ELINVO (Electronics, Informatics, and Vocational Education), November 2021;6(2): 157-165
ISSN 2580-6424 (printed), ISSN 2477-2399 (online,) DOI: https://doi.org/10.21831/elinvo.v6i2.43873

Crowd Detection System Using *Blimp Drones* as an Effort to Mitigate the Spread of Covid-19 Based on *Internet of Things*

Mashoedah[1], Oktaf Agni Dhewa[2], Zulhakim Seftiyana Roviyan[3], Dheni Leo[4], Silvia Larasatul Masyitoh[5]
[1,2,3]Electronic Engineering Education Study Program Faculty of Engineering Yogyakarta State University, [4]Mechatronic Engineering Education Study Program Faculty of Engineering Yogyakarta State University, [5]Information Technology Study Program Faculty of Engineering Yogyakarta State University
E-mail: zulhakim.sr@gmail.com

ABSTRACT

The method of giving warnings for violations of health protocols manually by officers is still the choice for most managers of public facilities in the era of the covid-19 pandemic. This manual method has several weaknesses, including staff saturation and inconsistency. In addition, large public areas require a large number of officers. Therefore, we need another better alternative to replace the manual method. One alternative that can be chosen is to implement an automatic crowd detection system utilizing blimp drone technology. This study aims to produce a *blimp drone* based on the *internet of things* as a warning system for health protocol violations. The method applied consists of literature review, needs analysis, design, manufacture, and testing. The results of the activities are described as follows. (1) The *Blimp drone* is IoT-based in the form of an ellipse with a diameter of 0.524m and a height of 1.05m with a weight of 1.1kg. (2) The movement of the *blimp drone* utilizes helium gas and 4 propellers capable of covering a large area in a time duration of +/-40 minutes. (3) The intelligent system on the *blimp drone is* able to detect and warn crowds of people whose distance is < 1m, people who are not wearing masks, and everyone's body temperature is > 37.5 °C. (4) The warning system on the *blimp drone* uses audio that will sound when there is a violation of health protocols. All data is sent to the database web using the IoT protocol (MQTT).

Keywords*:* Health Protocol*, Blimp Drone, Internet of Things*

INTRODUCTION

Efforts to prevent and reduce the spread of the Covid-19 outbreak continue to be carried out by the Government of Indonesia. Various ways have been applied to prevent and reduce the worst impact of the Covid-19 outbreak. *New normal* is an acceleration step in dealing with the impact of the Covid-19 outbreak in various fields [1]. *The new normal* requires us to live side by side with Covid-19, so health protocols are implemented to prevent and reduce cases of the spread of Covid-19. However, in reality the implementation of health protocols during the period *new normal* is not considered optimal. Public awareness of the importance of maintaining distance and wearing masks in various public places is still very lacking [2].

Tourism is one of the fields that was raised during the *new normal.* However tourism is prone to crowds or can lead to breaches of health protocols [3]. According to [4] as many as 215,660 people received warnings for violating health protocols at tourist attractions during May 2021. Therefore, in maximizing the application of health protocols [5] has created a COVID-Robot technology that can detect distance in a crowd and body temperature. However, the output of the COVID-Robot has not been able to directly warn of violations of health protocols. In addition, COVID-Robot also cannot move independently or is passive. On the other hand, [6] created a similar technology by utilizing drones that can sound an alarm to the public. However, the *flight time is* relatively short and the drone control system is not yet *autonomous*

To complete these weaknesses, we need a system that moves automatically with a longer *flight time* . One solution option is to use a flying object *blimp drone. Blimp drone* itself is a type of UAV made from hot air balloons[7], where the UAV *(Unmanned Aerial Vehicle) is* known as an unmanned aircraft that uses aerodynamic force to fly [8].

In its application, operations are carried out with reference to crowded points in tourist attractions. The vehicle will fly *autonomously in* accordance with the *waypoints* that have been marked as a path in carrying out flight missions [9]. Wahana will perform *scanning* and *capturing* using digital cameras and thermal cameras [10]. The results of *capturing* using a digital camera will be processed as distance detection in the crowd and masks are issued in the form of an audio warning. While the results of processing *capturing* using a thermal camera are issued in the form of images that are visualized on a *dashboard in the* form of a *web application* [11]. The system on the rides is integrated with the system *Internet of Things* so that all data obtained can be easily accessed by local governments and tourism officers for further action [12].

