Video Transmission and Navigation System using QR-Code on Quadcopter

Shinta Dwiyana Saraswati[1], Ahmad Wilda Yulianto[2], M. Nanak Zakaria[3]
[1,3]Digital Telecommunication Networks Study Program, Department of Electrical Engineering,
State Polytechnic of Malang, Malang, 65141, Indonesia
[2]Telecommunication Engineering Study Program, Department of Electrical Engineering,
State Polytechnic of Malang, Malang, 65141, Indonesia
[1]1841160038@student.polinema.ac.id , [2]ahmadwildan@polinema.ac.id , [3]nanak_zach@polinema.ac.id

Abstract— **In the current era of 4.0 technology, there are many quadcopter applications for testing and usability in life) to monitor the surrounding environment while operating and navigate through the GCS depending on the purpose made. Therefore, the operation of the drone is controlled directly by the operator through certain communication networks such as remote control or automatically through devices that have been previously programmed. This is necessary in order to make it easier to move the drone and monitoring can be done through operator directions or image processing. Image Processing in the form of a QR Code that can provide directions to the drone so that navigation can run smoothly. Research using how the camera detects QR Code will give directions to the drone to navigate to make movements following the QR Code directions in a sequence of numbers so that the final result in the form of video can be viewed via GCS and camera via IP CAM. The results of this study indicate that the drone can detect QR Code and opencv also successfully translates pixels is a distance of 5 meters and navigating based on pixel size with more than 100 pixels, the drone can move automatically to a certain destination. With a distance of 1 meter, it produces 100 pixels on the x-axis and 108 pixels on the y-axis, while for the furthest distance from the QR Code, which is 5 meters, it produces 50 pixels on the x-axis and 80 pixels on the y-axis. So that in programming, if there are more than 100 pixels on the x-axis and y-axis, the drone must move in a predetermined direction. Based on the results of the test, it has been successful in navigating the QR Code from a distance of 5 meters, to find out information on the placement of the QR Code on the quadcopter can be seen from the results of image processing that can detect objects according to pixel/frame.**

Keywords— **Wireless, Qr-Code, IP CAM, Image Processing, Navigating.**

I. INTRODUCTION

In the current 4.0 technology era, especially in developed countries, many are trying to develop unmanned vehicle technology or often called Unmanned Aerial Vehicle (UAV), used to monitor the surrounding conditions when operating and navigation via GCS depending on the purpose made. Many UAVs are equipped with cameras that are useful for seeing a situation that cannot be seen directly so they can. Therefore, in operation, unmanned aircraft are controlled directly by the operator through certain communication networks such as remote control or automatically through devices that have been embedded with previous programs.

In UAV operations, the task of the ground control station is as a monitoring and command station so that operators on the ground can send mission orders and monitor the condition of the UAV during the mission. The ground control station can monitor the condition of the UAV indoors. Research H of communication between GCS and UAV utilizes local networks without GPS so that the coverage area becomes limited and can be accessed to target indoors to be implemented in navigation by utilizing the five senses such as image processing and QR Code so that drones can detect and control automatically, and so that drones can process as desired by the operator through GCS by compiling coordinates so that the mission runs smoothly.

In the research entitled Quadcopter Design for Color Detection Using Image Processing conducted by H.Hikmarika [1], in this study the quadcopter can search for objects and land autonomously by flying based on the waypoints that have been set before takeoff. Quadcopter will search for objects in the form of red circles using digital image processing using the OpenCV library. After detecting the object, Odroid will send commands to Pixhawk as the quadcopter controller so that the quadcopter is above the object. Therefore, research was carried out under the title Video Transmission and Navigation Systems for UAVs Using QR-CODE with the addition of QR-CODEs for automatic detection and navigation tools in the direction of movement of quadcopter / UAV drones and video transmission processes with the Ground Control System.

II. METHOD

This section describes system block diagram, flowchart system, mechanicals design and flowchart image processing from "Video Transmission and Navigation System using Qr Code on Quadcopter".

