

ARMED AUTONOMOUS HELICOPTER THAT CAN ATTACK USING IMAGE PROCESSING TECHNIQUES

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ABSTRACT

Alpin is an unmanned and autonomously controlled helicopter and there are areas of use for example transportation, agricultural spraying, camera shooting, fire extinguishing and military purposes such as surveillance and reconnaissance. TAI T-629 is an electric and unmanned heavy class attack helicopter and is under development. In the literature review, helicopters capable of autonomous flight were found, but no attack helicopters were found. The designed helicopter has 3 main autonomous missions: area scanning, target detection and attack.

Key Words : *Artificial Intelligence, Image Processing, Assault, Autonomous Helicopter*

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1. Introduction

Today, the use of unmanned aerial vehicles has increased, so the areas of use of unmanned aerial vehicles have also varied. One of these areas is national defense. In the developed project, a helicopter was designed that can be used in military activities such as field scanning, target detection and target destruction by making helicopters normally controlled by a human autonomous. Türkiye's national and original vehicles Alpin and TUSAŞ T-629 can be given as examples of existing systems. Alpin is an autonomous helicopter capable of carrying payloads to target detection, surveillance and military areas. The T-629 is a remotely controlled heavy class attack helicopter. The feature that distinguishes the unmanned aerial vehicle designed in the project from these vehicles is that it can autonomously attack the determined target by performing area scanning and target detection. In addition, the project will be a project in the Presidential Eleventh Development Plan, which will serve the goal of meeting the needs of Türkiye's armed forces in national defense with national and domestic projects. In this context, within the scope of the national technology move, the software of a defense vehicle, whose flight capabilities and autonomous attack capabilities were determined by us, was developed.

National defense is to protect Türkiye against internal and external threats. One of the most important and supreme duties we will do for Türkiye is any action we will take for the defense of the homeland. With the developing technology, Türkiye's national defense remains strong largely based on Türkiye's defense industry.

The foundation of the Turkish defense industry goes back to the Ottoman Empire. For example, the production of cannons, which Mehmet the Conqueror named SHAHI during the conquest of Istanbul, which he drew and followed the castings, shows the importance given to the defense industry in the Ottoman Empire. Since then, Türkiye's national defense industry has developed more and more every day. Currently still developing and going strong. Among these developments, unmanned aerial vehicles, which have been studied and produced to a great extent in recent years, take their place.

In the Eleventh Development Plan of the Presidency, it is aimed to meet the needs of Türkiye's Armed Forces and security forces, with the understanding of continuous

development, with national technologies and domestic opportunities to the maximum extent (TC Presidency Eleventh Development Plan, 2019). The project has been prepared in line with this goal. The use of domestic technologies in national defense is of great importance for Türkiye. Therefore, the production of domestic technologies will contribute to Türkiye's military power, inventory and, therefore, to the country's economy.

Unmanned vehicles are technological vehicles that do not contain human elements, can be managed remotely or autonomously, and are developed to perform predetermined tasks. Unmanned vehicles can be examined in four different groups depending on their application purposes: Unmanned Aerial Vehicles, Unmanned Land Vehicles, Unmanned Marine Vehicles, Unmanned Submarine Vehicles. Unmanned aerial vehicles are used in counter-terrorism, warfare, space, building security, and many scientific applications. For this reason, investments in this field are increasing day by day (Aksoy & Kurnaz, 2009).

UAVs, consisting of electronic and written systems, will strategically affect the defense technology of Türkiye negatively if they are not produced nationally and specifically, that is, imported. Since the software of the imported UAVs is not national and original, they have the potential to pose great threats to the national defense of Türkiye (BAKIR, 2019). If the UAVs used in military operations that must be carried out in secrecy are not national and original, it may lead to the leak of many important information that needs to be protected. Considering the geopolitical situation of Türkiye, it is very important to protect Türkiye's borders, ensure Türkiye's internal and external security, and especially successfully conduct the fight against terrorism (Kasapoğlu & Kırdemir , 2019). For these reasons, it is extremely important that the system and software used in the fight against terrorism and the protection of national borders are national and original.