METHOD

The development of this system is carried out using a method consisting of literature review, needs analysis, design, manufacture, and testing. Figure 1 shows the steps involved in developing a crowd detection system using a blimp drone

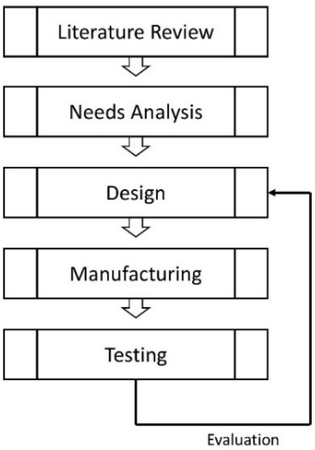

Figure 1. Stages of Development of a Detection System Using a *Blimp Drone*

The flow sketch of the crowd detection system using the blimp drone is shown in the following figure.

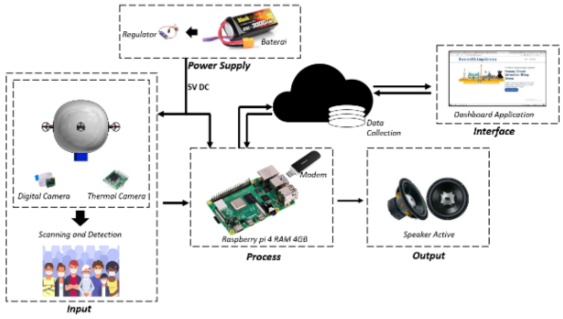

Figure 2. Crowd Detection System Diagram Using *Blimp Drone*

Based on the diagram, it can be explained that the *blimp drone* will fly *autonomously* with a certain height while *capturing* visitor activities at tourist attractions using thermal cameras and digital cameras connected to the SBC raspberry pi4 [13]. The system will work when a crowd is detected with a distance between visitors of less than 1 meter*, the* SBC raspberry pi4 will communicate with the *flight controller* as a control to maintain the *blimp drone* in the position *altitude hold* [14]. Then simultaneously, the SBC raspberry pi4 will issue *output* warning audio to keep the distance through the *speaker*. Once no crowd is detected, the *flight controller* will control the *blimp drone* to fly to the *waypoint* next. The same thing happened when it was detected that visitors were not wearing masks. *Blimp drone* will switch to mode *altitude hold* and simultaneously audio warning to wear an active mask through the *speaker* connected to the SBC raspberry pi4. The data from the distance detection in the crowd and the detection of masks will be sent to in the *dashboard* form of a *web application* that is integrated with the *internet of things*. In addition, the system will also *capture* all visitor activities using a thermal camera. When a visitor is detected with a body temperature > 37.5 ºC, the system will send data to the *dashboard in the* form of a web *application* integrated *with an internet of things*.

After the system design stage, the next step is the electronic design stage, programming algorithm, and mechanical design. Design improvements were made to make the system integrated with each other. Electronic designs, programming algorithms, and mechanical designs that have been made can be seen in the following figure.

