ASPIRE: Autonomous System to Prevent Impulsive Riots on Eyesight

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***Abstract* - With a multitude of diverse thoughts and opinions thriving in a country like India which has been recognized as secular for the past many centuries, it has witnessed many conflicts of interests and schools of thoughts on different grounds which has painted it with a history of riots and violent protests. Despite the presence of many security and law enforcement authorities for pre-intimation of riot developing situations, the actions in response have been lackadaisical as well as inefficient. This research paper proposes the framework of ASPIRE - an entirely autonomous and environmental-friendly system that uses a 5G network for prediction, tracking, and possible prevention of riots. It is accomplished through machine learning (ML), natural language processing (NLP), and other such algorithms implemented on distinct devices and UAVs which are integrated to form one entire autonomous system.**

With the initial phase focusing on predictive analysis of sentiments expressed on social media sites, this will help authorities to predict any possible occurrences of protests taking a violent turn. Along with this, multiple microphones made out of discarded 2G/3G/4G phones (due to rolling out of 5G) and implemented with NLP algorithms in the backend will be installed in several streetlights at strategic locations. With a low power consumption, they will enable authorities to detect hate speeches by rioters and anticipate the severity of a protest. Deployment of autonomous UAVs from transmission stations for aerial surveillance and visual inspection through VR technologies like First-Person-View (FPV) will provide a real-time assessment of a protest or riot to the law enforcement authorities. This will assist the authorities to take well-planned and swift actions against the perpetrators while also estimating the losses of life and property.

***Keywords:* ASPIRE, Abstract, The World at a Glance, Methodology, Predictive Analysis, ASAR, Autonomous Surveillance System, Drone Deployment, UDAAN, Control Room, First-Person-View, Aftermath, Future Scope and Other Use Cases, Conclusion.**

1. The World at a Glance

Throughout the annals of its history, the world has spectated the rise and fall of multifarious regimes in different parts, across different generations, and by different people. Starting from the 1789 French Revolution to the Global Protest Wave of 2019, common people have stood at the helm of these protests. A sense of moral responsibility blended with their interests, disapprovals, needs, opinions, and threats prompt the people to uncover the most tempestuous issues of the society in front of the Government and hold it accountable. A prime example of this is the Global Protest Wave of 2019, where protests erupted across the world in different forms by different sections of society on differing issues. With the dawn of the new era, protestors and law enforcement authorities have actively utilized technology to both conduct and control the occurrences of protests turning into riots, respectively. In this section, the paper discusses three case studies from around the world, highlighting the role of technology in shaping the dynamics of a protest.

In the wake of the 2011 London Riots in the United Kingdom, protesters extensively exploited Blackberry Messenger, a then secured, encrypted and free-to-use messaging service, to perpetuate violence in the cover of protests. When Research in Motion (RIM), the parent company of BlackBerry, announced its full assistance to the British law enforcement authorities, protestors reciprocated by hacking into the Inside BlackBerry Blog to revitalize their provocative activities. However, people became oblivious of the fact that they could be traced back and held liable for their actions which prompted the authorities to spring into action. Pre-installed CCTV cameras captured footage of thousands of rioters using face recognition technology. This bolstered the efforts of the law enforcement authorities to distinguish rioters in an anonymous crowd and prosecute them for their crimes. Authorities also made use of websites like Flickr to find the vandals and arrest them for cases of loots and property damages. Various interactive maps depicted the satellite views of the street to street occurrences and developments during the rioting through websites such as Google Maps. Media channels also utilized this public service to record live footage on the streets and notify citizens to avoid particular areas based on the danger levels.