A. System Block Diagram

Planning a navigation system and video transmission using the QR Code on the quadcopter, in this system there is a lidar sensor that measures the height of the quadcopter connected via serial 4 to the Flight Controller. There are 4 BLDC motors to drive the drone which are controlled by the Flight Controller with the help of the Motor ESC driver (ESC as a companion or increase the speed of the drone) which is powered directly from the lipo battery, besides supplying the ESC this battery also supplies the Flight Controller. The Flight Controller in this system communicates with ground control (Laptop) wirelessly using radio telemetry, for the shooting method carried out by the GoPro Hero 5 camera via WiFi which is sent directly to ground control (Laptop) wirelessly which is then processed to obtain coordinates, coordinates is processed using python where the output value is adjusted for the quadcopter drive, and sent to the Flight Controller wirelessly from ground control (Laptop). In this system the quadcopter is not only operated programmatically, but generally can be controlled by remote control as usual, due to security reasons if the drone fails to complete its mission or loses control.

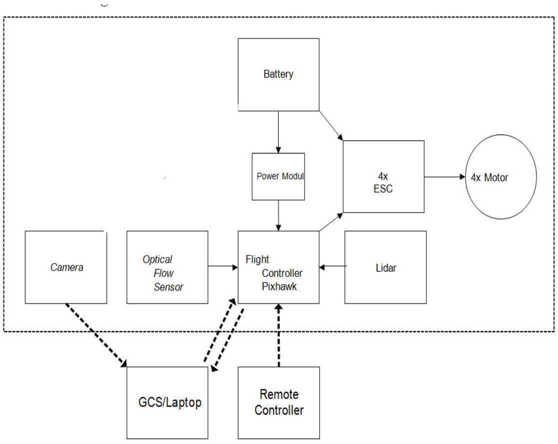


Figure 1 System Block Diagram

B. Flowchart System

The procedures to be used in qr code navigation on drones as shown in figure 2.

1. At first the system takes off automatically then hover to take pictures automatically in the middle (with the zoom process).
2. This image processing is decoding the QR code in the frame and using the polygon points to draw a bounding box around our QR code and displaying the corresponding decoded text in the input frame of the camera itself.
3. If the object has been detected, the drone moves forward (QR Code A). If it has been detected, the system will know which frame is in A (after converting from cm to pixels).
4. If the QR Code has been detected with a pixel of more than 100 px then the drone moves to the left until it finds QR Code B if not then it will be calibrated in the QR Code A detection control system.

If a QR Code B with a pixel of more than 100 px is detected, it will switch to QR Code C, while it is not detected, it will be recalibrated in control system A. And if the QR Code C is successfully detected, the drone moves backwards.

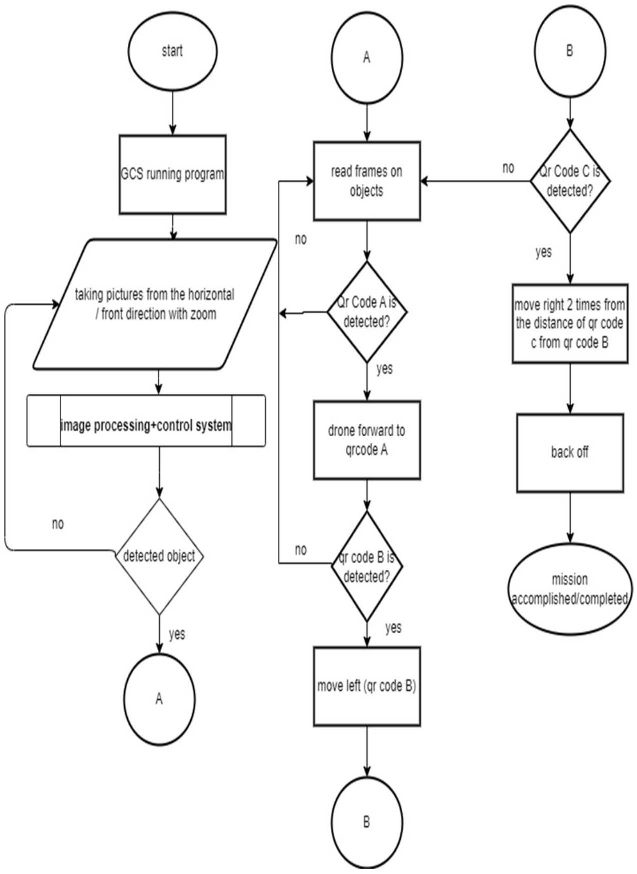


Figure 2 Flowchart System

C. Mechanical Design

This section describes the mechanical design of the research "video transmission system and navigation using a QR Code on a quadcopter" on figure 3 and 4.