There are some studies on autonomous helicopters in the world and in Türkiye. Black Hawk designed in the USA and Alpin and TUSAŞ T-629 designed in Türkiye can be given as examples. Black Hawk is an unmanned and autonomously controlled helicopter and performs military purposes such as surveillance and reconnaissance (Lockheed Martin, 2021). Alpin is an unmanned and

autonomously controlled helicopter and has uses for military purposes such as surveillance, reconnaissance, transportation, agricultural spraying, camera shooting, fireextinguishing (Titra, 2020). TAI T-629 is an electric and unmanned heavy class attack helicopter and is under development (TUSAŞ, 2022). The most important feature that distinguishes our project from other existing projects is that it attacks by scanning the target area. In the literature research on current projects, no attacking autonomous helicopter design was found.

Artificial intelligence technology, which is one of the technologies of the future, is a system that learns the relationships between events from examples and then makes decisions using the information they have learned about examples that they have never seen. Artificial intelligence is computer systems that perform the learning function, which is the most basic feature of the human brain. Artificial intelligence technology is developing more and more every day. New products emerge and show themselves more in daily life. Automation systems are also equipped with artificial intelligence technology and the decision-making power of the computer is utilized.

Image processing is a method developed to digitize the image and perform some operations, using artificial intelligence technology to obtain a special image or extract some useful information from it. (Türksan, 2018) Image processing; It is widely used in many applications, including areas such as medical imaging, industrial manufacturing, security systems, biometric recognition, human-computer interaction, and satellite imaging. It is also used for mapping in some UAV systems with image processing. In this project, field scanning and target detection were provided by using image processing techniques.

The developed autonomous helicopter performs the tasks of area scanning, target detection and destroying the target thanks to the ammunition on the helicopter, using image processing techniques. By using the developed unmanned aerial vehicle image processing techniques, it will obtain information about the target by performing Area Scanning, Enemy Detection or both according to the task given, and will be able to attack if desired. The image processing technique used in the project and the ability to attack autonomously are the most important points that make the project different from the existing systems.

1.1. Python

Python programming language; It is an open source free programming language that is object oriented, portable, easy to learn and software, and offers coders the opportunity to freely write code. Due to these features, it has become one of the popular languages in recent years. In 2017, it ranked first in the most popular programming languages according to IEEE (Wissen, 2018). While the project is being developed; Python language was preferred because of the rich image processing libraries it has and the easy and understandable writing language. Python programming language is used because it provides convenience in Raspberry's programming. The developed algorithm is programmed in the python environment.

2. Method

Within the scope of the literature review, whether there are similar software to be developed and books, articles, papers and theses that can help the system to be developed have been scanned. Before the autonomous helicopter was

designed and the software was developed, an interview was held with the military pilot working at the Gendarmerie General Command, and information was obtained about the differences between the system to be developed and the existing systems. (Information about these differences can be briefly mentioned.) In addition, information about the usability of the system to be developed was obtained. At the same time, meetings were held with relevant institutions and organizations that manufacture helicopters.

2.1. Project Construction Steps

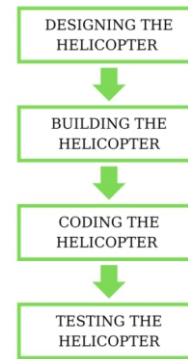


Fig. 1: Project Construction Steps

2.2. Materials

2.2.1. Raspberry Pi

The Raspberry Pi is a credit card sized computer made in the UK. Raspberry Pi is an inexpensive, small and multifunctional computer with simple programming. It provides ease of use thanks to the input and output units it contains. In addition, images can be taken by connecting to a monitor. Raspberry Pi, which uses a Linux-based operating system called Raspbian, also supports other Linux-based operating systems such as Ubuntu, OpenElec, RISC OS. (Dündar & Vural, 2018).

2.2.2. Pixhawk

Accelerometer, 3-axis gyroscope, barometer and compass modules, enabling flight with the engine control required for remote or autonomous flight. With the Raspberry interaction, it enables autonomous flight independently from the ground station.



