci 2023;18:1–10.

[28] Kinaneva D, Hristov G, Raychev J and Zahariev P. Early Forest Fire Detection Using Drones and Artificial Intelligence,42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, Croatia, 2019, p. 1060–1065. [CrossRef]

[29] Roldán-Gómez JJ, González-Gironda E, Barrientos A. A survey on Robotic Technologies for forest Firefighting: Applying drone swarms to improve firefighters' efficiency and safety. Appl Sci 2021;11:363. [CrossRef]

[30] Kara M, Yumuşak R, Eren T. Fire brigade drone selection for response to stubble fires: The case of Giresun. J Aviat Res 2023;5:1–15. [Turkish] [CrossRef]
[31] Lohit GVS. Reforestation Using Drones and Deep Learning Techniques, 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2021. p. 847–852. [CrossRef]
[32] Lohit GVS, Bisht D. Seed Dispenser using Drones and Deep Learning Techniques for Reforestation, 5th International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2021. p. 1275–1283. [CrossRef]
[33] Benic Z, Piljek P, and Kotarski D, Mathematical modelling of unmanned aerial vehicles with four rotors. Interdiscip Descr Complex Syst 2016;14:88–100. [CrossRef]
[34] SunnySky X2216 Brushless Motors Short Shaft Version. (n.d.). SunnySky USA. Available at: https://sunnyskyusa.com/products/sunnysky-x2216-brushless-motors Accessed Nov 3, 2023.
[35] Ulutaş T, Avci O, Akar E, Köksal B, Kalkan Y, Simple Design and Implementation of Two-Way Communication System through UAV. Balkan J Electr Comput Eng 2023;11:61–70. [CrossRef]