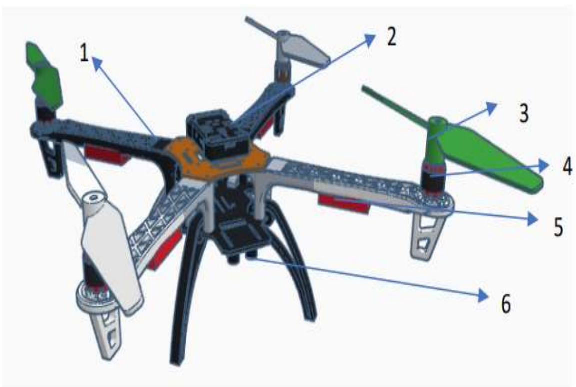


figure 3 Quadcopter Top View

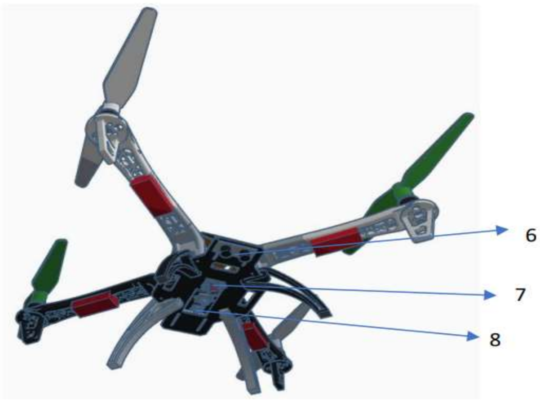


figure 4 Quadcopter Bottom View

The above mechanical planning is as follows:

1. The frame is the frame for the Quadcopter body to place all components.
2. Flight Controller (FC) Pixhawk as the main controller of the Quadcopter.
3. Propellers as Quadcopter drivers so they can fly.
4. Motors brushless
5. Electronic Speed Controller (ESC) as a regulator of motor rotation speed.
6. Lidar sensor as a sensor to determine the height of the Quadcopter.
7. Camera to capture images
8. Optical Flow sensor to help stabilize the Quadcopter
9. Electronic Speed Controller (ESC) as a regulator of motor rotation speed.
10. Lidar sensor as a sensor to determine the height of the Quadcopter.
11. Camera to capture images
12. Optical Flow sensor to help stabilize the Quadcopter

D. Flowchart Image Processing

In this research, the author uses the QR Code library which searches for the same and largest set of pixels in image processing using the opencv library program, due to the simplification of programs related to digital images and therefore it can speed up processing on figure 5.

1. There is an object captured by the camera (cv2.videocapture) in the form of a frame.

   The captured image frame continuously generates a video image and reads/encodes a QR Code :

   (while(cap.isOpened()): ret, frame = cap.read())

