Vol. 4, No. 1, 2023, pp. 22-27
DOI: https://doi.org/10.29210/810304900

Contents lists available at Journal IICET

Southeast Asian Journal of technology and Science
ISSN: 2723-1151(Print) ISSN 2723-116X (Electronic)

Journal homepage: https://jurnal.iicet.org/index.php/sajts

QR code detection using OpenCV python with tello drone

Masrul Nizam bin Mahmod[1], Mastura binti Ramli[2], Sharifah Nurulhuda Tuan Mohd Yasin[3]
[1]Department of Mechanical Engineering, Politeknik Muadzam Shah, Malaysia
[2]Department of Information and Communication Technology, Politeknik Muadzam Shah, Malaysia
[3]Department of Electrical Engineering, Politeknik Kuala Terengganu, Malaysia

Article Info

Article history:

Received Feb 26th, 2023
Revised Mar 25th, 2023
Accepted July 4th, 2023

Keyword:

Tello drone
QR code detection
OpenCV

ABSTRACT

The rapid advancement of unmanned aerial vehicles (UAVs), commonly known as drones, has opened up new possibilities for various applications, including aerial imaging, surveillance, delivery services, search and rescue operations. One particular area of interest is the integration of computer vision techniques with drones to enable autonomous detection and recognition of visual markers or codes. The objective of this research is to design and implement an efficient and accurate QR code detection system using the Tello drone. Our project aimed to develop a solution that only requires a simple vision system to achieve accurate positioning (altitude) in closed spaces. The method is developed in python environment using OpenCV library. This paper presents an efficient method for QR code detection using HSV color space algorithm. Based on experiments and findings, it is recommended to maintain a range of approximately 90cm - 120cm for optimal QR code reading using the Tello drone. This range provides a suitable balance between capturing clear and detailed images of the QR codes and ensuring accurate decoding and recognition. The combination of the Tello drone and computer vision techniques provides an efficient and reliable solution for QR code detection in practical scenarios. Lastly, this research also able to stimulate further innovation in the field and inspire the development of more sophisticated and efficient QR code detection systems using autonomous drones.

Corresponding Author:

Mahmod, M. N.
Affiliation
Email: masrul@pms.edu.my

Introduction

Drones are becoming increasingly popular in various fields, such as photography, surveying, transportation, and military systems (Hulek et. al, 2023). The rapid advancement of unmanned aerial vehicles (UAVs), commonly known as drones, has opened up new possibilities for various applications, including aerial imaging, surveillance, delivery services, search and rescue operations. One particular part of interest is the integration of computer vision techniques with drones to enable autonomous detection and recognition of visual markers or

codes. Among these codes, Quick Response (QR) codes have gained significant popularity due to their ability to store large amounts of information in a compact and easily scan able format. Created by the Japanese company Denso Wave in 1994, a QR code is a type of two-dimensional barcode (or matrix code) consisting of black modules arranged in a square with a white background. Each module represents either 1 or 0 (Datsi et. al, 2023). QR codes can store a wealth of information, including website URLs, product details, contact information, and more. It also become ubiquitous in marketing, logistics, inventory management, and other fields due to their ease of use and versatility.

Several approaches have been described on how to detect QR code images. Tong et. al (2014) proposed a scheme based on a local binary pattern and a contour image for QR code detection. QR code detection techniques, the QR code is a simple and effective means of processing information readable two-dimensional barcodes that contain information about a system, object, or another system. QR codes reduce the complexity of visual recognition in AI with their simple and fast features (Chinaechetam, 2022). By employing image processing recognition algorithms, the system detects and extract QR codes from the captured video feed by a drone. The Tello drone was chosen because it is affordable, appropriately sized, and easy to program (Pinney, 2022) and suitable to operate indoor or in controlled lab environment. The Tello drone, equipped with an onboard camera, provides a suitable platform for exploring computer vision techniques and implementing QR code detection algorithms. The Tello drone, known for its compact size, affordability, and ease of use, provides a versatile platform for experimenting with computer vision algorithms.

According to Bradski and Kaehler (2008), openCV Python is an open source computer vision library and designed for computational efficiency and with a strong focus on real-time applications. One of OpenCV's goals is to provide a simple-to-use computer vision infrastructure that helps people build fairly sophisticated vision applications quickly]. Therefore, OpenCV Python algorithm used to enable Tello drone to perform task like object detection specifically QR code detection. Other technology used in this research is HSV color space-based algorithm. The HSV color space is represented by H (hue), S (saturation), and V (value). The HSV color space corresponds closely to the human perception of colors (Herodotou et. al, 1998). Color space is a mathematical model that represents color information as three or four different color components (Shaik et. al, 2015). It is suitable as a color space that deals with human visual perception. HSV color-space-based image segmentation is better than RGB color space (Sural et. al, 2002).

