Journal of Advanced Control, Automation and Robotics, 5 (1): 181-188, December 31, 2020
e-ISSN 2432-5562, p-ISSN 2186-9154
Applied Science and Computer Science Publications

New Image Processing Application for Life Signs Detection

Zacharie Mbaitiga
Department of Media Information and Engineering, National Institute of Technology Okinawa College, Japan
zacharie@okinawa-ct.ac.jp

Tanaka Shosaku
Department of Literature
Ritsumeikan University, Japan
zacharie@okinawa-ct.ac.jp

Abstract: Natural disasters such as earthquakes, landslides and tornados, occur quickly and unexpectedly leaving no time to prepare for rescue, thus causing loss of lives. Unlike the types of disasters mentioned above, this research focuses on disasters such as typhoons and tsunamis, where there is little time to prepare for the worst cases when people are stuck in their home waiting for the Search and Rescue Team (SRT). In most cases, after a disaster occurs the SRT are often unable to quickly search and rescue those who need help. This is due to many reasons. One of the most important reasons is the lack of a practical and efficient rescue system available for the rescue task. To overcome this problem, this research proposes a practical, comprehensive and efficient new search scheme to quickly detect and rescue people and facilitate the SRT task. In this new scheme a person waiting for the SRT, will post outdoors a fife sign which can be made with any familiar household items. The sign should not coincide with any existing outside signs. Once the SRT arrives on the disaster site, each drone is launched at the search spot, based on the damage area and city map information integrated into the drones. The drones mission is to automatically and quickly identify and find signs of life. This new search and rescue scheme is developed on the basis of high image processing technology. This current article proposes a rescue sign for the task.

Keywords: Pattern recognition, rescue team, disaster, search, image processing, search and rescue

I. INTRODUCTION

Natural disasters are unpreventable events, in spite of the advances in technology and learning from past disasters. In order to find a way to reduce the loss of lives during a disaster, many private universities, national research institute laboratories, national universities and college laboratories are working to find a solution to this challenging issue. Although it is difficult or even impossible to prevent natural disasters, a solution to limit the damage is still possible and this is the only alternative for the time being. In recent years throughout the world we have been hit by many sever disasters. Each time a disaster occurs, state, government, local governments or non-profit organizations deploy various resources, such as manpower and financial aid, in addition to the best technology available.

This research is supported by Japan Society for the Promotion of Science (JSPS) Grant-in-Aid for Scientific Research 20K05038 ©

In spite of all the resource deployment, the damage caused by disasters is always higher and sometimes beyond our expectations. Why and what is happening on the disaster scene? If we try to answer this question from an engineering viewpoint, we can say that the real problem is the lack of a robust search and rescue system made available to the rescue team. Therefore, establishing a comprehensive disaster prevention and rescue system is an urgent task for many countries and regions. After the emergence of the Unmanned Aerial Vehicle (UAV) or drone, the academic community has put forth a lot of effort to implement a robust control system or imagery for fast victim detection in a disaster scene. Such as:

A drone for human breathing and heart rate detection [1]. In this article they used s hovering drone to record the skin color variation of the facial region at a distance of three meters. Their solution consisted of an improved video

Corresponding Author: *Zacharie Mbaitiga: Dept. of Media Information Engineering, National Institute of Technology, Okinawa College, Nagoshi Henoko 905, Okinawa 905-2192, Japan, Tel: +81-980-55-4174, Fax: +81-980-55-4012, E-mail:zacharie@okinawa-ct.ac.jp*

magnification technique, spatial averaging, signal decomposition and blind source separation to suppress noise artifacts. The proposed method was constrained to short distances and a single pose where the participant was standing in front of the drone. Detection and localization of the life sign from the air using image recognition and spatio-temporal filtering [2]. In this research too, a complete process for survivor detection from drone recorded videos, that consists of video stabilization motion magnification and temporal filtering has been proposed. A survey on Unmanned Surface Vehicle for Disaster Robotics: Main challenges and directions [3]. In this article the gap between many proposed search and rescue methods have been illustrated and based on this article we are far from finding a better solution. The article that analyses the main challenges of the search and rescue system and that we should pay a close attention to is from [4]. We found it reasonable and very helpful in the designing and implementation of the search and rescue system. Among the challenges the author pointed out, three are of interest, as follows:

A. **Quality of sensory data:**

In search and rescue operations, to properly assess the quality or trustworthiness of the information reported to the rescue team is of paramount importance. If a UAV is surveying an area, a victim should not be missed, i.e. the probability of false negative should remain low; at the same time, the probability of false positive, i.e. the probability that a victim is considered as detected when it is actually not there, should remain low to avoid sending a ground rescue team to a place of no interest. The challenge is then to establish accurate models of the quality of the sensory data obtained from the UAVs.