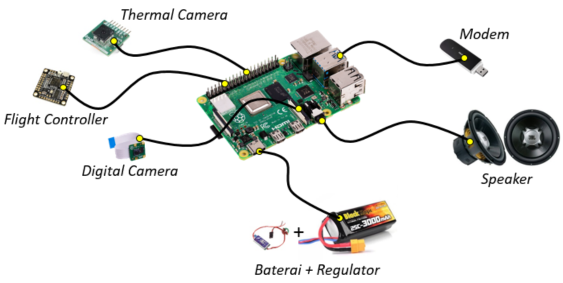

Figure 3. Electronic Component Wiring

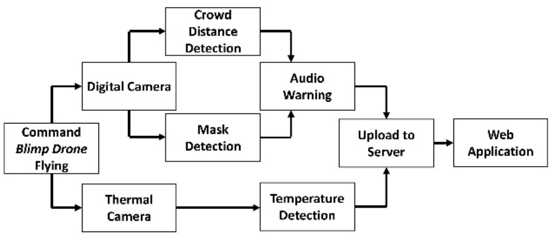

Figure 4. Crowd Detection Program Algorithm Using *Blimp Drone*

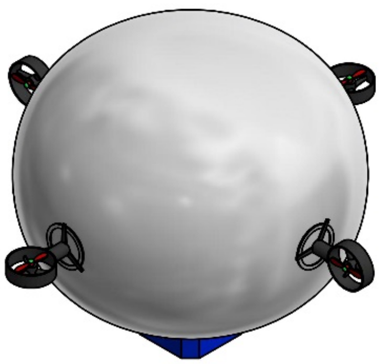

Figure 5.Vehicle Design *Blimp Drone*

The manufacturing stage is the implementation of the design to validate the performance of the tool. This stage is carried out in stages starting from the creation of the vehicle, the creation of a detection system, and the creation of a *web application*. Figure 6 shows *the developed blimp drone*. *Blimp drones were* made by analyzing the helium balloon lift and load points on the *blimp drones* based on research results [15].

Figure 6. Vehicle *Blimp Drone*

Making a distance detection system in crowds is done using the YOLO algorithm in the CNNarchitecture *(Convolution Neural Network)* installed on a raspberry pi4. The algorithm works by calculating the formula *euclidean*, where *euclidean* itself is an algorithm related to the theorem *Pythagorean* [16]. The algorithm will calculate the distance between objects. If the distance between objects is less than 1 meter, the program will mark the object in red. If it is more than 1 meter, the program will mark the object in green.

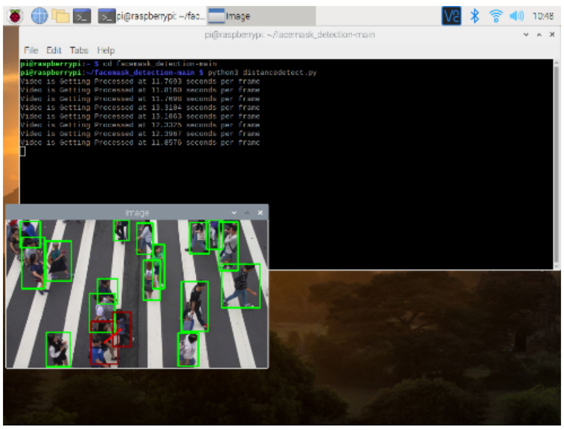

Figure 7. Object Detection Distance Less than 1 Meter

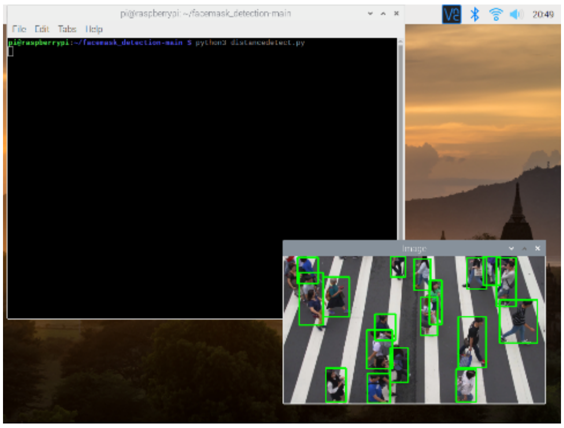

Figure 8. Object Detection Distance More than 1 Meter

The mask detection system is made using the *libraries* TensorFlow and OpenCVto recognize and process images [17]. The dataset in the form of people wearing masks as many as 534 images and not wearing masks as many as 534 images was extracted into a data type *array*. The algorithm is made in order to define *the transformation* data for the process *augmentation*. The process of making a model *image classifier* utilizes the MobileNetV2 algorithm in the CNNarchitecture *(Convolution Neural Network)* with a method *looping* on the *base model* and *head model* [18]. The result of the *loop* that has been compiled and trained *is* called the model *image classifier*.