Taking the example of Hong Kong riots in 2019, the protestors made use of messaging applications like Telegram and online forums to meet, plan, and advertise their campaigns, something termed as a 'leaderless protest' by many. Chat rooms and forums enabled the protestors to launch financial campaigns. For instance, protestors and their supporters were able to accumulate more than a million USD to place advertisements of police brutality warranted by the state in global newspapers. Another key landmark of the protest was when the people felled a smart lamp-post; one of the many that had been recently installed by the Chinese authorities. Although the authorities claimed that the smart lamp posts were equipped to provide smart-city capabilities, the protestors feared otherwise. Recalling the mass surveillance of Uighur Muslims in China, the protestors feared a repeat of the same in Hong Kong. As the events unfolded, the authorities did not stay silent for long. Chinese authorities sought out and arrested chat-group administrators, as well as influential chat contributors while launching distributed denial of service (DDoS) cyberattacks against the Telegram to disrupt its service. Cases of doxxing also emerged wherein private information of protestors, journalists, and officials were widely circulated online by both protestors and the state authorities, something that was largely unprecedented.

Amid the Anti-CAA riots of 2019 and the following outbreak in India, the Government authorities and Delhi police employed facial recognition technology to identify around 1100 protestors who actively participated in the violent protests that occurred in the national capital of the country. Although India has observed numerous cases of Internet shutdowns during earlier protests, this protest instead witnessed the flow of information being used to recognize and prosecute the perpetrators. The police officials also made use of drones to monitor the protests in some regions of Delhi. The hovering drones made people wary of being caught on tape and recognized, which resulted in decreased cases of vandalism and property damage. Despite this, recorded footage from drones and CCTVs was processed and analyzed in real-time to know the protestors' whereabouts, their numbers, and their actions following which they were arraigned.

Delving into the three case studies discussed above, it is easy to observe that although both protestors and authorities have successfully used technology during recent protests, it lacks to account for all the root aspects as well as repercussions of any protest. This research paper lays down a clear framework strategy for autonomous surveillance of protests from an early stage of the protest to defining a proper course of action for the law enforcement authorities.

2. Methodology

2.1 Predictive Analysis

Social media is one of the most influential and useful tools that has been invariably used by protestors to systematically plan, organize, promulgate, and mobilize the common masses for demonstrations and protests worldwide with far-reaching consequences. The 2011 London riots, the 2016 post-election civil unrest in the U.S., and the 2019 Citizenship Amendment Act (CAA) riots in India are just a few instances. In this context, this paper aims to apply machine learning algorithms to analyze the content posted on social media sites like twitter to predict the development of a protest.

To predict the development of a protest-like situation through the use of Twitter analytics autonomously, an algorithm that encompasses four fundamental steps is employed. As demonstrations happen, relevant data is collected to gain information for two of the initial stages, i.e. detecting early signs of a protest through hashtags and the severity of the situation which focuses on making a calculated estimate of elements of violence in the protest. The preliminary step involves searching for the initial indications of a protest by continuously looking for signaling hashtags such as: 'protest', 'riot' and so on. The algorithm also looks for the daily count of trending posts, including these hashtags. Whenever the number of signals in a fixed time interval passes a certain threshold predetermined by the algorithm, the system moves up to the second stage.

Searching for leading hashtags and reasons for protests holds a real significance as hashtags are one of the essential tools in twitter to organize and sort tweets. People use these hashtags to express their sentiments, perceptions, and opinions on up to the minute happenings of a particular protest. Activists play a vital role in creating several hashtags during the early stage of a protest to ignite a desired sense of action, among others. Many a time it is observed that the ground reality behind devising these new hashtags is to raise concerns against something that a particular section of society cannot fully accept and something they might want to bring to the Government's notice. Later on, very few hashtags are used usually to attract user attention towards a specific subject. There are different approaches to evaluate the austerity of a protest.

One possible approach is to determine the main extraction features. In this case, the main extraction features that have been taken into account by the algorithm are: timestamp of the tweet, username, user id, tweet id, tweeted content, tweet location, the verification status of a tweeter, number of followers, and retweets of the tweet. The user id, username, tweet id, and tweet location are used to explicitly recognize the main perpetrators behind the dissemination of information pertaining to the protest while the verification status helps to distinguish verified tweeters from non-verified ones. It also eases the process of removing any tweets by bots from the data set that is prepared for further analysis. The tweet's content is directly fed into the algorithm to analyze the sentiments of the tweeter in the ensuing steps of the algorithm. Furthermore, the higher the amount of followers and retweets, the higher is the priority of feeding the hashtag in the Google News API for headlines. Table 1 and 2 illustrate the main extraction features of Twitter analytics. The second step also incorporates prioritizing tweets based on additional three criteria that are- the average number of tweets per hour based on user id, results of Google News API, and regional concerns as motivators of protest.

