استخدام الطائرات المسيرة لإدارة امن وسلامة الحشود

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الخلاصة:

لا يتعلق المسح الجوي على استخدام الطائرة فقط، بل باستخدام كل تقنيات الاستشعار عن بعد ومنها استخدام الطائرات المسيرة، ان هذه التكنولوجيا المتطورة يحتاجها المحترفون في مجال الجغرافيا المكانية لأداء مهامهم بدقة وكفاءة وأمان. ان أحد اكبر واهم التحديات التي تواجهها قوات الدفاع المدني والقوات الامنية هو الزيادة غير المتوقعة في عدد الناس في التجمعات والحشود البشرية الكبيرة. ويتطلب هذا الأمر فريق عمل مدربًا لإدارة هذه الحشود البشرية لتحديد التوزيع المكاني لها او تحديد أي تصعيد او خسائر محتملة حتى قبل حدوثها. في الآونة الاخيرة ظهرت تكنولوجيا الطائرات المسيرة او ما يطلق عليه بالدرون والتي تمكننا من رسم الخرائط للتجمعات البشرية ومراقبة وتحليل المعالم الارضية او بما قد يحدث على الأرض بشكل مفصل ودقيق، ومن خلال استخدام رؤية الكمبيوتر والذكاء الاصطناعي. كما يمكن ايضا رسم الطرق التي تسلكها الحشود البشرية اثناء المناسبات والتجمعات الكبيرة مثل المناسبات الدينية او الرياضية. حيث يمكن ايضا التعرف على الوجوه، والتصوير الحراري أثناء الليل، وتقدير كثافة الحشود، وأنماط الحركة التي تحصل، وتوجيه القوات الامنية وقوات الدفاع المدني على ضوء الخرائد المرسومة بدقة مكانية عالية باستخدام الدرون، كل ذلك ليس سوى بعض الأشياء القليلة التي يمكن للطائرة بدون طيار أن تستطيع القيام بها لتعزيز إنفاذ القانون وادارة الحشود جغرافيا ومكانيا وانقاذ الناس بشكل امن. في هذا البحث سيتم استعراض انواع وخصائص الطائرات المسيرة المستخدمة في رسم الخرائط الجغرافية وفي ادارة الحشود والتطرق الى الامكانيات التي تستطيع هذه الطائرات من القيام بها. اضافة الى استعراض بعض الوقائع والاحداث التي استخدمت فيها هذه الطائرات كأمثلة في مختلف المناسبات مثل المناسبات الدينية او الرياضية او المظاهرات المدنية. كما سيتم مناقشة التحديات والمعالجات التي تواجه استخدام هذه التكنولوجيا في مثل هذه الاحداث. ان مثل هذه الخرائط والمعلومات ستسهل وتساعد متخذي القرار لاتخاذ الاجراءات السريعة والمناسبة لتفادي وقوع أي مشاكل كبيرة للتجمعات والحشود البشرية.

الكلمات المفتاحية: الجغرافيا البشرية، درون، رسم الخرائط، مراقبة الحشود، تحديد الحشود، المستوطنات البشرية.

1. Introduction:

Human geography is one of the branches of geography that studies the models and processes that formulate humans with the environment in general, with a focus on the reasons and results of spatial distribution of human gatherings. Monitoring and analyzing human crowds has become very important today for public safety and security because group members may demonstrate strange behavior. Increased crowd size and

unusual conduct may eventually cause stampedes, with the potential of mass death and injury. The potential danger multiplies when combined with strict temporal and spatial restrictions, such as those practiced in religious gatherings or opposition demonstrations [1 and 2]. Moreover, the potential hazards to the public's safety are more significant in such large crowds, with the probability of terrorist occurrences and violent mob behavior as a result of alcohol or drug use [3]. Religious gatherings may draw hundreds of thousands of people to certain locations in order to promote communal ideals. The Hajj, for instance, is one of the biggest organized large-scale gatherings, with nearly 2 million Muslims congregating every year in Mecca, along with other volume religious gatherings, like shrine events in Iraq and Kumbh Mela gatherings in India, which may lead to unwanted crowd behavior, panic, and fatal accidents.