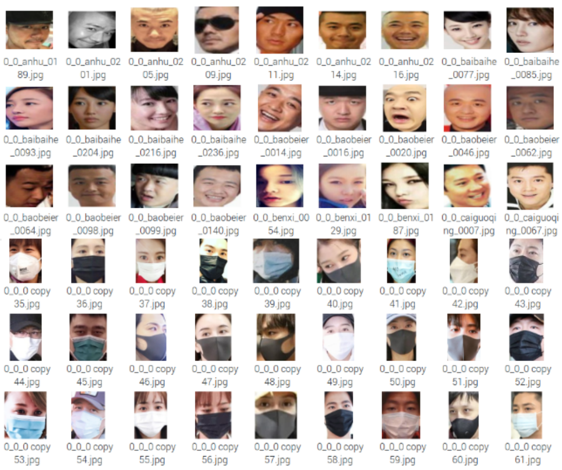

Figure 8. Mask Detection System Dataset Collection Mask

The detection algorithm works using face and mask location recognition methods. The Object Captured will be compared with the model *image classifier*. If the object is not wearing a mask, the program will mark the object in red. If the object is wearing a mask, the program will mark the object in green.

```
prototxtPath = os.path.sep.join(["face_detector", "deploy.prototxt"])
weightsPath =  os.path.sep.join(["face_detector", "res10_300x300_ssd_iter_140000.caffemodel"
faceNet = cv2.dnn.readNet(prototxtPath, weightsPath)

# load the face mask detector model from disk
print("[INFO] memuat model pendeteksi masker...")
maskNet = load_model("MaskDetector.h5")
```

Figure 9. *Path* Image Model

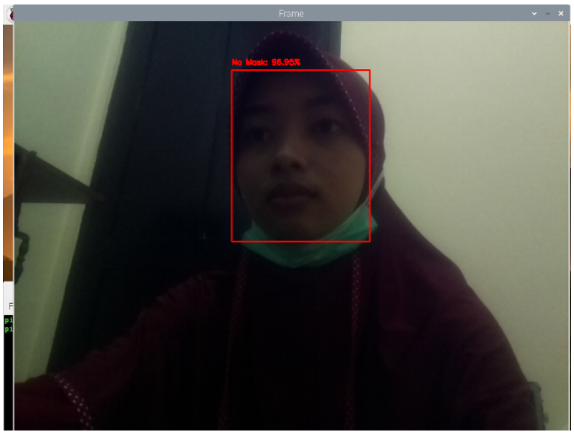

Figure 10. Detection Object Not Using Mask

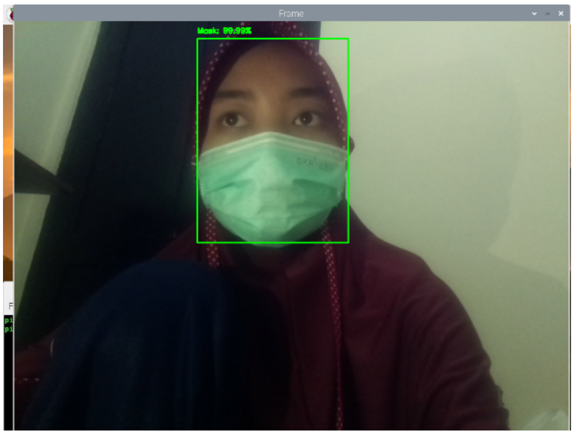

Figure 11. Detection Object Using Mask

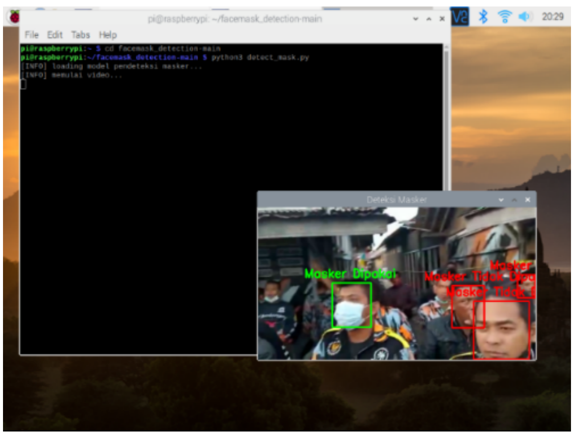

Figure 12. Combination Mask Detection Object

Audio system programming is done using the *library* Simple Audio [19]. In the test, the audio warning system sounds when the system detects people who are not wearing masks and the distance in the crowd is less than specified. Here is the *source code* used.

```
for (box, pred) in zip(locs, preds):
    # unpack the bounding box and predictions
    (startX, startY, endX, endY) = box
    (mask, withoutMask) = pred

    if mask > withoutMask:
        label = "Masker Terdeteksi"
        color = (0, 255, 0)

    else:
        label = "Masker Tidak Terdeteksi"
        color = (0, 0, 255)
        wave_obj = sa.WaveObject.from_wave_file("deteksi_masker.wav")
        play_obj = wave_obj.play()
        play_obj.wait_done()

    # display the label and bounding box rectangle on the output
    # frame
    cv2.putText(frame, label, (startX-50, startY - 10),
        cv2.FONT_HERSHEY_SIMPLEX, 0.7, color, 2)
    cv2.rectangle(frame, (startX, startY), (endX, endY), color, 2)
```