Fig. 2: Pixhawk

2.2.3. ESC (Electronic Speed Control)

ESC stands for electronic speed controllers. It adapts the pilot's controls to the engine movements. It then sends this data to the engines as a precise instruction. ESCs are used to control the speed of the brushless motors used in the helicopters we design and to protect these motors against inrush currents.

2.2.4. Engines and Propellers

DC motors are the most widely used motor type in robotics. DC motors appear in a wide variety of shapes and sizes. For example: permanent magnet ferrous core motor, permanent magnet ferrous non-ferrous motor and permanent magnet brushless motor. The total weight of the helicopter designed in the project, including the fuselage and electronic components, is 795 gr. For this reason, 3400KV motors and 35A ESCs were preferred. Considering the engine power, 325D PRO Carbon Fiber blade set was preferred for propeller selection.

2.2.5. Servo Motor

Servo motors are a type of motor produced for parts that need to make rotation movement in fine tuning (specific acceleration, speed, angle). It was used to provide maneuverability to the helicopter.

2.2.6. Lipo Battery

containing Lithium and Polymer chemicals in their structure are called lipo batteries for short. In the project, a 2200mAh lipo battery was used as the power source of the helicopter.

2.2.7. Camera

The camera to be positioned on the helicopter will record every data in the field of view with Raspberry . By transferring it to the Pi, it will transmit the data that enables the detection of enemy elements to the station. In addition, the camera to be used, the Logitech C920, has a resolution of 1920 x 1080 px .



3. Project Work-Timeline

Job description	MONTHS											
	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021	November 2021	December 2021	January 2022	February 2022	
Literature Review	x	x	x	x	x							
Arge work		x	x	x	x	x	x	x				
Data Collection and Analysis					x	x	x	x	x			
Project Report Writing							x	x	x	x	x	

4. Findings

4.1. Design of the Helicopter

Carbon fiber body was preferred in the design of the helicopter. 325D PRO Carbon Fiber blade set was used for 3400KV motors and propeller.



Fig. 3: Front View of the Helicopter



Fig. 4: Side View of the Helicopter



Fig. 5: Rear View of the Helicopter

4.2. Autonomous Operating System of the Helicopter

The designed helicopter has 3 main tasks: area scanning, target detection and attack. In the field scanning task, mapping is made using image processing techniques with the data coming from the camera. In the target detection task, target detection is made by using the data from the field scanning and image processing techniques in the first task. In the attack mission, the attack takes place by examining the data from the target detection and the existing ammunition data in the helicopter, or the data obtained from the military base is transmitted to the aid units and the target is destroyed.

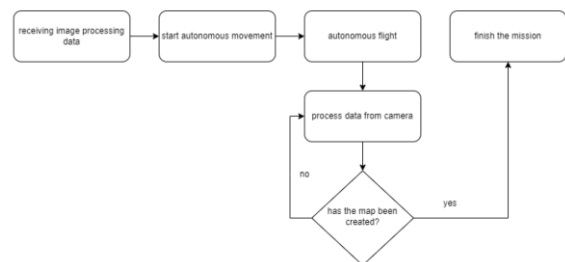


Fig. 6: Autonomous Operation Order of the Autonomous Attack Helicopter for Mission 1

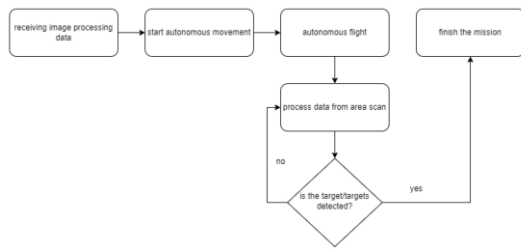


Fig. 7: Autonomous Operation Order of the Autonomous Attack Helicopter for Mission 2