Conventional crowd assessment approaches depended on visual input from still cameras that captured photographs or films, which led to the fixed-angle vision and restricted coverage. It is thus unable to conduct continuous tracking of moving crowds.

In recent year, a new technology has emerged to track human gatherings and their activities so that they can be mapped, analysis and managed, complementing stationary monitoring devices [4], this technology called Unmanned Aerial Vehicles (UAVs) or Drones. A drone is a small aircraft capable of operating without a human pilot, used to monitor crowds at large gatherings and help ensure safety and security. Drones can be used to monitor large crowds from a distance and detect potential threats, allowing for more effective crowd management. These robotic birds soar in the sky, silently watching the crowd below. Drones provide a unique vantage point for monitoring the safety and security of human crowds. Briefly and concisely, UAVs offers the following benefits: 1/ the capability to provide other devices and sensors to obtain additional metrics besides visual data [5], 2/ the ability to provide real-time data and information for modeling human crowd dynamics, 3/ With the ability to use on-board processing units to estimate crowd dynamics, 4/ reduce total effective charges [6-7], 5/ as well as reduce human resources. Crowd monitoring and its analyzes can be divided from the previous literature into several areas, which are crowd detection [7-13], knowing crowd numbers [7,14-16], estimating crowd density [11], and mapping crowd tracking [16], and the analysis of crowd behavior [17,18]. Fig.1 explains some occasions on which drones can be used to monitor and manage human crowds.

In this research, the types and characteristics of drones used in drawing geographical maps and crowd management will be reviewed, and the

capabilities that these drones can perform. In addition to reviewing some of the facts and events in which these aircraft were used as examples in various occasions such as religious or sporting events or civil demonstrations. The challenges and solutions facing the use of this technology in such events will also be discussed. This research relied heavily on the relevant information found in the research [19]. Such maps and information will facilitate and help decision makers to take quick and appropriate measures to avoid any major problems for human gatherings and crowds.

 With almost two million Muslims congregating in Mecca each year, the Hajj is one of the greatest scheduled mass gatherings.	 Other mass religious gatherings, shrine events in Iraq.
 Holding conferences at the University of Mosul.	 Holding a festive day for the University of Mosul (the number of university students has reached more than 75,000 students).

Fig. 1: Explains some occasions on which UAVs can be used to monitor and manage human crowds.

2. Characteristics and Specifications of UAVs

2.1 UAVs Types for Crowd Control

Drones are classified in a variety of ways, starting with utility to size, dimensions, operational qualities, and different kinds of engines. This section addresses the construction of drones utilized for gathering surveillance and analytics, as well as their internal detectors, communications, and battery management systems.

Crowd control drones come in a range of configurations. The usage of multi-rotor UAVs with vertical landing and takeoff systems is mentioned extensively in the literature. The use of multi-rotor UAVs has several benefits. For starters, it is superior to other methods since it doesn't need extra pads for launch [20,21]. This enables for simple configuration and quick installation for crowd management, as well as a lower installation footprint. Second, because multi-rotor UAVs are capable of remaining in one place, they are the favored choice for surveillance because they can be stationed over human crowds to photograph and record their movement. In addition to uses of continuous human crowd monitoring [11].

The second alternative is fixed-wing UAVs, which have a longer flying period and are more productive. DJI manufactures among the most popular UAVs used for crowd control. It is delivered as a complete package that comprises the UAV architecture, lighting control module, mission preparation framework, and information transfer connection, enabling ready to use installation and on-board picture processing .

Although UAV or Uav is an extremely generally used and recognized word in the media, other acronyms are now used while refer to these lower-level aerial vehicles (Fig. 2):

٨ . Rotary Wing

Quadcopter

Multicopter

- **Hexicopter**
- **Octorotor**
- **Hexarotor**

B. Fixed Wing

Fig. 2: low-level aerial platforms shapes and names, A: Rotary Wing, B: Fixd Wing.