B. **Environmental hazards.**

During its flight, a UAV should be capable of avoiding environmental hazards (trees, building, etc.) as well as avoiding collisions with other UAVs. It is also necessary to account for the fact that depending on the position of the UAV, some areas on the ground might be occluded.

C. **Information Sharing.**

Two aspects of the information sharing process need to be considered: *data fusion* and *network connectivity*.

These issues discussed by the author are very important. Additional steps to analyze them (data fusion and network connectivity) from an engineering viewpoint will help in understanding past research, and what future research is needed. and we should take one more step to analyze them with high level and make connection of them from an academic or engineering perspective or viewpoint to better understand what have been done so far; what remain to be done and among them what can be done from now on. To this end our focus is on the quality of sensory use for search and rescue design, and the recognition accuracy and signs to be detected. It is what this article is about to answer.

Many open access search and rescue articles have not clearly specified which disaster a system is developed for. Unlike other work on search and rescue, this research focuses specifically on typhoons, floods or water immersion and tsunamis, During these disasters there is time to prepare for the worst case, while victims are in their home waiting for the rescue team. However, the system can also be used eventually in a disaster such as earthquakes or landslides. This new search and rescue scheme is developed on the basis of new image processing technology. This article proposes the prospective and possible life sign detection for the task.

II. SEARH AND RESCUE MAIN FACTORS

The word “search” means to find something by looking or otherwise seeking carefully and thoroughly. On the other hand “rescue” is to save someone from a dangerous or difficult situation. The main objective of the two verbs can be met by effective Search and Rescue Planning (SARP) and the plans should be prepared to:

- Optimally use available SAR[5] resources
- Identify and achieve SAR objectives
- Facilitate supported and supporting relationships, and
- Enable integrated planning and interoperability among different search teams and the disaster scene.

Routine SAR planning [5] is generally focused on locating persons in distress as quickly as possible. This is accomplished through the employment of SAR resources based on the developed Search Action Plan (SAP) that meets SAR objectives. The effectiveness of the SAP is normally subject to the experience of the SAP planners, the efficient use of the planning tools and the correct employment of SAR resources. But in reality, that is not an easy task due to many factors that arise during the SAR operation such as:

A. Quick Localization of the Victims

Systematic Search and Rescue is difficult immediately after a disaster occurs, as in most cases the SAR team is not familiar with the disaster area and may need the help of local people or volunteers familiar well with the area. Depending on the SAR team planning strategies, the victims are not always able to reach the rescue team due to overloaded emergency call channels. Thus, reducing the chances for rescue.

Additionally, physical problems or obstacles may prevent the victim, from reaching out to the SAR team even if they have all the rescue information at their access.

B. Ongoing information sharing of the victim

One of the most critical issues the SAR team encounters is the need for a victims response to a SAR team call or for the victim to call out to a SAR team, in order to show their existence. In such situations and drone is of great help.

C. Promptness of the Rescue

Factors such as weather conditions or a fear of widespread damage may prevent the rescue team from immediately starting a rescue operation.

D. Adequacy of the Resources

In the case of simultaneous or widespread disasters, there is a limit to human resources and equipment deployment on the scene. The rescue task is not something which anyone can easily do. An experienced team familiar with rescue work is necessary, and this experience is not always available during a disaster.

These four points listed above are common problems encountered by the Search and Rescue Team (SART) each time a disaster occurs, no matter the size or location of the disaster. From an engineering view point, there is a need to develop a new scheme very different from those in current use. Using all the information technology resources at our disposal in order overcome the above problem, this new scheme should have a high life signs detection capability and accuracy.