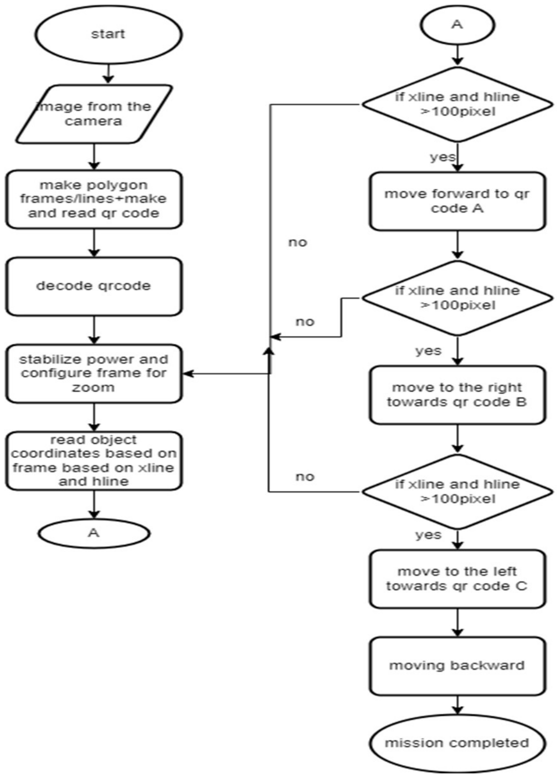


Figure 5 Flowchart Image Processing

2. After which it forms a polygon line during processing encode by providing a pixel label to represent an object, namely creating points/coordinates x(wline) and y(hline).

```
xpos = int(wline/2+decodedObject.rect.left)
ypos = int(hline/2+decodedObject.rect.top)

cv2.putText(resized,'(w,h): ('+str(wline)+','+str(hline)+')',
    (10, 20), font, .75, (0,0,255) , 2, cv2.LINE_AA)
```

3. For the decoding process, define the decode function by taking the frame in the function when taking pictures.

```
(def decode(im):decodedObjects =pyzbar.decode(im)).
    decodedObjects = decode(frame)

for decodedObject in decodedObjects:
    points = decodedObject. Polygon

if len(points) > 4 :
    hull = cv2.convexHull(np.array([point for point  in
    points], dtype=np.float32))
    hull = list(map(tuple, np. squeeze(hull)))

else :          hull = points;
```

4. Wline and hline can function as frame readers and for zooming if the QR Code has not been detected.
   Cropped = frame[yCrop:yCrop+hCrop,xCrop:xCrop +wCrop]
   #scale_percent = 200 width = int(cropped.shape[1] * scale_percent / 100) height = int(cropped.shape[0] * scale_percent / 100)
   im cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

5. Read the coordinates based on the frame which consists of xline and hline.

6. If the xline and hline exceed 100 pixels then the drone will move forward to QR Code A whereas if it is less than 100 pixels then reconfigure the frame by zooming and reconfiguring it on power so the drone doesn't crash.

7. If the xline and hline exceed 100 pixels then the drone will move to the right towards QR Code B whereas if it is less than 100 pixels then reconfigure the frame by zooming and reconfiguring it on power so the drone doesn't crash.

8. If the xline and hline exceed 100 pixels then the drone will move to the left towards QR Code C whereas if it is less than 100 pixels then reconfigure the frame by zooming and reconfiguring it on power so the drone doesn't crash.

9. After that the drone moves backwards.

III. RESULTS AND DISCUSSION

A. Hardware Design Result

Figure 6 Quadcopter Top View

1. Frame as the main quadcopter frame to put everything component.
2. Flight Controller (FC) Pixhawk as the main controller of the quadcopter so it can fly according to the algorithm.
3. Electronic Speed Controller (ESC) as a speed and direction controller turn of the brushless motor.
4. Brushless DC motor as propeller drive.
5. Propellers as quadcopter wings so they can fly.
6. Lidar functions as a height sensor on a quadcopter.
7. Optical Flow as a quadcopter stabilizing sensor when flying.
8. Camera to capture pictures