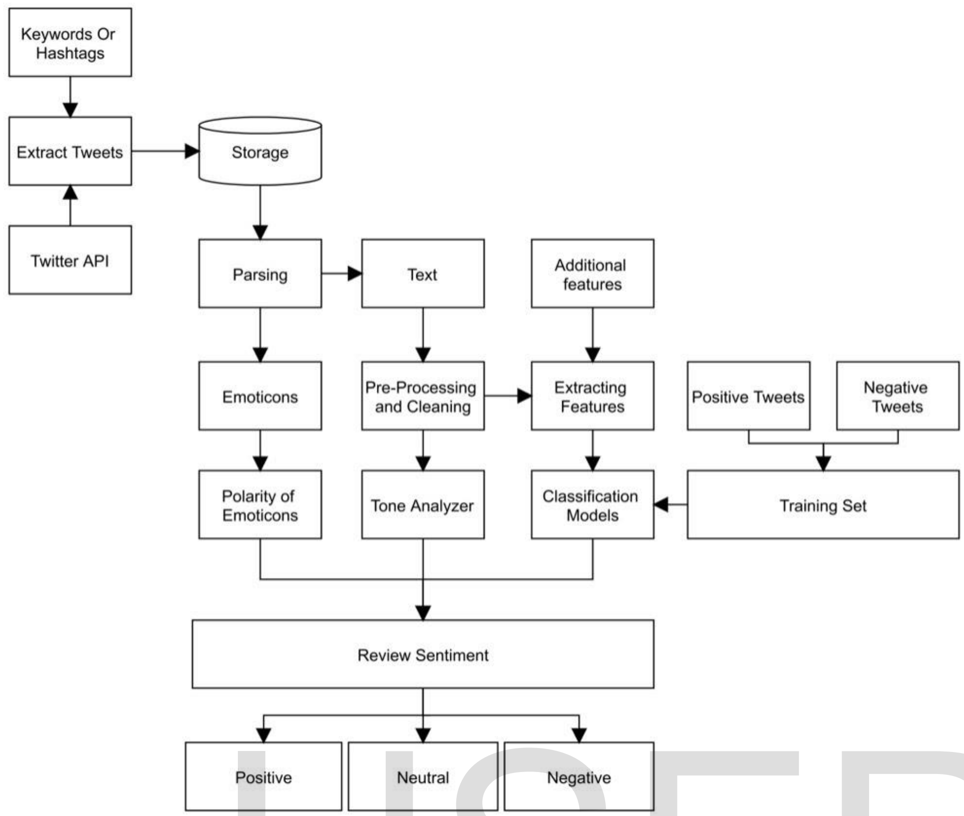

Figure 1. Predictive Analysis flowchart of Protests

To further improvise the obtained dataset, the additional criteria are also analyzed as independent variables in the prediction model. The average number of tweets per hour reflects the volume of online tweeting activities in direct correlation with the approaching offline protest. The Google News API depict the number of retweets and followers, which is a direct manifestation of the penetration rate of the tweet in public. The third aspect of regional concerns as motivators evinces the personal factors which lead the people to join the protest as a ramification of personal agendas. To the best of our insight, the combination of the main features with the additional features discussed in this paper is unique in producing an efficient prediction model for twitter analytics.

Now that a data set of top tweets has been generated as a result of the second stage, it is easy to process those tweets for sentiment analysis. In this step, the tweets are relatively categorized as positive, negative and neutral to ascertain the user's attitude towards a particular tweet based on its content. It can also be termed as a classification of tweets to predict a probable violent turn in any protest from the results of sentiment analysis. The final course of action is to discern the feasible geographical locations of the protest based on top tweets.

Altogether, this predictive analysis aims to estimate the prospects of a protest sprouting up in any specific turbulent region and the possible odds of the protest turning into vicious riots based on the last analysis phase.