2.2 Numerous Drone Applications

Drones In recent years, technology has grown and profited. Individuals, businesses, and governments are aware that drones may be used for a variety of purposes, in addition to the manage crowd safety and security which include: (Fig.3)

- **Military uses**
- **Gas detecting and mapping**
- **Building safety inspections**
- **Digital archeology**
- **Saving Heritage**
- **Information gathering or provision of basics for disaster management**
- **Infrared sensor UAVs for search and rescue missions**
- **Agricultural analysis: precision crop monitoring**
- **Unmanned freight transport**
- **Investigations and immigration surveillance**
- **drone photography for media and cinema**
- **Quick delivery and shipping**
- **Evaluation of the environment**

Fig. 3: Numerous Drone Applications in addition to the manage crowd safety and security

2.3 The Latest UAV Mapping Applications

People are currently flying UAVs on a regular basis. They use the software on gadgets to operate the flying contraption hovering above their heads. As a result, here is a list containing some of the finest UAV applications for Android and Laptop devices available at the present time. The top three most popular UAV mapping platforms out there are Pix4D, UAV Deploy, and Data Mapper. DroneDeploy DJI's official app. DJI is undeniably a power to be dealt with in the UAV industry,

thus it is only right that they possess an app that lives up to its expectations. The program includes regular flight planning as well as automatic control of the UAV being flown. As the user needs to do is enter the coordinates, and the UAV will fly over the chosen routes. [22]. Pix4D: A a one-of-a-kind photogrammetry software suite for UAV mapping, Measure from photos provides numerous software options to help you get the most out of your UAV mapping. Applications for specialized purposes, such as photorealistic 3D modeling and agricultural mapping, are available, as are crucial capabilities such as CAD overlay, online sharing, NDVI organizing, and DTM and DSM viewing. It even has technologically advanced mapping tools like thermography, making it a popular choice for anything from mining to forensics. Figures 4 and 5. This enables you to do things like create a 3D video fly over of the mapped region or compare construction sites with design drawings to detect building faults [23].

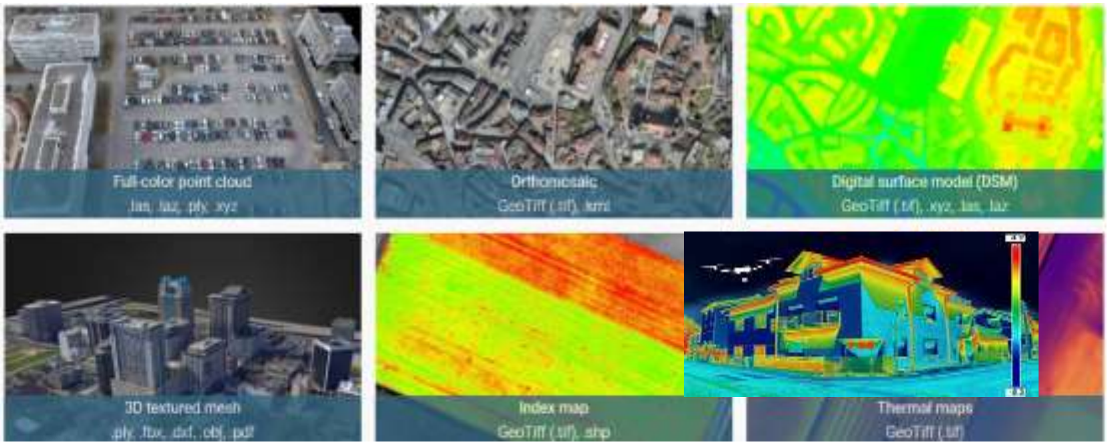

Fig. 4: The Pix4D software, collect RGB, thermal, or multispectral pictures.

Fig. 5: Using the Pix4D Application, triangulated photos and built a 3D point cloud.

DataMapper will turn your UAV into a powerful mapping machine. The DataMapper in-flight smartphone app transforms a UAV into a sophisticated remote sensing tool, allowing businesses and consumers to collect usable aerial data automatically. This app guide the UAV to capture aerial images for 2D/3D maps and advanced analysis (Fig. 6) [24].