III. MATERIALS

A. Camera specification and Connection

Camera choice is important for an image processing application, and in particular an application with the aim to aid SRT to quickly detect people trapped in brick debris or a collapsed house. Camera features such as image acquisition clarity, pixels format, binning mod, to mention only a few are critical. If the choice of the camera is not made based on the aim of the application when it involves live, it going to really affect the outcome of the application and consequently may eventually affect the search operation on the scene. Camera choice will affect the search operation on the scene. To this end, our camera choice is the Toshiba Corporation BU238MCF series of USB 3.0 color camera type, which is an integrated one type camera that adapts a global shutter complementary metal oxide semiconductor sensor know as a (CMOS) sensor. The suffix C is attached to the color model. For its connection to the host PC, a USB 3.0 cable with a control packet (Micro B) on one side and a stream packet on the other side is required as shown in Fig.1

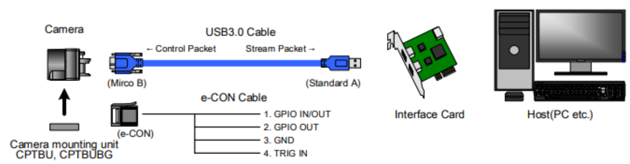

Fig.1 Host PC and camera connection.

For video output and camera control, the BU328MCF interface standard adopts a high transfer rate, which is easy to integrate into industrial equipment such as drones or UVAs. Its high frame rate BU238M 165fps is equipped with a global shutter that employs a global electronic shutter similar to CCD image sensor and a fast-moving clear image of object are obtained with even less blur. The camera data transfer is up to 5Gbps that enables to output uncompressed video data at high frame rate. One of the most important features of this camera is its scalable mode as shown in Fig.2

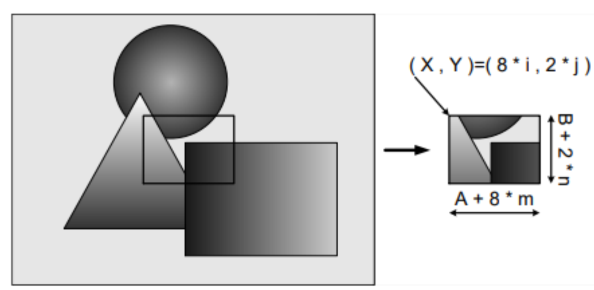

Fig.2 Camera scalable mode

This mode reads out an arbitrary image area. It achieves a higher frame rate by reducing the vertical output area. It also reduces occupied data of USB bus by reducing the horizontal output area. Color mode is built in color processing feature like white balance are available in Bayer output mode. Table I shows the camera specifications.

Table I Camera Specifications

Element Name	Data Value
IR-cut filter	BU328MCF
Imager	CMOS image sensor
Number of effective pixels	1936 \times×1216
Scanning area H	2048×1536
Scanning area (H) ×(V)	11.25 ×703(1/1.2 type)
Pixel size (H) ×(V)	5.86×5.86
Color filter	RGB primary color mosaic
Electronic shutter method	Global shutter
Aspect ratio	16:10
Sensitivity	
IR-cut filter	4100lx, F8, 1/200s
Minimum illuminance	F1.4, Gain+18db, Video level 50%
Gain	Manual
Setting range	-6 to+18db
Black level	-25 to 25%
Gamma	Y=1.0 to 0.45
White balance	MWB, OPWB
Effective range	
IR-cut filter	2,500 ~ 6,500K
MWB setting format	R/B gain independent setting
OPWB effective area	Full pixel
LUT	Input 10-bit, output 10bit
Image buffer	256M Byte
User setting Memory	15 channels
User Free Memory	64 Byte
Test Pattern	Black, White, Grey A, Grey B
Power supply	DC+5V+-5%(from USB connector)
Power consumption	2.9 W minimum

2. Image format Control.

Image processing is a method to perform manipulation on an image. Particularly to get an enhanced image or to extract some useful information from it based on the aim of the application being developed. The step of an image digitization project is the capturing of documents or images. Those familiar with image manipulation, know that the most important aspect in image processing is the format control. The format control of the chosen camera after the image has been captured will certify how best the product is and eventually will have impact on the application in terms of image clarity. A camera's format control will impact image clarity and product quality. A color camera aims to make color reproduction closer to the human sense of sight, so spectral response and color filters of an image sensor have similar characteristics. The BU328MCF we are using has three different banks of Image format control. Format0 (*), Format1 and Format2 with a Window size of { A+ 8 × m(H) }×{ B + 2 × n(V) }. Here B denotes the minimum unit size, m, n represent an integer. This window size is equal or less than the maximum image size (1920 by 1200). Width/OffsetX unit size is 8. Width/OffsetY unit size is 2 and its minimum unit size is 64 × 64 respectively.