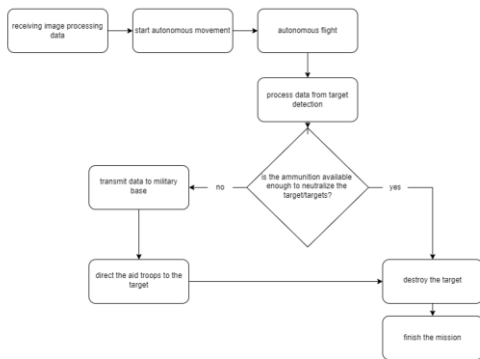


Fig. 8: Autonomous Operation Order of the Autonomous Attack Helicopter for Mission 3

4.3. Coding of the Helicopter

By using the data coming from the camera and image processing techniques, the autonomous helicopter is provided with area scanning and target detection. The developed helicopter, after starting its autonomous flight, runs the image processing algorithm given in figures 14, 15, 16, 17 and 18 in the light of the data coming from the camera. In this way, the helicopter was ensured to be locked to the target.

The image processing algorithm of the helicopter consists of 4 main parts. First, image data is obtained with the fixed camera on the helicopter. Then, this image data is transmitted to the Raspberry Pi card for processing, and the image processed on the Raspberry Pi is sent to the ground station. With this image data, the process of locking to the enemy is performed. If the target escapes lockout by leaving the field of view, the lock-on-target algorithm is reset.

```

1 import cv2 as cv
2 import numpy as np
3
4 video = cv.VideoCapture(0)
5 wHt = 320
6 confThreshold = 0.5
7 nmsThreshold = 0.2
8
9 ## Coco isimleri
10 sinif_dosyaları = "coco.names"
11 sinif_isimleri = []
12 with open(sinif_dosyaları, "rt") as f:
13     sinif_isimleri = f.read().rstrip('\n').split('\n')
14 print(sinif_isimleri)
15 ## Model dosyaları
16 model_konfigürasyonu = "yolov3-320.cfg"
17 modelWeights = "yolov3-320.weights"
18 net = cv.dnn.readNetFromDarknet(model_konfigürasyonu, modelWeights)
19 net.setPreferableBackend(cv.dnn.DNN_BACKEND_OPENCV)
20 net.setPreferableTarget(cv.dnn.DNN_TARGET_CPU)
21
22 def obje_tanima(çiktılar,img):
23     ht, wt, ct = img.shape
24     bbox = []
25     classIds = []
    
```

Fig. 9: Image Processing Codes

In the working state of the above image processing codes, the output of detecting a person/target is as in Figures (10) and (11).