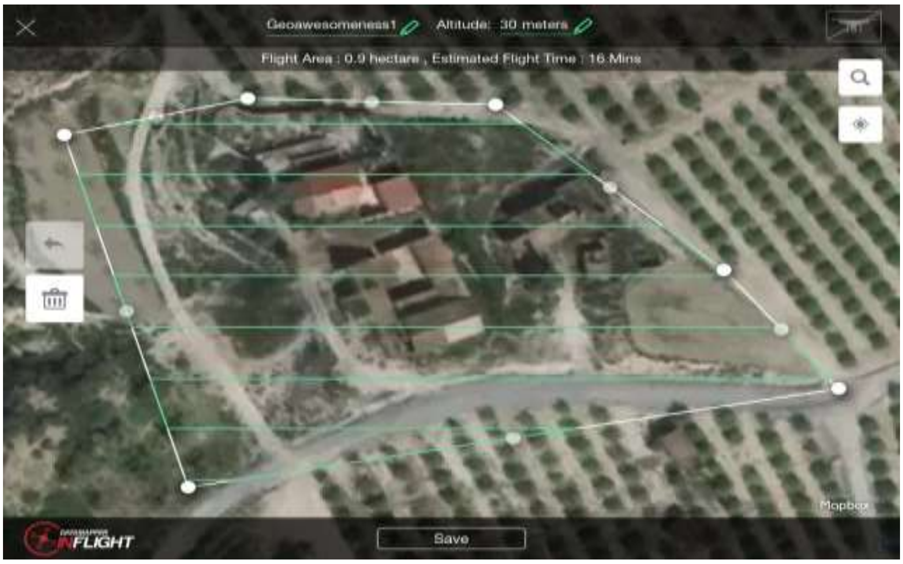

Fig. 6: The autopilot follows the routes marked on the map after mapping the region.

Light Detection and Ranging (LiDAR) was born, which is a technique for remote sensing that employs pulsed laser illumination to detect distances to the Ground. LiDAR is a land mapping technique that determines the distance to a target by lighting it with pulses laser illumination and detecting the reflected pulses with a sensor. The UAV LiDAR business is quickly expanding, particularly in recent years. Manufacturers of the best aircraft LiDAR sensors have created LiDAR sensors for tiny UAVs in a very short amount of time [25]. LiDAR UAVs will have a significant influence on all aspects of life, Fig. 7.

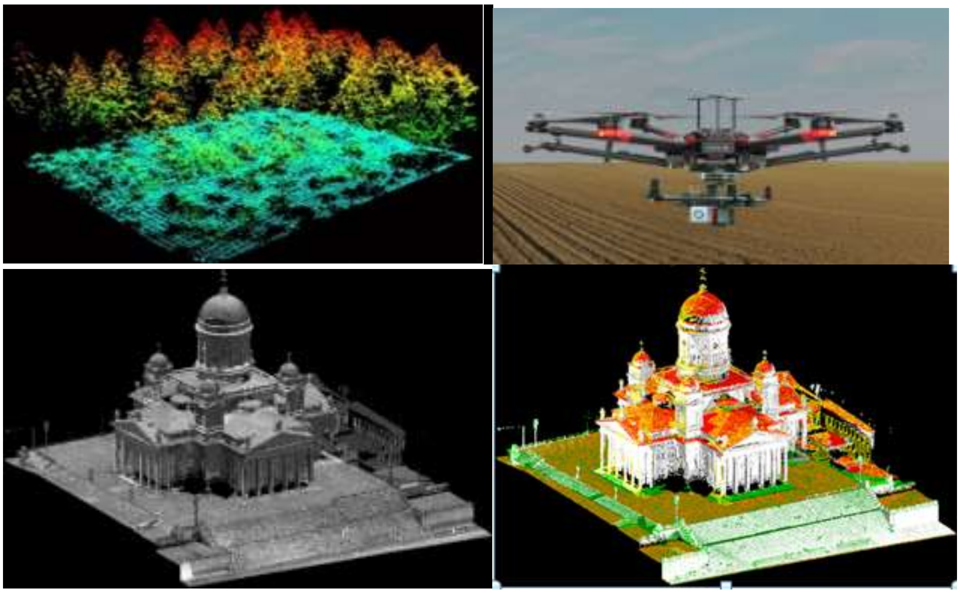

Fig. 7: LiDAR and photogrammetry survey results. An example of a point cloud before and after the addition of color characteristics.