IV. METHODOLOGY

As we have mentioned in the previous sections, the aim of this research is to develop a new life signs detection scheme to precisely and quickly detect any person trapped in their home during a disaster such as a typhoon, flood waters and eventually an earthquake where the victim has time to prepare for the coming of the SRT. In search and rescue operations, to properly assess the quality or trustworthiness of the information reported to the ground rescue team is of paramount importance. If a drone is surveying an area, a victim should not be missed, that is to say, the probability of false negative should remain low; at the same time, the probability of false positive, that is to say, the probability that a victim is considered as detected when it is actually not there, should remain low to avoid sending a ground rescue team to a place of no interest. In addition, the information of the map used during the system development should update automatically to avoid a miss-area scan by the drones during the search task. That is to say the probability of misinterpretation of the integrated map information should be remain low or zero to avoid scanning unnecessary areas.

A. Color Space Data base

Before tackling the core of this project, which is the detection of different life signs, which consist of many colors, a need to focus on a color data base is important. This will facilitate the detection task, as all materials used to make these signs will have their colors in the range of the color Database. Color is one of the most important aspects in computer vision, since it allows to discriminate and recognize information from objects. From a physics view, color is caused by the reflection of a portion of light in an object. Basically, it is an electromagnetic wave in a range of frequencies. The longest wavelength produces the color red and the shortest, blue-violet (Fig. 3).

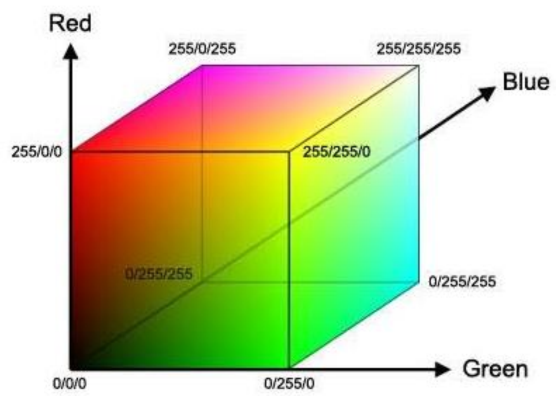

Fig.3 RGB color space representation (from wikipedia)

1. Normalized RGB:

This model is a variation from the RGB, which is created under the premise of protecting the color model from the illumination changes. The main idea behind this variation is that the colors are formed using a certain proportion of three primary colors from the model, but not a defined amount of each one. So, the sum of all the colors proportions must equal to 100%. The process of normalization is straightforward and can be easily computed for each of the equations used to transform RGB to normalized RGB which obtains the proportion of each color. The advantage of this model is that any color can be described just using two colors instead of three. This is possible due to the fact that the third color will always be the difference between one and the addition of the other two colors (Eq 1):

$$r = \frac{R}{R+G+B} \qquad g = \frac{G}{R+G+B} \qquad b = \frac{B}{R+G+B} \tag{1}$$

The new rgb color obtained from Eq.1 will allow us to reduce the negative effect of the illumination changes like shadows or shines. Although it has some drawbacks, such as reducing object detection capability. This model is still used in machine learning with some degree of success [7]. The second color space we will focus on is the perceptual color space HSL. The use of this model will depend on the outcome of the Normalized RGB results.

2. Perceptual Color Space

The perceptual color space is a color that is created from those models that treat the color in a more human intuitive form. In order to achieve this objective, any color is represented by a specific tone or hue. That is to say a level of saturation for the hue, and the amount of light available or illumination. This model consists of Hue Saturation Value (HSV), Hue Saturation Lightness (HSL), and Hue Saturation Intensity (HSI) respectively. All of these color models have a similar description about the color hue but they differ only in the saturation and illumination definition (6). If the outcome of the Normalized RGB is not as we expected, then we will compute the HSL from the RGB standard model by using a following set of equations (Eqs. 2–4).

$$H = \begin{cases} 60 * \left(\frac{G-B}{max(R,G,B) - min(R,G,B)} \right) \\ 60 * \left(\frac{2+(B-R)}{max(R,G,B) - min(R,G,B)} \right) \\ 60 * \left(\frac{4+(R-G)}{max(R,G,B) - min(R,G,B)} \right) \end{cases} \tag{2}$$

$$S = \frac{max(R,G,B) - min(R,G,B)}{1 - |max(R,G,B) + min(R,G,B) - 1|} \tag{3}$$

$$L = \frac{max(R,G,B) + min(R,G,B)}{2} \tag{4}$$

Where

$$\begin{cases} R = max(R,G,B) \\ G = max(R,G,B) \\ B = max(R,G,B) \end{cases}$$

The major advantage of using this model (Fig.3) is the fact that it presents immunity to illumination changes, since the illumination is enclosed in the lightness component of the model.