Time	User_Name	Tweet	Tweet_ID
2020-03-13 12:09:55	Ramasya Da	@vishnuguptuvach: The foreign media chanted that #DelhiRiots2020 was about Hindus attacking M\xc3\xbcsl\xc3\xaems... "how minority was being targete	1238437129870405632
2020-03-13 17:21:10	Shahadat H	@IPS_Association @nytimes @PMOIndia @HMOIndia We the people of INDIA strongly condemn biased reaction on the cond\xe2\x80\xa6 https://t.co/KOL	1238515460049481729
2020-03-13 17:54:15	Pursue-Ram	@EconomicTimes @ArvindKejriwal It seems @DelhiPolice report on #DelhiRiots2020 is out and outcome not favoring\xe2\x80\xa6 https://t.co/Ip0CoDlaX5	1238523784392355840
2020-03-13 17:25:42	Zainab Bug	@bugti_zainab: Kashmiris are love \xe2\x9d\xa4\xef\xb8\x8f\n\n#abhinandan #CoronavirusOutbreak #HappySurpriseDayIndia #DelhiRiots2020 #SurpriseDa	1238516599642042370
2020-03-13 15:00:19	Nitisha	The 3 alleged #PFI members , Danish, Parvez and Illiyas, who were earlier arrested for their alleged role in the an\xe2\x80\xa6 https://t.co/JrMebjCJWr	1238480010857472001
2020-03-13 11:56:32	shakaaal	@drsarahumer: Heart touching quote of Sahil Ludhianvi by #Mpjavedalikhan ... on Delhi pogrom #DelhiRiots2020 @RanaAyyub @SalmanNizami_ @\xe2\x	1238433763039883270
2020-03-13 11:10:14	Mayank Jai	GTB hospital seems to have been ill-equipped to cope with the rush of patients from the nearby riot-hit area of Nor\xe2\x80\xa6 https://t.co/KNwLtcj50y	1238422111385006080
2020-03-13 16:30:35	Hanif MD.	@poojansahil: Zia (name changed) ran a mechanic shop. Fully burnt down during #DelhiRiots2020. A customers scooter and lots of spare pa\xe2\x80\xa6"	1238502728348758019
2020-03-13 17:43:13	Dr Ishanvi	@SanjayAzadSln can you explain this #DelhiRiotTruth #DelhiRiots2020 https://t.co/USjEjSYz60	1238521006496587776

Table 1. Extracting features - timestamp, user_name, tweet content and tweet_ID

Tweet_ID	location	verified	User_ID	followers	retweet
1238437129870405632		FALSE	984632976	316	5
1238515460049481729	katihar	FALSE	2289665252	255	0
1238523784392355840	Delhi	FALSE	1023219169440018433	1	0
1238516599642042370	Balochistan, Pakistan	FALSE	1151937502753824770	1195	3
1238480010857472001	New Delhi	TRUE	1673394092	5051	2
1238433763039883270		FALSE	1150986484046008320	86	10
1238422111385006080	Delhi, India	FALSE	2223407635	62	1
1238502728348758019		FALSE	3116561466	17	11
1238521006496587776	Pune, India	FALSE	1222328988900655106	243	0

Table 2. Feature Extraction from the joint dataset

2.1. ASAR: Autonomous Speech and Audio Recognizer

An eco-friendly approach to deal with electronic wastes is employed in the second phase of ASPIRE, codenamed ASAR that emphasizes on hate speech detection by utilizing E-waste. With the high prospects of 5G rolling out in the near future, improper disposal of electronic devices using 4G or lower technologies carries a high probability. A simple example of this can be a regular smartphone. As per a report of the United Nations, nearly 50 million tonnes of electronic and electrical waste is generated every year, and with the current annual growth rates, it is projected to reach nearly 120 million tonnes by 2050. In countries such as India, where there are record-high occurrences of unregulated electronic waste disposal, this can cause significant environmental degradation while further aggravating the deteriorating climatic situation worldwide and causing unforeseeable natural phenomena to happen, even if on quite a small scale. This is due to the presence of toxic substances like lead, mercury, and arsenic compounds in discarded electronics that result in detrimental damage to natural resources and living organisms alike.