Figure 13. *Source Code* Audio Mask Detection Warning

```
    for i in flat_box:
        (x, y) = (outline[i][0], outline[i][1])
        (w, h) = (outline[i][2], outline[i][3])
        if status[index] == True:
            cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 0, 150), 2)
        elif status[index] == False:
            cv2.rectangle(frame, (x, y), (x + w, y + h), (0, 255, 0), 2)
        index += 1
    for h in pairs:
        cv2.line(frame, tuple(h[0]), tuple(h[1]), (0, 0, 255), 2)
        wave_obj = sa.WaveObject.from_wave_file("deteksi_jarak.wav")
        play_obj = wave_obj.play()
        play_obj.wait_done()
processedImg = frame.copy()
```

Figure 14. *Source Code* Audio Distance Detection Warning

Making temperature detection is done by a thermal camera Flir Lepton 2.5. The algorithm is made in order to be able to do *thresholding in* order to obtain a binary image. Then the extraction of morphological features from binary images is carried out based on parameters *eccentricity* and *metric* [20]. The algorithm will classify the image into body temperature based on color indicators.

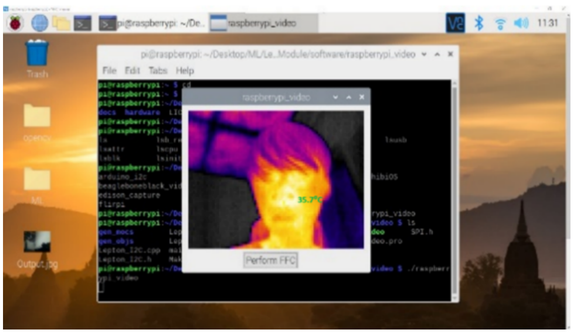

Figure 15. Temperature Detection Object

Web Applications are made using HTML, CSS, and PHP. *Web application is* divided into two *pages*, including the *home page* and *dashboard*. *The home page* contains general information, while the *dashboard* contains information on system detection results. The integration process with the IoT system utilizes *a gateway* communication in the form of an MQTT proxy [21].

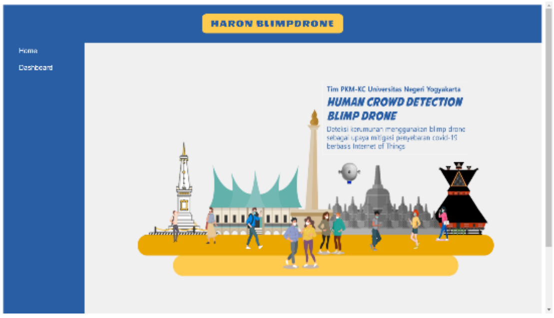

Figure 16. Display *Home Page*

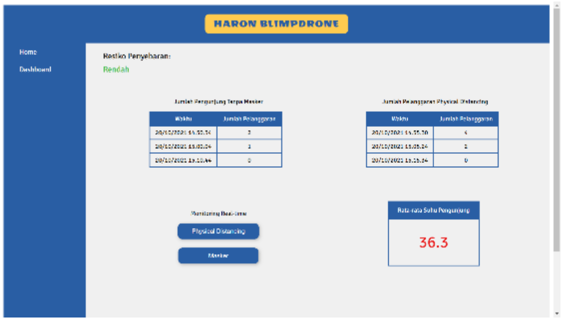

Figure 17.View *Dashboard*

RESULT AND DISCUSSION

The results of the analysis of component requirements on tool performance are generally carried out in order to improve the identification of needs analysis.