2.4 Cameras and Devices Installed on UAVs

The availability of cameras is a prerequisite for human UAV operations, and the RGB or visible light type camera is the most extensively utilized. Alongside RGB, an infrared camera is an additional sensor that is usually used alone [13,17] or used in combination with RGB [10,14] to avoid visual camera drawbacks such as drawbacks in night photography. However, thermographic photos frequently suffer from low resolution [11].

Despite the fact that commercial UAVs frequently include other sensors such as GPS, Bhatari et al. [26] discussed the use of an internal GPS in conjunction with an RGB sensor to detect the geographic position of people in crowds. This, consequently, allowed managers to observe the human position identified on a Geographic Information System portal like Google Earth.

Many new options and functions that companies have offered to UAVs are presented in Fig. 8.

A. Return to Home **Function used to send UAVs back to the takeoff position**	**B. Waypoint Navigation** **UAVs flies to GPS points that you navigate on the UAV's map.**	**C. Geofence** **GPS tells UAVs to never go outside the GPS range that you navigated.**

		
E. Using Oxygen and Hydrogen: to power UAVs while flying and it's better than (litheome) batteries 	**D. foldable UAVs (12/2018):UAVs can fold to get through a small hole.** 	**F. Electronic weapons: To hunt unauthorized UAVs (UAVs Shield).** 

Fig. 8: Depicts the new feature that the corporation has introduced to UAVs.

2.5 Solve the Battery Problem

While UAVs can carry out missions beyond human comprehension, current technology that relies on onboard batteries limits their operation. The plane can only stay in the air for 20 to 30 minutes. Adoption of UAV time optimization methods has been documented in studies and literature. First, it is possible to use an alternate power source to provide additional power for a period of time without having to recharge frequently. Second, charging can take place contactlessly, either on the ground or atop a building or vehicle, and is fully automated eliminating the need for the operator to manually remove and install the battery. Another option mentioned is "battery hot swap," which involves swapping the battery on the UAV without having to switch it off in CS (for example, by employing a robotic arm) [27]. Some proposed solutions include contactless charging of CS UAVs while in flight utilizing laser beam technology [28]. In the context of crowd management. Fig. 9 highlights these approaches.

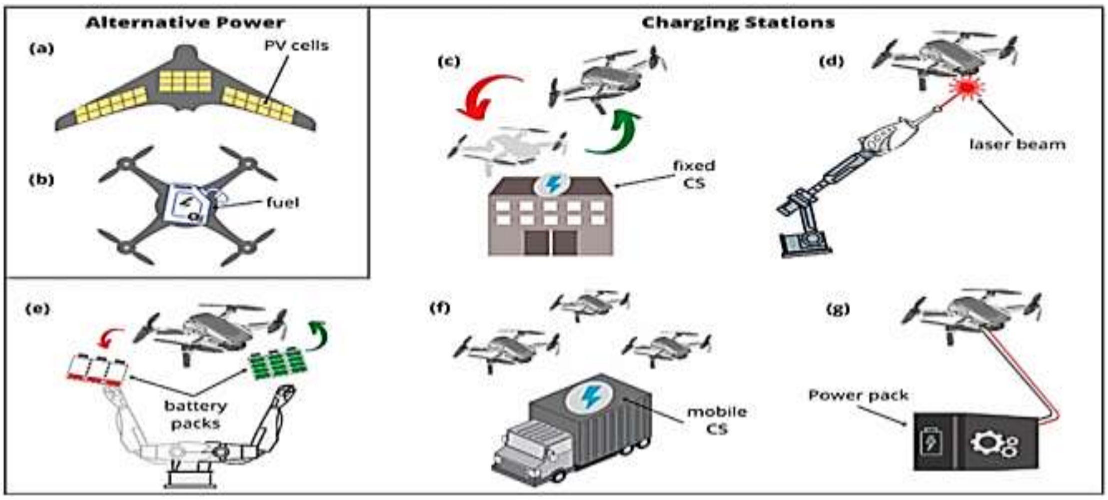

Fig. 9: Solve UAV power Problem. (a:) Solar-powered UAVs for fixed wing Drone. (b:) UAVs drove by a hybrid of electrical and fuel. (c:) UAV-swapping approach with a static charging location. (d:) On-the-fly laser charging. (e:) Battery hot swapping devoid of shutting down the UAV. (f:) Portable charging stations with preprogrammed charging schedules, (g:) Tethered UAVs.