ASAR lays the groundwork for establishing a highly efficient technological infrastructure for early detection of hate speeches that are used by perpetrators to instigate the crowds against the authorities and turn peaceful protests into riots. This phase is inspired by two major technological stratagems that have been recently implemented successfully. The first is the use of a decibel meter installed on traffic signals by the Mumbai traffic police in India to instil the sense of 'honk with a responsibility'. This move helped to tackle the problem of excessive noise pollution caused due to continuous honking of vehicles at traffic signals. The latter is the use of discarded smartphones to create a real-time alert system to preserve rainforests from poachers and illegal logging activities. Recycled old phones are used to distinguish the noises of chainsaws, loading-trucks, rifles, and other equipment from the natural sounds in the rainforest. Any form of discrepancy sends an alert to the nearest local authorities such as the forest officer's station or police station who can then swiftly move to take stringent actions against the poachers and criminals.

ASAR uses old and discarded smartphones that come with microphones. These are installed on street lights where considerable mob movements are expected to pass by during a demonstration or protest. These microphones detect the sounds and audio in a radius of a few metres and using computer linguistic algorithms, determine whether hate speeches are used to manipulate the protestors to cause unrest and riots. This assists the law enforcement authorities to differentiate between hate speeches, offensive language and other speeches based on sentiments and tone of voices. Powered by mini-solar panels and possessing a long-lasting battery backup, these microphones can operate even during adverse weather conditions without affecting their effective range by a large margin.

To classify different speeches into genres such as hate speech, offensive language, and neutral, specific steps need to be kept in mind. One approach to predict the notion of expression is by utilizing an algorithm that consists of five key steps. Several papers have been published on hate speech detection, studying which, it is easy to conclude that the classical and frequently used approach is Support Vector Machine (SVM). As per SVM, the primary step involves the classification of strings. Speech or audio is converted into string or text transcripts to perform text classification based on the sentiment it pertains. In this step, a label is assigned to a string. Sentiment analysis is conducted for the classification of speech in broad categories of hatred, offensive language and neutral.

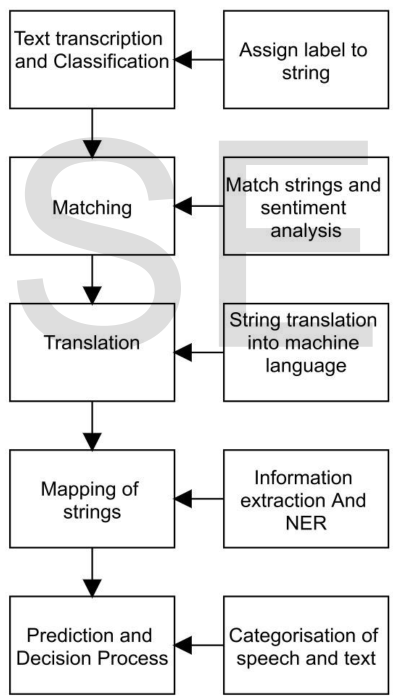

Figure 2. Simple Flowchart of ASAR

The next step matches the string that is obtained from the previous step. Here two strings of the same classification are matched in the sentiment analysis. String, if matched, is assigned to the same genre, and if it is not matched, then a search is performed to classify the particular string. The next step in the process is translation. The string is translated into machine language. This is done by transforming one string into another. The resultant string from the translation phase is mapped to a structure that can be termed as 'Mapping'.

The next stage is information extraction which requires locating and classifying the named entities in a string into pre-defined classifications, for instance: 'Name of the person', and 'Name of the city'. In this step, the prediction and decision process is made by mapping the string to a structure, which is generally followed by Named Entity Recognizer (NER) and is the first step towards information extraction. Moreover, this step is followed by word segmentation and semantic parsing. Now that the prediction process is complete, the last step incorporates the result of prediction based on the classification that has already been discussed.