Table 1. Analysis of Requirements

Component	Specifications	Description
Raspberry pi4	Large memory capacity and *clock speed* up to 1.5 GHz	Data processing from digital cameras and thermal cameras *(image processing)*

Digital Camera	Cameras Raspberry pi camera 5mp compatible with the microprocessor used and high image resolution	Taking pictures for distance and mask detection
Thermal Camera	Flir Lepton 2.5has a wide range and sensitivity levels up to 0.050 ºC	Taking pictures for temperature detection
Speaker	The Bluetooth 5.0 speaker has a more stable signal, saves battery, and is able to reach up to 10 meters.	Warning audio output.
Modem	USB Modem provides better internet connection with 4G network	System connection with internet
Flight Controller	Omnibus F4 V3 with specifications in control *blimp drone* capable, even though the price is relatively cheap.	The Control system *blimp drone* while flying
Electronics Speed Controller	ESC type *hobbywing xrotor* 4 in 1 with easy and more practical wiring	Adjusting the rotational speed *of the brushless*
motorBrushless	*5000kvOutrunner* motor efficiently in conversion of electric power into mechanical power and relatively high rotational speed	Moves the propeller
Helium balloon	PVC/Latex material is easier to obtain and stronger in storing helium gas	Basic material *blimp Drone*
Propeller	Type 3 *blades* with a size of 2x3 *inches* more efficient in flowing wind	Converts the rotational force of *a brushless motor* into thrust
Lipo battery	Capacity 5000mAH has great power, so *flight time blimp drone* is longer	DC power source
Regulator	Ubec *step down* 5V 4Awith *output* a more stable voltage	Converts 12V DC voltage to 5V

The results of the literature review show that the lifting power of the *blimp drone is* influenced by the diameter of the helium balloon used [15].

Table 2. Analysis of Helium Balloon Lift

No.	Balloon Diamet (m)	Height Balloon (m)	Volume (m^3)	Lifting (N)	Mass (Kg)
1.	0.524	1.05	1.1	139.9	1.1
2.	0.38	0.764	0.8	101.7	0.8
3.	0.95	1.91	2	254.4	2

Note :
FA = *air gV – helium gV*
Density of helium (helium) = 0.1785 kg/m^3
Density of air (air) = 12.9 kg/m^3
Earth's gravity (g) = 10 m/s^2

From the table of analysis results, it can be stated that a *blimp drone* with a diameter of

0.524m and a height of 1.05m can produce a lifting force of 139.9N so that it has the potential to lift a load of 1.1kg, provided that the helium used is pure helium. *Blimp drone* with a balloon size of 0.524m in diameter and 1.05m in height, with specification *brushless motor* 5000kvand a 2x3propeller *inch* can fly with mode *altitude hold*. The construction of a *blimp drone* with a motor position that is symmetrical to the shape of the balloon will minimize the reaction torque force caused by motor rotation. The prototype of the tool is shown in the following figure.

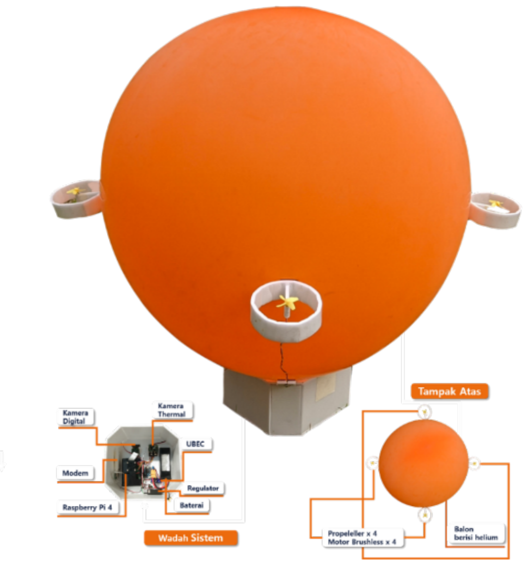

Figure 18. Rides and Specifications *Blimp Drone*

The results of testing the accuracy of the distance detection system for crowds, masks, and body temperature are shown in the following table.