The objective of this research is to design and implement an efficient and accurate QR code detection system using the Tello drone. Our project aimed to develop a solution that only requires a simple vision system to achieve accurate positioning (altitude)in closed spaces. Furthermore, the research aims to optimize the computational efficiency of the algorithm to ensure real-time performance during drone operations. With the increasing popularity of unmanned aerial vehicles (UAVs) and the widespread use of Quick Response (QR) codes in various industries, there is a growing interest in the detection and decoding of QR codes using drones.

Method

In this work, the Tello quadcopter was selected for the current testing phase of this case study due to the programming capabilities of the drone, simplicity, and the cost-effective nature of this model (Pinney, 2022). Fig. 1 illustrates the Tello model.

Figure 1 <A Tello Drone Used for Testing>

The Tello is capable of 13 minutes of flight time and a maximum flight height of 30 meters. This drone also supports a built-in range finder, barometer, Wi-Fi system, and a 720p camera with the 82.6° field of view that can capture photos in JPEG format and video in 30fps MP4 format (Tello Official Website, 2022).

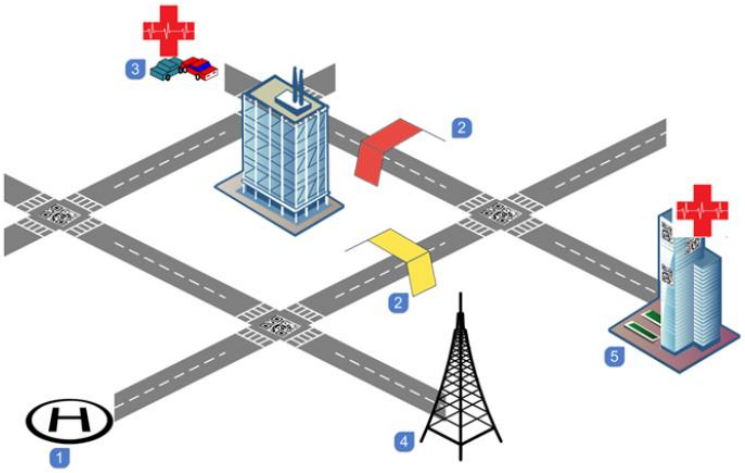

Figure 2 <Playing Field for Navigation Testing>

The playing field is a simulated model of an urban environment consisting of several streets, crossroads, buildings, obstacles and designated places with markers. Figure 2 shows the playing field consists of these elements; starting point, obstacles, emergency delivery location, electricity pylons inspections, and tall building inspection (and package delivery).

Streets have a different color to the floor (white or black) and a dashed line in the middle. These roads are connected to each other by several crossroads, and there is a QR code located in the center of each crossing. Data of these QR codes tell the drone where it should go next to reach every mission element (navigation information).

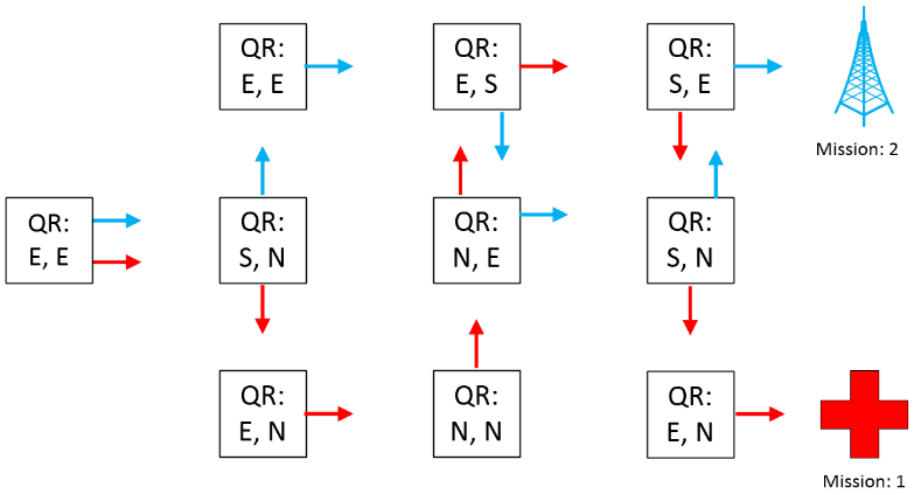

Figure 3 <Navigation Plan using the QR contents>

In the fig. 3 a simplified example is shown with only 2 target positions (mission 1 and 2). The Tello drone can reach the first target position by flowing the first character in the sequence (red arrow) and following the second character (blue arrow) will guide it to the second target position.