3. Monitoring and Identification of Crowds

UAVs are increasingly being utilized in tandem with standard CCTV surveillance equipment and systems. Crowd control is an important instrument in public safety because the precise evaluation of human crowds through monitoring may prevent possible tragedies caused by aberrant crowd formation [10]. Motion UAVs surpass the constraints of standard CCTV deployment in terms of imaging angle, coverage, and cost [5,10], increasing their value in actual time observation operations. Authors of [10] suggested utilizing RGB with infrared picture from a single UAV for crowd monitoring. The scientists stated that because UAV photos are more likely to be shot vertically, it is harder to detect faces and extract body characteristics. Moreover, whereas RGB photographs give superb detail owing to their higher resolution, lower-resolution thermal images might provide supplementary input.

In contrast, in [11,13], thermal pictures alone were employed to detect the human population. The authors presented a finding approach built on supervised machine learning (SML) classification and area of interest (ROI) extraction. While producing excellent results, the procedures have only been tested on a small number of photos.

The Multiview CNN method, which utilizes RGB inputs and manually created collective heatmaps, was introduced by the authors in [24]. The researchers recommended that the method be implemented on a commercial UAV processor board, like the NVIDIA Jetson-TX2 board, verifying its applicability for actual-time airborne crowd recognition

applications. The authors of [26] demonstrated methods for actual time crowd location on a UAV using a GPS sensor. This enables the data to be plotted as maps in mapping systems like Google Earth.

3.1 Predicting the Number of People in a Crowd

Crowd mass assessment is an important aspect of crowd organization because crowd mass can suggest possible problems evolving from participant performance. Counting the number of individuals is the simplest approach to assess crowd size (human crowds). Many studies have detailed approaches for counting crowds, each addressing a distinct set of possible problems to reliable crowd counting using aerial photography. One such problem is the variation in photo size since local restrictions in certain countries prohibit UAVs from flying straight over people, therefore aerial images are slanted when shot at an angle; hence, the number is subject to volume fluctuations owing to modifications in the UAV's height.

The writers of [8] introduced an adaptive actual-time crowd identification and calculating in UAV images (SARCCODI) approach for thick population computation that takes picture scaling variables into account. For comparable aerial imaging datasets, this strategy outperforms convolutional neural network (CNN)-based algorithms.

The authors of [14] created a dataset that is available to everyone called DroneRGBT, which includes 3600 RGB and thermal photo pairs, and created a technique that can work independently on RGB or thermal photos, or with a combination of both data sets. It is important to note that few research employing UAV pictures in crowd-counting estimation apps have offered insights into the recommended method's ability to operate in real time.

Crowd density estimate, in addition to crowd enumeration, is a successful approach for determining crowd size. Prior methodologies for assessing cluster density relied on discovery-based, regression-based, or density estimation-based approaches [29]. The writers of [9] explain the use of segmentation based on color maps to estimate crowd density. This strategy is effective in airborne images when the color of the gathering stands out from the contextual, like pilgrimage photos. In subsequent work, authors used a modified angle-detection method known as Features from the Fast Tomography Test (FAST) to estimate crowd density in aerial pictures [30].

A new methodology has focused on CNN-based approaches for imaging UAVs, and the writers describe in [24] how they employed a neural network to reliably estimate human crowd density from UAV photographs by providing a standpoint plan into the algorithm

(CSRNet). This was accomplished by shifting from an estimate of crowd density at the image level to an estimate at the head level, which is a plane parallel to the ground that translates vertically into a person's average height. Fig. 10 depicts an example of crowd detection using the CNN approach.