Table 3. Mask Detection System Accuracy

No	Detection	Distance	Accuracy
1.	Mask	1 meters	99%
2.		2 meters	99%
3.		3 meters	98%
4.		4 meters	98%
5.		5 meters	96%
6.		6 meters	96%
7.		7 meters	96%

Table 4. Distance Detection System Accuracy

No	Detection	Distance	Accuracy
1.	Distance in Crowd	1 meters	99%
2.		2 meters	99%
3.		3 meters	99%
4.		4 meters	99%
5.		5 meters	99%
6.		6 meters	98%
7.		7 meters	98%

Table 5. Temperature Detection System Accuracy

No	Detection	Distance	Accuracy
1.	Body Temperature	1 meters	98%
2.		2 meters	98%
3.		3 meters	98%
4.		4 meters	98%
5.		5 meters	98%
6.		6 meters	96%
7.		7 meters	96%

The advantage of a crowd detection system using bump drones is its flexibility and portable tools. The existence of a system *autonomous* that is owned, this tool is able to handle a large tourist area with only one vehicle. In addition, this tool is also able to provide direct warnings when there is a violation of health protocols automatically with long *flight times* . This is different from the *Social Distance Drone Technology* which cannot move *autonomously* and the *flight time* is relatively short. Therefore, this system has high yield potential and usefulness to be implemented on a larger scale. The system developed will make it easier for local governments and tourism managers to enforce the implementation of health protocols. The system can detect the distance in the crowd and the use of masks as well as detect the temperature through the programming algorithm embedded in this tool. In addition, connectivity from the internet can provide flexibility for local governments and tourism managers in obtaining data in *real time*. Thus, the tourism sector, which has fallen due to the Covid-19 pandemic, can be improved again along with the implementation of strict health protocols.

CONCLUSION

TheBlimp drone has an IoT-based diameter of 0.524m and a height of 1.05m with a volume of 1.1m^3. The movement of the *blimp drone* utilizes helium gas and 4 propellers able to cover a large area in a time duration of +/-40 minutes. The intelligent system on the *blimp drone is* able to detect and warn crowds of people who are <1m away, people who are not wearing masks, and everyone's body temperature is >37.5 ^{o}C. The warning system on the *blimp drone* uses audio that will sound when a health protocol violation occurs. All data is sent to *the database* web using the IoT protocol (MQTT). Some suggestions for improvements to improve the tool, namely: (1) improvements in systematic calculations that are more precise in the design of the *blimp drone Drone* by considering the aerodynamic force and the working Archimedes style (2) considering the specifications of the microprocessor used for *image processing* so that the process carried out can run with *delay* low.

REFERENCES

[1] R. Widiyani, "Tentang New Normal di Indonesia: Arti, Fakta dan Kesiapan Daerah," *https://news.detik.com/berita/d-5034719/tentang-new-normal-di-indonesia-arti-fakta-dan-kesiapan-daerah*, 2020. .

[2] N. Ramadhian, "Syarat Wisata ke Banyumas jika Tempat Wisata Sudah Dibuka Semua," *https://travel.kompas.com/read/2021/09/23/131600427/syarat-wisata-ke-banyumas-jika-tempat-wisata-sudah-dibuka-semua?page=all*, 2021. .

[3] F. C. Rosana, "Kemenparekraf Tiadakan Agenda Wisata yang Berpotensi Menimbulkan Kerumunan," *https://bisnis.tempo.co/read/1411851/kemenparekraf-tiadakan-agenda-wisata-yang-berpotensi-menimbulkan-kerumunan*, 2020. .

[4] P. T. Violleta, "Pelanggaran protokol kesehatan di tempat wisata meningkat selama libur," *https://www.antaranews.com/berita/2161926/pelanggaran-protokol-kesehatan-di-tempat-wisata-meningkat-selama-libur*, 2021. .

[5] A. J. Sathyamoorthy, U. Patel, Y. A. Savle, M. Paul, and D. Manocha, "COVID-Robot : Monitoring Social Distancing Constraints in Crowded Scenarios," *IEEE Robot. Autom. Lett.*, pp. 1–11, 2020.

[6] L. Ramadass, S. Arunachalam, and S. Z., "Applying deep learning algorithm to maintain social distance in public place through drone technology," *Int. J. Pervasive Comput. Commun.*, vol. ahead-of-print, Jun. 2020, doi: 10.1108/IJPCC-05-2020-0046.