There are various computer vision approaches explored and assess their suitability for accurate and efficient QR code detection. In this research paper, we are using color-space algorithm for QR code detection. Changing color-space algorithm is converting images from one color-space to another, like BGR ↔ Gray, BGR↔ HSV. There are more than 150 color-space conversion methods available in OpenCV. But we look into only two which are most widely used ones which is BGR ↔ HSV. For color conversion, the function cv2.cvtColor(input_image, flag) used where flag determines the type of conversion. For BGR → HSV, the flag cv2.COLOR_BGR2HSV used. In HSV, it is easier to represent a color than RGB color-space (Mordvintsev, 2017). One suitable method for QR code detection using the Tello drone is the combination of computer vision techniques, specifically image processing and feature extraction algorithms. By combining these steps, the method aims to achieve accurate and reliable QR code detection using the Tello drone.

Result and Discussion

The experiments were conducted and data collection has been analyzed to get meaningful findings about QR code detection. The results then be documented based on the findings obtained based on Figure 4 and Figure 5. The image of the QR code is captured in real-time and further processed using the HSV color space method. In the context of QR code detection using the Tello drone, the appropriate height at which the drone should fly plays a crucial role in achieving accurate and reliable results. The discussion regarding the appropriate height involves considering various factors such as the size of the QR code, camera resolution, image quality, and environmental conditions. Computer vision is the transformation of data from a still or video camera into either a decision or a new representation. All such transformations are done for achieving some particular goal (Bradski and Kaehler, 2008). In this experiment the QR code contain information about navigation need to do by Tello drone.

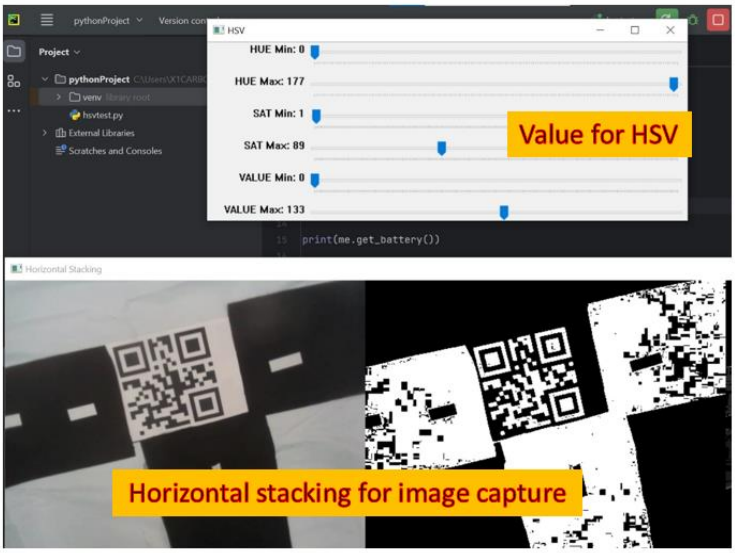

Figure 4 <Algorithm for HSV Color Space>

Based on experiments and evaluations, it is recommended to maintain a range of approximately 90cm - 120cm for optimal QR code reading using the Tello drone. This range provides a suitable balance between capturing clear and detailed images of the QR codes and ensuring accurate decoding and recognition. Flying the drone at a closer distance to the QR code can help ensure that it occupies a larger portion of the image, leading to better recognition and decoding. Operating the drone within this range allows for precise focus and minimizes any distortion or blurring that may occur due to variations in lighting conditions or motion. It is important to highlight that QR codes should be positioned within this range to ensure successful detection and decoding. Extending the range beyond that may result in reduced image quality and potential decoding errors. Therefore, for efficient QR code reading using the Tello drone, it is recommended to maintain a close proximity of 90cm -

120cm between the drone and the QR codes of interest. The recognition of quick response (QR) codes is considered one of the most challenging research areas in the field of computer vision (Yan et. al, 2020).

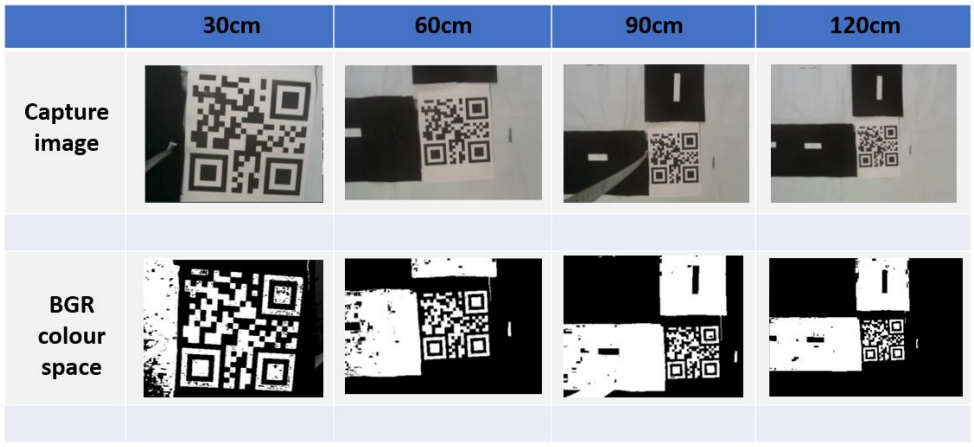

Figure 5 <Data Captured during Experiment Using Tello Drone with Different Range of Height>