Figure 7 Quadcopter Bottom View

B. Image Processing Result

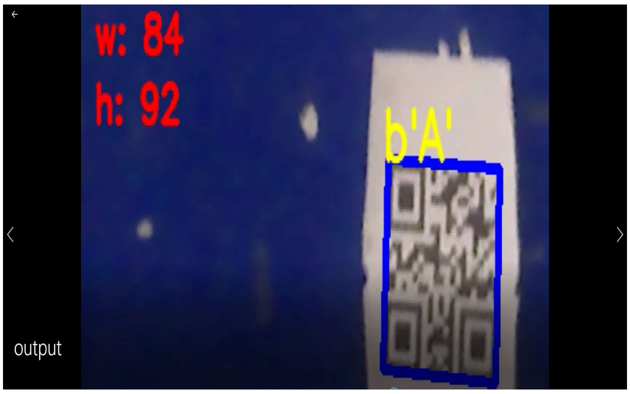


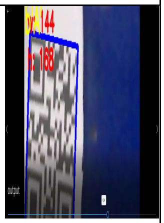
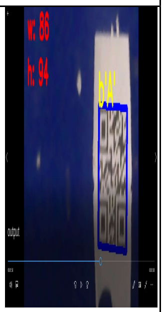
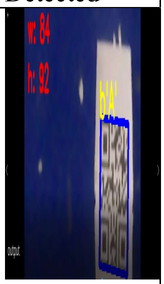
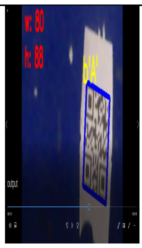
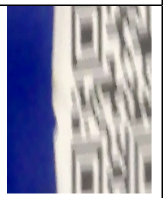
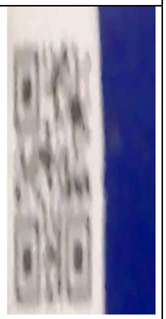
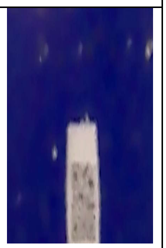
Figure 8 Image Processing Result

The first QR Code detection must define the videocapture contained in the OpenCV library as a camera, to create a frame line (polygon) if the QR Code can be detected. Then the camera can capture the QR Code with the pyzbar library so that it can decode the results of the QR Code with the decodeobject program.

C. Object Detecting Test Result

This test was conducted to determine the camera's ability to detect objects using a QR Code based on horizontal distance. The procedure used to carry out this test, first prepare the quadcopter and laptop for monitoring, then prepare QR Code 1,2 and 3 then run the program from a distance of 10 m from the camera, the quadcopter will take off, observe the results of object detection at each specified horizontal distance , then record the results. After going through these steps, the following data is obtained:

TABLE I
OBJECT DETECTION TEST RESULT

no	Real (m)	Lidar (m)	Cam. HP	Cam. Drone
1	1	0.9	 Detected	 Detected
2	2	2	 Detected	 Detected
3	3	2,9	 Detected	 Detected
4	4	4	 Detected	 Detected
5	5	5	 Detected	 Detected
6	6	5.7	 Not detected	 Not detected
7	7	6.9	 Not detected	 Not detected
8	8	8	 Not detected	 Not detected
9	9	9	 Not detected	 Not detected
10	10	10	 Not detected	 Not detected

Based on table 1 From the test table above the distance measured from the actual distance (using a meter) with the lidar sensor has a small difference horizontally.Whereas for those who tested the images using a cellphone camera with a Gopro camera (carried on a drone) almost had the same value from a distance of 1 to 5 meters and had a small pixel difference, while a distance of 6 meters-10 meters the qrcode was not detected.