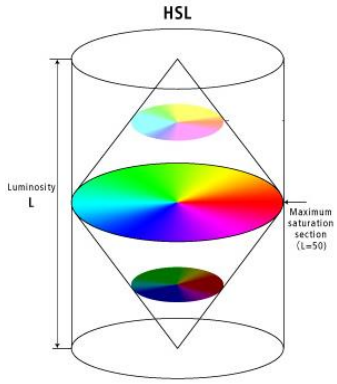

Fig.4 HSL color space (from wikipedia)

In addition to the advantages of this model mentioned above, is its color hue changes which are continuous and linear. The hue component is usually expressed in angle terms, from 0 to 359°, since every tone has a previous and next tone that follows a cyclic pattern and can be visualized in a circular diagram. The last feature of the HSL model is the geometric representation which can be expressed as a cylinder (Fig. 4), which allows to manipulate easily each color hue by changing its illumination and saturation [8]:

B. Life Signs Detection

After the color space Database is developed, we will focus on different life signs detection, in order to cover at least 200 to 500 signs at first, then gradually increase the number of these signs to reach 3500. In the case of disaster assistance, the search and rescue tasks are difficult challenges for Search and Rescue Team (SRT) or lifesavers (LSV) when contact with the survivors is difficult for the following reasons:

1. Potentially unsafe places where survivors are (Fig.5).

Fig.5 unsafe disaster site (from google pictures)

2. Inaccessible site due to collapsed structures and debris (Fig.6).

Fig.6 inaccessible disaster site (from google pictures)

3. Physical fatigue due to stress and (4) weather conditions (Fig.7).

Fig.7 Bad weather preventing search during a disaster (from google pictures)

Recent advances in unnamed aerial vehicles (UAV) or "drone" technology is suitable to help life savers in their effort to search for living person in the aftermath of a disaster (9). Many approaches for life signs detection have been proposed. Most are based on human body part detection, such as skin detection, hand, head detection, and so on. But thus far life signs detection has not been proposed. For these applications, when the UAV or drone flying over the target scene cannot detect the human body or a body part, based on the pre integrated human body, the ground rescue team receives a "no human body found" message from the drone. Although this may be false, and lead to cognitive miss search and eventually can affect the outcome of the SRT. To this end, our new scheme approach will reduce at maximum the probability of a false detection to a low level or to "zero." That means the drone should be equipped with a capability to detect life signs that can be only made by human beings. These signs can seem strange but certify that there is a person in danger and in need of help. These signs should be made from at least two items. Any item the person waiting for the rescue team can find around him/her. Two methods will be used for the life signs collection. First a survey is being conducted now at the National Institute of Technology, Okinawa College asking students to propose the prospective life signs they can make with anything they have in their home if they are waiting for the Search and Rescue Team (SRT), when a drone is going to fly over them to detect the sign in order to rescue them in case of disaster. Next, a computational linguistics study of a computer system for understanding and generating natural language will be used. This study is widely used in machine translation, information retrieval and man-machine interfaces which are a branch of computer science. Among these three classes we will use the information retrieval class to automatically form the life signs detection, because most of the information the image processing techniques use are in natural language form. The image will have a query to extract the relevant information text from a corpus and combine them to form the right sign which will pay the way to the camera to detect all signs on the camera lens. Table 1 shows some life signs examples and Fig.8-9 some pictures for the image processing recognition.