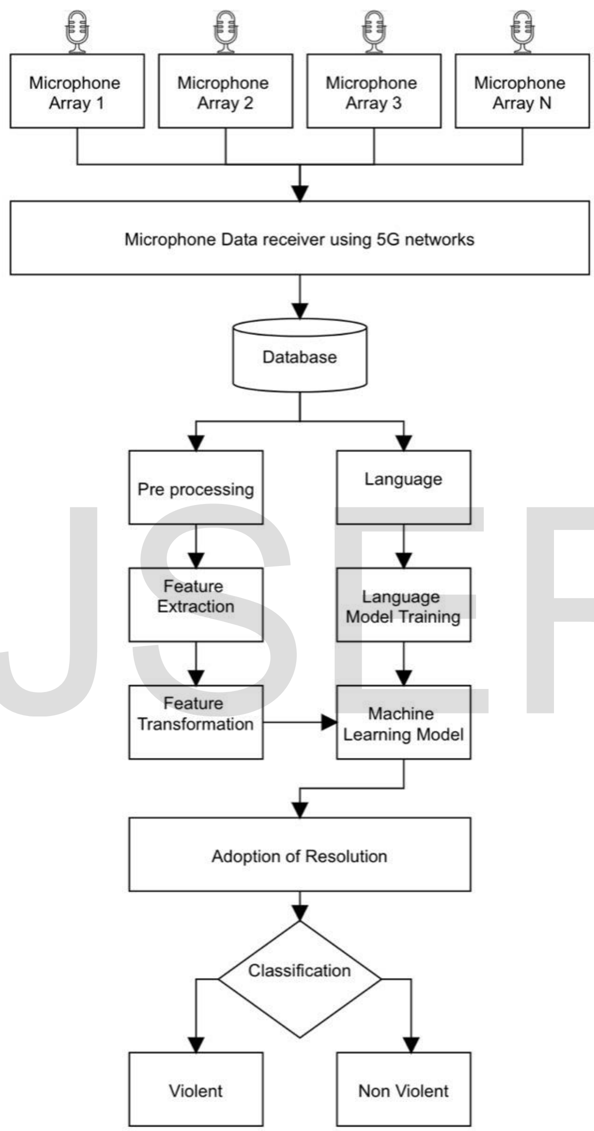

Figure 3. Explanation of processes in ASAR

2.2. Autonomous Surveillance System

2.2.1. Drone Deployment

In congruence with the outcomes of the initial phases of ASPIRE, the authorities have a rudimentary idea of the events unfolding before any protest along with a calculated estimate of the severity of the protest that may involve high risks of riots taking place. The subsequent phase of ASPIRE focuses on the deployment of a UAV system from pre-installed stations termed as UDAAN, that is in the closest proximity to the affected region. The primary function of this UAV system is to provide a real-time assessment of the situation to the concerned authorities during the protests and report any new developments that could brew further trouble.

UAV systems are undergoing a continuous phase of evolution over the past few years. Thus, it remains one of the most engaging topics to be followed up by research paper writers and technology enthusiasts. Taking into consideration the fact that ‘surveillance and monitoring’ is one of the most significant use cases of 5G, this research paper attempts to elucidate the steps to deploy the finest of the surveillance techniques that utilize certain characteristic features to provide higher efficiency in terms of real-time monitoring capability. These features encompass a wide variety of attributes such as overcoming disturbances through 3D path planning, formation flying, visual inspection, night vision, endurance, safe emergency landings, efficient self-communication and networking, fault tolerance, and so forth. This section briefly discusses these features and the control strategies used for their incorporation in the proposed UAV system.

With the current technological prowess, the number of UAVs is going to surge substantially in the near future with its varied uses in different fields, and hence constructive control strategies need to be devised. Traffic planning and interconnectivity are two of the significant challenges that need to be bested by any autonomous UAV system. A UAV needs to autonomously steer clear of any obstacles in its path throughout its flight, and this is achieved by implementing effective 3D path planning techniques. For most of the UAV systems that already exist in markets, this feature comes pre-programmed. However, a feasible and computationally streamlined approach employs the use of an adaptive discrete mesh. Unlike the classical techniques for path detection, this approach uses a recursive reward cost paradigm to explore and decompose the 3D environment to formulate an efficient path for the UAV to follow.