D. Qr Code Navigation Time Result

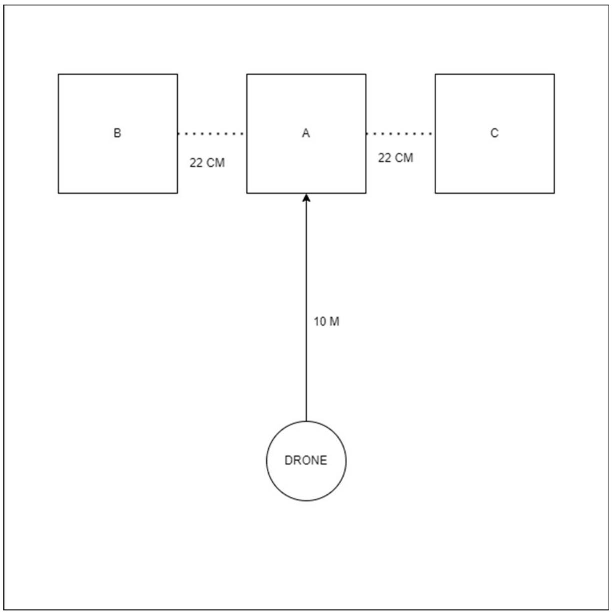


Figure 9 Navigation Of Drone

TABLE II

QR CODE NAVIGATION TIME TEST

No	Nav.drone to A (s)	Nav A-B (s)	Nav B-C (s)	Total time
1	30	15	45	1 m. 30 s.
2	27	10	43	1 m. 20 s
3	28	12	32	1 m. 12 s.
4	26	18	32	1 m. 16 s.
5	29	16	30	1 m. 15 s.
6	28	12	30	1 m. 20 s.
7	27	13	40	1 m. 13 s.
8	26	14	40	1 m. 10 s.
9	26	10	44	2 m. 20 s.
10	25	10	45	1 m. 20 s.
11	22	10	38	1 m. 10 s.
12	20	8	30	58 s.
13	18	9	30	57 s.
14	20	7	27	54 s.
15	15	5	30	50 s.

so from the first to the last try that the drone can navigate quickly from 1 minute 50 seconds for the first try and 50 seconds for the last try

CONCLUSION

The conclusions that can be drawn from the thesis entitled "Video Transmission and Navigation System using QR Code on Quadcopter" are as follows:

1. This research has succeeded in navigating the QR Code from a distance of 5 meters, to find out information on the placement of the QR Code on the quadcopter, this can be seen from the results of image processing which can detect objects according to pixel/frame coordinates from a horizontal distance of 5 meters, using a camera Gopro Hero 5 with digital transmission using ip cam. By navigating based on a pixel size of more than 100 pixels, the drone can move automatically towards a certain destination
2. The video quality results are of good quality by zooming in at a distance of 5 meters while 10 meters are blurry quality.

REFERENCES

[1] Akhmad Taufik, Remigius Tandioga, Ifan Nugraha, dan Ardiansyah Tri Utomo, “Drone Pengikut Objek Berbasis Image Processing,” Prosiding Seminar Hasil Penelitian (SNP2M), pp. 218-223, 2018.

[2] Fredy Aga Nugroho, Raden Sumiharto, dan Roghib Muhammad Hujja, “Pengembangan Sistem Ground Control Station Berbasis Internet Webserver pada Pesawat Tanpa Awak,” Indonesian Journal of Electronics and Instrumentation Systems (IJEIS), vol. VIII, pp. 1-12, 2018.

[3] Gembong Edi Setyawan, dan Hurriyatul Fitriyah, “Sistem Ar Drone Pengikut Garis Menggunakan Algoritma Progressive Probabilistic Hough Transform” Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer, vol. II, pp. 2965-2971, 2018.

[4] Ferry Setiawan, “Rancang Bangun Sistem Pengaman Transmisi Video Pada Pesawat Tanpa Awak,” TUGAS AKHIR ITS, 2018.

[5] Shofiyyullah Shofiyyullah, Angga Rusdinar, Ahmad Sugiana , dan Dr. Eng. Ahmad Sugiana, S.Si., M.T., “Perancangan Drone Hexacopter Untuk

Mendeteksi Kualitas Air Sungai Citarum," e-Proceeding of Engineering, vol. VII, pp. 2939-2946, 2020.

[6] Anata Tumonglo , Gembong Edhi Setyawan, dan Rizal Maulana, "Sistem Deteksi Api pada Quadcopter Ar Drone Menggunakan Metode Color Filtering HSV dan YCbCr Color Space" Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer , vol. III, pp. 4622-4630, 2019.

[7] Jin Guo, Xiaoyan Li, Zhigang Lv,, Yongxia Yang, dan Liangliang Li, "Design of Real-time Video Transmission System for Drone Reliability" IOP Conf. Series: Materials Science and Engineering 790, vol. 1, 2020.

[9] Yetti Yuniati, Melvi Melvi, Andrew Andrew, dan Herman H Sinaga, "Hijacking Menggunakan Metode Man-in-the-Middle dengan Denial of Service untuk memutuskan Live Monitoring pada UAV Untuk Pemantauan Daerah Vital" Jurnal Sains, Teknologi dan Industri, vol. XVIII, pp. 188-195, 2021.

[10] Pella Stepani Imelda, “"Rancang Bangun Dan Analisa Unjuk Kerja Sistem Pengawasan Dengan Frame Rate Dinamis Berdasarkan Deteksi Pergerakan" Jurnal Media Elektro, vol. 10, pp. 8-14, 2021.