Flying the drone at an appropriate height can help maintain good image quality. Factors such as lighting conditions, sharpness, and clarity of the captured image can influence the accuracy of QR code detection. By flying at an optimal height, the drone can capture well-lit and focused images, minimizing the risk of misreads or errors during the detection process. It is recommended to conduct experiments and evaluate the detection performance at different heights to determine the optimal range that balances accuracy, stability, and practicality to get a reliable QR code detection.

Conclusion

The outcomes of this research contribute to the advancement of QR code detection using autonomous drones, particularly focusing on the capabilities and limitations of the Tello drone. The findings provide valuable information into practicality of using drones for QR code detection tasks by integrating computer vision algorithms with lightweight drones like the Tello. This method involves several steps to accurately detect and locate QR codes within the drone's captured video feed. The choice of specific algorithms and techniques may vary depending on the requirements, computational resources, and performance constraints of the system. By developing a reliable QR code detection system for the Tello drone, we aim to enable a range of applications that benefit from aerial scanning and analysis. For instance, this technology can be employed in asset tracking, inspection tasks, geolocation services, or even interactive games and experiences. Through this research also support the growing field of drone-based computer vision applications and explore the potential of QR code detection in various domains, ultimately paving the way for enhanced functionality and autonomy in drone systems. Lastly, this research also able to stimulate further innovation in the field and inspire the development of more sophisticated and efficient QR code detection systems using autonomous drones.

References

Bradski, G., & Kaehler, A. (2008). Learning OpenCV: Computer vision with the OpenCV library. *" O'Reilly Media, Inc.".*

B. Pinney, S. Duncan, M. Shekaramiz and M. A. S. Masoum. (2022). Drone Path Planning and Object Detection via QR Codes; A Surrogate Case Study for Wind Turbine Inspection, 2022 *Intermountain Engineering, Technology and Computing (IETC)*, Orem, UT, USA, pp. 1-6, doi: 10.1109/IETC54973.2022.9796739.

Chinaechetam, N. E., Njoku, J. N., & Kim, D. S. (2022). Real-Time QR Code License Plate Detection in Vehicles Using Pyzbar. 한국통신학회 학술대회논문집, 669-670.

Datsi, Toufik & Aznag, Khalid & Ahmed, EL OIRRAK. (2023). A Novel Approach for QR Code Image Based on Decimal Coding Technique, Gray Level Co- Occurrence Matrix and Local Binary Pattern. 101. 1361-1372.

Herodotou, N.; Plataniotis, K.N.; Venetsanopoulos, A.N. (1998). A color segmentation scheme for object-based video coding. *In Proceedings of the IEEE Symposium on Advances in Digital Filtering and Signal Processing, Symposium Proceedings, Victoria, BC, Canada*, 5–6 June 1998; pp. 25–29.

Hulek, Kacper & Pawlicki, Mariusz & Ostrowski, Adrian & Mozaryn, Jakub. (2023). Implementation and analysis of Ryze Tello drone vision-based positioning using AprilTags. 10.48550/arXiv.2305.05673.

L. Tong, X. Gu, and F. Dai. (2014). QR code detection based on local features, *Proceedings of International Conference on Internet Multimedia Computing and Service*, pp. 319–322.

Mordvintsev, A., & Abid, K. (2017). OpenCV-python tutorials documentation. *Obtenido de https://media. readthedocs. org/pdf/opencv-python-tutroals/latest/opencv-python-tutroals. pdf*.

Q. Yan, X. Ji, and Y. Liang. (2020). Displacement detection method of QR code reference object based on computer vision, *Proceedings of2020 IEEE International Conference on Parallel & Distributed Processing with Applications*, Big Data & Cloud Computing, Sustainable Computing & Communications, Social Computing & Networking (ISPA/BDCloud/SocialCom/SustainCom), Exeter, United Kingdom, pp. 895–900

Shaik, K.B.; Ganesan, P.; Kalist, V.; Sathish, B.S.; Jenitha, J.M.M. (2015) Comparative study of skin color detection and segmentation in HSV and YCbCr color space. *Procedia Comput. Sci.*, *57*, 41–48.

Sural, S.; Qian, G.; Pramanik, S. (2002) Segmentation and histogram generation using the HSV color space for image retrieval. *In Proceedings of the IEEE International Conference on Image Processing, Rochester*, NY, USA.

"Tello EDU Specs, Tello Official Website-Shenzhen Ryze Technology Co.Ltd., (2022). Retrieved from https://www.ryzerobotics.com/tello-edu/specs.