Table 1 shows some life signs examples

1	Newspaper tied with a hanger
2	A wall Clock in the laundry basket
3	Inflated plastic bag
4	Rolled and lengthened newspaper
5	Fishing rod rolled with a shirt
6	Towel wrapped around a bag
7	Making string with tied clothes
8	Pillow pierced with pen
9	Banana pierced with pen

Fig.8 Wine bottle wrapped with a kitchen towel

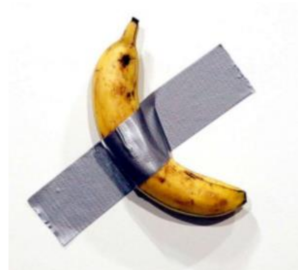

Fig.9 Banana and tape

Fi.10 Banana pierced by a pen

These pictures that represent life signs seems bizarre but these certify that a person is alive and asking for help.

V. DISCUSSION

A reproduction of a disaster scene will be made for the test evaluation. At least two to three drones integrated with city map information, collected from the city authority, will be used. A small group of ground Search and Rescue Teams will be formed for the new life signs detection scheme evaluation. Drones and high spec computers for monitoring the drone data and for real time communication between drones surveilling the disaster scene will be used. The evaluation test will specifically focus on the interaction between drones. For example, how drones communicate to avoid collision, and is each drone surveilling the area set by the ground rescue team correctly, and is the city map information from the city authority up to date? Additionally, if there is an error between the map information on the scene, and the drone's information, how will this information be updated automatically to avoid a miss detection? One of the strongest parts of this life signs detection scheme is that when the search result sent to the ground rescue team by the drone is "*no life signs found*" the system of the ground rescue team sends an automatic query to the drone to carefully search the site again for miss detection and this query should force the drone to return to the site scene. The objective of this system is to prevent a false detection or miss detection and send the ground rescue team to a place of no interest.

VI. CONCLUSION

This article proposes a new scheme for life signs detection using image processing through drones before and after the disaster. The life signs detection application will use normalized RGB color and will convert to Hue, Saturation Lightness (HSL). This will allow us to reduce the negative effect of the illumination changes like shadows.

REFERENCES

[1] Al-Naji, A.; Perera, A.G.; Chahl, J. Remote monitoring of cardiorespiratory signals from a hovering unmanned aerial vehicle. *Biomed. Eng. Online* **2017**, *16*, 101.

[2] Al-Naji, A.; Perera, A.G.; Chahl, J. Remote measurement of cardiopulmonary signal using an unmanned aerial vehicle. *IOP Conf. Ser. Mater. Sci. Eng.* **2018**, *405*, 012001.

[3] Vitor A. M. Jorge et al."A Survey on Unmanned Surface Vehicles for Disaster Robotics: Main Challenges and Directions" p.1, MDPI Journal published online 2019

[4] Sonia Waharte and Niki Trigoni." Supporting Search and Rescue Operations with UAVs"Waharte and Niki Trigoni University of OxfordComputing Laboratory Oxford, United Kingdom.p.2

[5] Seoung Wug Oh, Seon Joo Kim."Approaching the computational color constancy as a classification problem through deep learning" Pattern Recognition.Elsevier p:402. 2017

[6] Edgar Chavolla, Daniel Zaldivar, Erik Cuevas and Marco A. Perez "Color Spaces Advantages and Disadvantages in Image Color Clustering Segmentation" *Advances in Soft Computing and Machine Learning in Image Processing*, Studies in Computational Intelligence 730, https://doi.org/10.1007/978-3-319-63754-9_1 Springer International Publishing AG 2018

[7] Finlayson, G., Xu, R.: Illuminant and gamma comprehensive normalization in logRGB space. Pattern Recogn. Lett. **24**(11), 1679–1690 (2003)

[8] Hanbury, A., Serra, J.: A 3D-polar coordinate colour representation suitable for image analysis. Pattern Recognition and Image Processing Group Technical Report 77. Vienna, Austria, Vienna University of Technology (2003)

[9] Ali Al-Naji, Asanka G. Perera , Saleem Latteef Mohammed and Javaan Chahl Life "Signs Detector Using a Drone in Disaster Zones" Multidisciplinary Digital Publishing Institute, remote Sensing journal, p:1, 2019

[10] Ralph Grishman "studies in natural language processing "computational linguistics. Institution of Mathematics Sciences, New Yeaok University, P.vi,1999

[11] https://blog.i2s.fr/en/the-importance-of-image-processing

[12] https://www.precisionhawk.com/blog/how-drones-aid-in-disaster-response

[13] https://www.arcgis.com/apps/Cascade/index.html?appid=a38c281e41e74d53a560296b8755f5fa