Fig. 10: Deep CNNs are used to estimate crowd size in this case [31].

3.2 Tracking and Spotting of Crowd

Crowd movement mapping for moving tracking can give information into possible crowd dynamics hazards, such as the onset of riots. A separate method was used in [20] to accomplish human crowd monitoring using UAV datasets. To process the periodic monitoring of many moving targets, the authors of [32] devised a transverse arrangement generation system. The suggested approach employs a distributed network of UAVs. The technique is built in such a way that the sequence of monitored targets may be calculated. By forecasting the location of the following object in the route scheduling, all targets are visited sequentially. The given algorithm changes between the UAVs as targets travel from one region to another. The suggested technique gives the crowd control system an excellent opportunity to detect unusual activity. It is worth noting that the Visdrone dataset [33] is the greatest dataset developed for multibody chasing, along with the smaller UAVDT-dataset [34], which has newly been used to monitor persons in crowds that do not meet with COVID-19 SOPs. [35], as indicated in Fig. 11.

Fig. 11: Crowd Monitoring for COVID-19 Violators [35].

3.3 Analysis of Crowd

Crowd analysis is a new trend that uses UAV images to find deviations or changes in crowd behaviors and structures. The authors reported using the complicated event detection technique described in [36] to determine the reactions of pedestrian groups during a variety of situations, including pedestrian walking, in lanes, bottlenecks, posture, and escape condition. The authors of [17] offer a method for identifying aberrant crowd behaviors based on two factors: crowd density and speed, employing UAV-based cameras and thermal images. A truth table with a mix of speed and severity elements will assess if the audience is normal or abnormal. For example, if the crowd's pace is unusual, an abnormal crowd should be predicted.

For example, if the crowd's speed rose while its density dropped, an atypical crowd would be predicted. Both crowding components were identified using an angle detection method and an optical flow-based technique, and crowd identification and density estimates were performed using a multitask CNN. The authors also showed real-time detection through processing onboard the UAV using single-board computer systems. As illustrated in Fig. 12, the status of the crowd's assessment is then shown on the UAV controller.

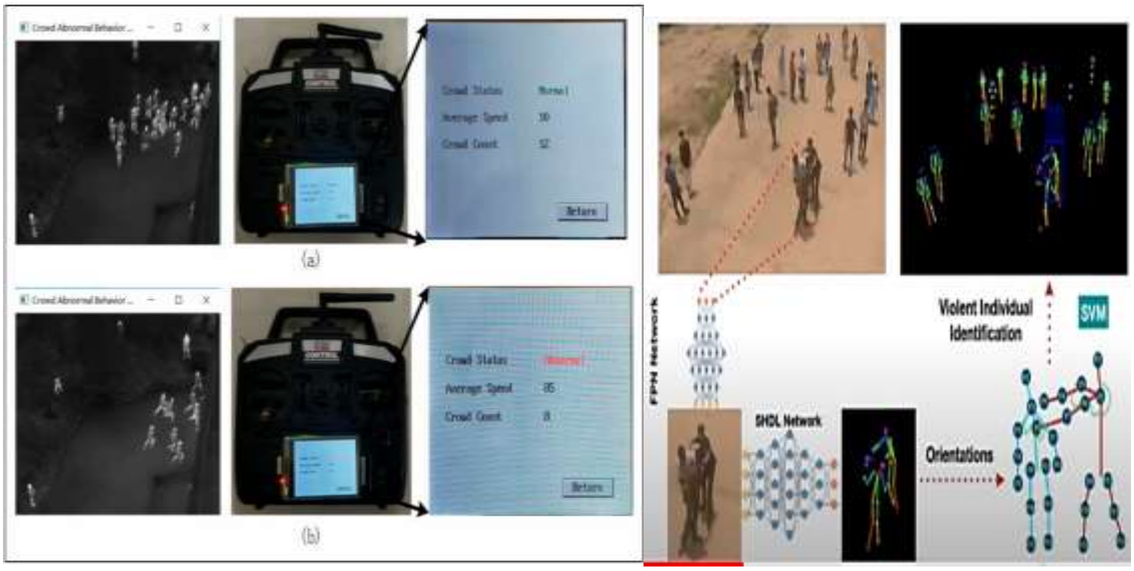

Fig. 12: A UAV detects aberrant activity in a simulated crossroads environment, as described in [17]. (a:) Standard crowd performance; (b:) aberrant crowd performance characterized by an increase in crowd speed and flight, as well as assaulting and advancing conduct.