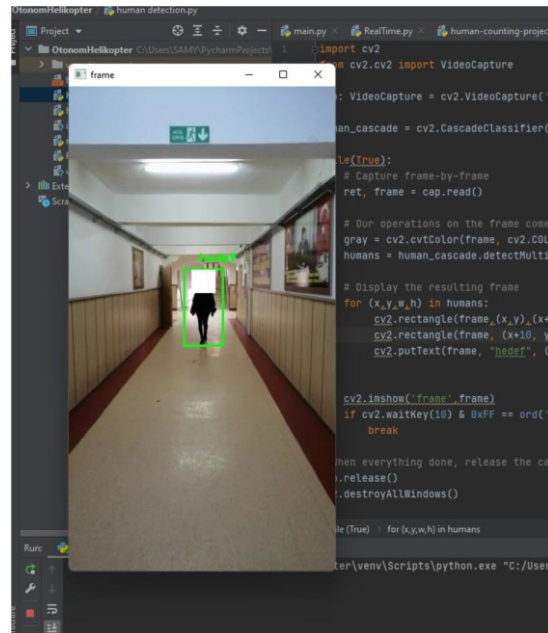


Fig. 10: Output of Image Processing Codes

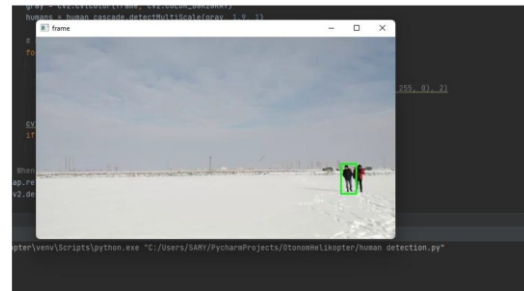


Fig. 11: Output of Image Processing Codes

5. Conclusion and Discussion

The developed system performs 3 different tasks with the data taken from the camera and image processing techniques: Area scanning, target detection and attack/destroying the target. The designed autonomous helicopter; It makes an attack on the target by scanning the area using image processing technique, target detection with the data from the area scanning, examining the data from the target detection and ammunition data. If the ammunition on the helicopter is insufficient to neutralize the target, it transmits data to the military base and ensures that the aid units head towards the target.

When the literature was searched, no helicopter was found with the ability to fly autonomously and the ability to detect and lock on the target and attack at the same time. Existing systems; attack in a remotely controlled manner. Helicopters operating autonomously are not used in the military field. In order to attack the autonomous helicopter designed in the project, unlike the existing systems, an autonomous armed attack helicopter using image processing technique for autonomous area scanning and target detection has been developed.

6. Suggestions

- Various additions to this developed autonomous helicopter can make the helicopter usable in fire and other natural disasters.
- integration with defense vehicles produced with

national technology in Turkey .

- An autonomous cargo helicopter can be built by placing a load instead of the ammunition equipment on the helicopter.
- The helicopter can use new engine and propeller to increase flight speed.
- It can be designed in different sizes for observation in extreme conditions and can also be used for civilian sectors.

References

- [1] AKSOY, R., & KURNAZ, S. (2009). Unmanned Ground Vehicles and Combat Requirements. Journal of Aerospace Technologies , 1-10.
- [2] Eleventh Development Plan. (2019). sbb: Retrieved from: <http://www.sbb.gov.tr/wpcontent/uploads/2019/07/OnbirinciKalkinmaPlani.pdf>
- [3] BAKIR, G. (2019). THE PLACE AND IMPORTANCE OF UNMANNED AERIAL VEHICLES IN DEFENSE INDUSTRY EXPENDITURE. (Journal of Eurasian Social and Economic Research , 6 (2), 127-134. www.asead.com
- [4] Kasapoğlu, C. , & Kirdemir , B. (2019, February). THE NEW DIMENSION IN THE TERROR THREAT: RELATED TO DRONE ATTACKS AND TURKEY'S NATIONAL SECURITY DEVELOPMENTS. EDAM
- [5] Foreign Policy & Security , 3 (2019). https://edam.org.tr/wpcontent/uploads/2019/02/EDAM_Drone-Sald%C4%B1r%C4%B1lar%C4%B1-ve-T%C3%BCrkiyenin-Milli-G%C3%BCvenli%C4%9Fi.pdf
- [6] ÖZTEMEL, E. (2012). Artificial neural networks. Istanbul: Papatya Publishing .
- [7] BAYKAR DEFENSE. (2017). Artificial Intelligence . Artificial Intelligence . <https://www.baykarsavunma.com/page-Artificial-Intelligence.html>
- [8] Turksan Corporation . (no date). Türksan Web Site: Retrieved from <http://www.turksan.com/yuz-tanima.html>
- [9] TITRA. (2020). alpine . Alpine Unmanned Helicopter. <https://titra.com.tr/products/alpin-insansiz-helicopter/>
- [10] Lockheed Martin. (2021). Black Hawk . Black Hawk helicopter <https://www.lockheedmartin.com/en-us/products/sikorsky-black-hawk-helicopter.html>
- [11] Ozgul, F. (2016). python_5-4. Wissen_ (2018, February 27). Wissen Corporation. Retrieved from wissen Corporation .: <https://www.wissenakademie.com/blog/ieee%E2%80%99yegore2017%E2%80%99nin-en-populer-programming-languages>
- [12] Dunder, Y. , & Vural, RA (2018). Embedded System-Based Strategic Positioning with RFID ., (p. 408).
- [13] TAI (2022). Heavy Class Attack Helicopter. Heavy Class Attack Helicopter. <https://www.tusas.com/urunler/yeni->