Over several years of research and implementation in the field of UAV inter-communication and networking, the UAV system is now capable of formation flying. Innumerable machine learning models have been generated to make systems capable of decision-making for an autonomous in-flight formation. Autonomous path planning in terms of a UAV set-up is a tedious task. One plausible approach to implement formation flying is reinforcement learning, where the model trains itself over repetitive cycles of failures and success. The system recognizes a plethora of possible alternate formations on a trial and error basis, following which it learns to formulate and use the best possible formation trajectory gradually. Furthermore, pre-programmed formation flying features in UAVs can be reprogrammed as many times as the user wants, thereby enabling the system to assimilate information and learn on its own.

To conduct surveillance, the UAV uses a high definition (HD) camera to capture pictures and live stream videos which can be analyzed for extracting information. This involves an interdisciplinary approach and the implementation of a sensing and perception paradigm. This UAV system applies computer vision using artificial intelligence to train a computer system making it proficient in extracting essential data from real-world visuals, and process digital images, thus providing a higher level of automation.

An in-depth study of the past occurrences of protests and riots reveal that a leading factor behind fuelling of hate and violence amongst the people is unforeseeable happenings such as night raids and attacks on people as well as their property in the name of protests. Often authorities are utterly oblivious of the real perpetrators behind these heinous crimes and are unable to take any action against them. To resolve this issue, the UAVs are equipped with uncooled thermal imaging sensors which enable them to incorporate night vision. Functioning at room temperature, this sensor quickly activates and begins thermal imaging of the target without creating any noise or disturbance. Night vision in patrolling UAVs allows quick detection of such crimes and the individuals behind them while simultaneously informing the authorities to take prompt actions.

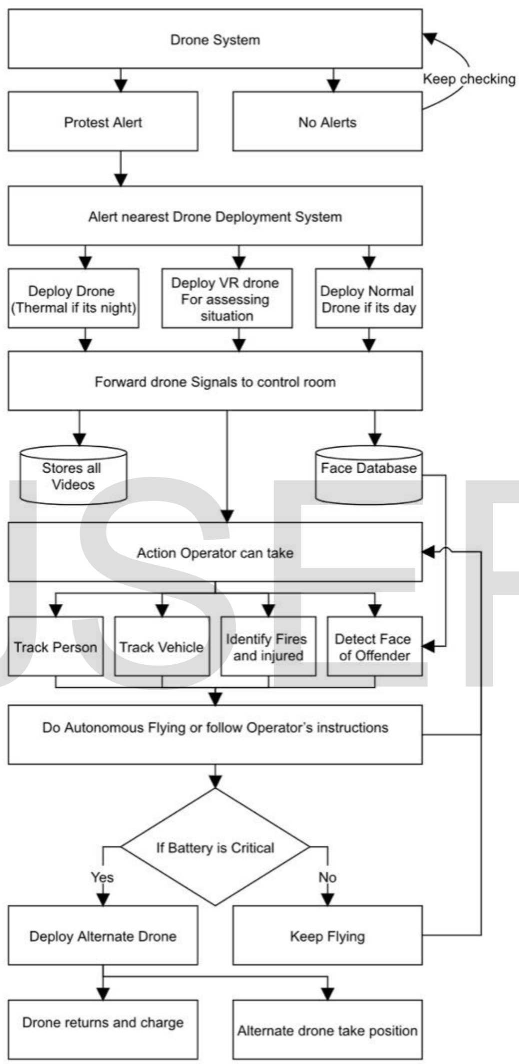

Figure 4. Process of drone deployment

Fundamental requirements, such as endurance are also addressed. UAVs are deployed with autonomous cooperative soaring in order to avoid missing out on further developments during the violent phase of the protest and prevent any data losses. Autonomous cooperative soaring utilizes autonomous soaring algorithms in conjunction with solar photovoltaics to enhance the endurance of the UAV by capturing energy from thermal air drafts and incident solar radiations.

There are several other issues that need to be resolved, such as excogitating safe emergency landings of a UAV in case of sudden exposure to an emergency or as a result of UAV failure due to unknown faults. For instance, sudden winds, low battery, connection interference, and extreme weather conditions to name a few, can lead to failures thereby compelling the UAV to go for quick and safe landings in order to safeguard valuable information and reduce any damages to itself. Whenever any such emergency occurs, the UAV sends out an alert signal to the nearest UDAAN station which releases the coordinates of its location where the UAV can make a safe landing.