Another fascinating aspect of the monitoring procedure is the real time study of crowd behavior. [18] demonstrates the notion by describing a UAV monitoring system for spotting dangerous persons in a crowd. This was accomplished by estimating human posture using the suggested Scatter-Net hybrid deep learning (SHDL) network technique. A curated collection of aerial pictures of people engaged in single of five violent actions (beating, choking, shooting, kicking, and stabbing) was created. Unlike in [36], the authors of [18] utilized cloud computing to execute intensive resource mode assessment operations, permitting the scheme to be deployed in actual time presentations. In [38], the authors presented a Priority-Based Routing of Ad-hoc (PRoFFAN) Networks architecture for improving data distribution and optimization to choice and regulator centers. This enhancement is accomplished by prioritizing the transfer of crucial picture data from the UAV to the station. Presenting the critical picture to decision makers as quickly as feasible can save lives and improve public safety and flow.

4. Conclusions

UAVs have emerged as the latest tool for human crowd management and continuous tracking. Current research mostly focuses on using a single UAV or swarm of aircraft to identify, localize, track and predict crowds. However, it is believed that UAV order, along with upcoming new technologies and developments, will make its way into human crowd management in the future. Among the issues to be overcome are the

optimal guidance and autonomous dispersal of a swarm of UAVs to perform crowd control and tracking. For example, while contemporary algorithms perform well in applications such as mass enumeration and crowd counting, object tracking methods on demanding aerial datasets are still not satisfactory and have great potential for improvement. Two important components were discovered in relations of actual times presentations for crowd investigation. For starters, the accessibility of high capacity single board computers in a minor form factor allows them to be installed aboard existing UAVs equipped with sighting and other telemetry tools. Second, a high-speed internet connection enables image analysis on remote servers or in the cloud.

In conclusion, this research presented a comprehensive examination of UAVs from the point of view of human crowd management and analysis. Energy management, onboard sensors and communications are among the topics covered. Due to the ease of use of UAVs in research and the growing demand for their use in public security and safety applications, recent work focusing on crowd-related programs including human crowd identification, observing, volume calculation, following, and analyzing has shown a growing interest in this field.

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Abstract

Aerial survey is not related to the use of aircraft only, but rather to the use of all remote sensing techniques, including the use of drones. This advanced technology is needed by professionals in the field of geospatial to perform their tasks accurately, efficiently and safely. One of the biggest and most important challenges that the civil defense and security forces face is the unexpected increase in the number of people in gatherings and large crowds. This requires a trained team to manage these crowds of people to identify any potential escalation or losses even before they occur. Recently, drone technology, or what is called a drone, has appeared which enables us to map human gatherings, monitor and analyze ground features or what may happen on the ground in a detailed and accurate manner, and through the use of computer vision and artificial intelligence. It is also possible to draw the routes taken by human crowds during events and large gatherings such as religious or sports events. Where it is also possible to recognize faces, thermal imaging during the night, estimate the density of crowds, the patterns of movement that occur, and direct the security forces and civil defense forces in light of scraps drawn with high spatial accuracy using the drone, all of which are just some of the few things that the drone can do. You can do it to enhance law enforcement, manage crowds geographically and spatially, and save people safely.

In this research, the types and characteristics of drones used in drawing geographical maps and crowd management will be reviewed, and the capabilities that these drones can perform. In addition to reviewing some of the facts and events in which these aircraft were used as examples in various occasions such as religious or sporting events or civil demonstrations. The challenges and solutions facing the use of this technology in such events will also be discussed. Such maps and information will facilitate and help decision makers to take quick and appropriate measures to avoid any major problems for human gatherings and crowds.

Keywords: Human geography, Drones, Cartography, Crowd Monitoring, Crowd Identification, Human Settlement.