[7] V. Mai *et al.*, "Local Positioning System Using UWB Range Measurements for an Unmanned Blimp," *IEEE Robot. Autom. Lett.*, vol. 3, no. 4, pp. 2971–2978, 2018, doi: 10.1109/LRA.2018.2849553.

[8] H. Chen, X. M. Wang, and Y. Li, "A survey of autonomous control for UAV," *2009 Int. Conf. Artif. Intell. Comput. Intell. AICI 2009*, vol. 2, pp. 267–271, 2009, doi: 10.1109/AICI.2009.147.

[9] A. G. Florea and C. Buiu, "Sensor fusion for autonomous drone waypoint navigation using ros and numerical p systems: A critical analysis of its advantages and limitations," *Proc. - 2019 22nd Int. Conf. Control Syst. Comput. Sci. CSCS 2019*, pp. 112–117, 2019, doi: 10.1109/CSCS.2019.00027.

[10] M. Aljehani and M. Inoue, "Multi-UAV tracking and scanning systems in M2M communication for disaster response," *2016 IEEE 5th Glob. Conf. Consum. Electron. GCCE 2016*, pp. 2–3, 2016, doi: 10.1109/GCCE.2016.7800524.

[11] A. R. Al Tahtawi, E. Andika, M. Yusuf, and W. N. Harjanto, "Design of Quadrotor UAV and Internet-of-Things Based Air Pollution Monitoring Systems," *IJITEE (International J. Inf. Technol. Electr. Eng.*, vol. 3, no. 4, p. 120, 2020, doi: 10.22146/ijitee.51203.

[12] K. K. Patel and S. M. Patel, "Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges," *Int. J. Eng. Sci. Comput.*, vol. 6, no. 5, pp. 1–10, 2016, doi: 10.4010/2016.1482.

[13] F. Arifin, R. A. Daniel, and D. Widiyanto, "Autonomous Detection and Tracking of an Object Autonomously Using Ar.Drone Quadcopter," *J. Ilmu Komput. dan Inf.*, vol.

7, no. 1, pp. 11–17, 2014, doi: 10.21609/jiki.v7i1.251.

[14] N. Xuan-Mung and S. K. Hong, "Improved altitude control algorithm for quadcopter unmanned aerial vehicles," *Appl. Sci.*, vol. 9, no. 10, 2019, doi: 10.3390/app9102122.

[15] M. Tayyab, U. Farooq, Z. Ali, M. Imran, and F. Shahzad, "Design of a blimp based unmanned aerial vehicle for surveillance," *Int. J. Eng. Technol.*, vol. 5, no. 1, pp. 519–530, 2013.

[16] I. Ahmed, M. Ahmad, J. J. P. C. Rodrigues, G. Jeon, and S. Din, "A deep learning-based social distance monitoring framework for COVID-19," *Sustain. Cities Soc.*, vol. 65, no. September, p. 102571, 2021, doi: 10.1016/j.scs.2020.102571.

[17] M. Abadi *et al.*, "TensorFlow: A system for large-scale machine learning," *USENIX*, vol. 33, no. 1, pp. 582–598, 2016, doi: 10.1016/0076-6879(83)01039-3.

[18] A. G. Sandesara, D. D. Joshi, and S. D. Joshi, "Facial Mask Detection Using Stacked CNN Model," *Int. J. Sci. Res. Comput. Sci. Eng. Inf. Technol.*, vol. 3307, pp. 264–270, 2020, doi: 10.32628/cseit206553.

[19] F. L. Ahmad, A. Nugroho, and F. Suni, "Deteksi Pemakai Masker Menggunakan Metode Haar Cascade Sebagai Pencegahaan COVID 19," vol. 10, no. 1, pp. 13–18, 2021.

[20] S. Ward, J. Hensler, B. Alsalam, and L. F. Gonzalez, "Autonomous UAVs wildlife detection using thermal imaging, predictive navigation and computer vision," *IEEE Aerosp. Conf. Proc.*, vol. 2016-June, pp. 1–8, 2016, doi: 10.1109/AERO.2016.7500671.

[21] B. M. Susanto, E. S. J. Atmadji, and W. L. Brenkman, "Implementasi Mqtt Protocol Pada Smart Home Security Berbasis Web," *J. Inform. Polinema*, vol. 4, no. 3, p. 201, 2018, doi: 10.33795/jip.v4i3.207.