Moreover, communication between UAVs, control rooms and UDAAN stations are addressed simultaneously. In order to maintain a dynamic connection, a stable, faster, reliable, and efficient network is chosen. With the onset of 5G, the telecommunication industry has finally evolved into a network with approximately zero latency and a faster data transfer rate.

2.2.2. UDAAN: UAV Dispatch and Authorized Administration Network

Many research papers have been published that address networking and communication of UAVs, which makes it crucial to comprehend the background and findings of past studies on UAV intra-communication as well as the significance of connectivity between the system's salient entities. UDAAN abbreviated 'UAV Dispatch and Authorized Administration Network', aims to establish a technologically sound infrastructure to impart hyper connectivity between the client, the server, and the service provider. Despite the umpteen use cases and applications of entirely autonomous UAV systems, there are several challenges that one must resolve in order to drive them into the future. In this section, the paper briefly discusses the different aspects of communication between different entities through UDAAN.

The third phase of ASPIRE emphasizes on dispatching UAVs from transmission stations termed as UDAAN for surveillance of protests. UDAAN is a unified UAV charging, dispatching and administrative station which serves as a gateway between the control room and the UAVs. As already discussed, the results from predictive analysis and ASAR prognosticate details about the probability of a protest in a particular geographical location along with a fair approximation of its severity as well as the presence of violent elements. To furnish the authorities with a clear-cut picture of the actual events transpiring during the protest, the closest UDAAN station dispatches a predetermined number of UAVs for conducting surveillance. Every UDAAN station is connected to all its UAVs through a 5G network which supports high data transmission as well as efficiency for a live video stream. A detailed flight plan is formulated and sent from the control room to the UAVs via the UDAAN stations. A UAV can also autonomously update its flight plan and easily coordinate even if it encounters any form of emergency or hazard.

Hyperconnectivity is a form of amalgamated communication and one of the most prominent use cases of the fifth-generation network. Hyperconnectivity promises to boost connectivity in almost every sector from telecommunication, energy, healthcare, transportation and logistics to information technology. In this proposed model, communication between UAVs, UDAAN and the control room is established through 5G, which supports applications of virtual and augmented reality, internet of things, cloud services, and machine-to-machine communication. 5G is anticipated to deliver greater bandwidth, more speed, near-zero latency, higher reliability, and enhanced QoS.

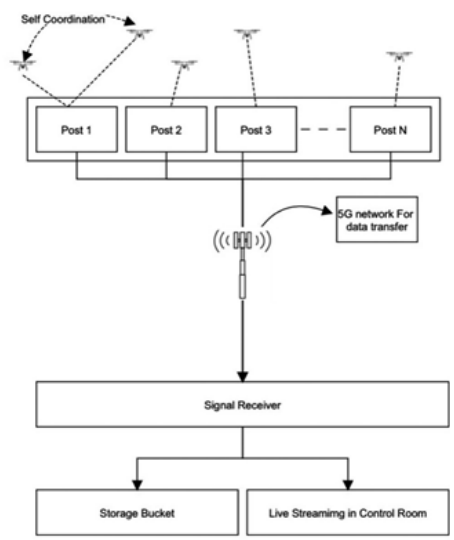

Figure 5. Communication diagram

To facilitate the efficient transmission of information and instructions, ASPIRE employs UAV radio communication. Two possible approaches for radio communication are VLOS (Visual Line of Sight) and BVLOS (Beyond Visual Line of Sight). The literal meaning of ‘Visual Line of Sight’ is that the UAV remains connected to the transmission station as long as it stays within its line of sight. On the other hand, ‘Beyond Visual Line of Sight’ ensures connectivity even when the station is out of sight. ASPIRE employs BVLOS for communication between different entities in an autonomous manner without any human intervention. Inter-station communication takes place via the control room in order to implement higher data security and prevent any data leaks and thefts. The process of transmission of the live video stream from a UAV camera to the control room takes place over the 5G network.

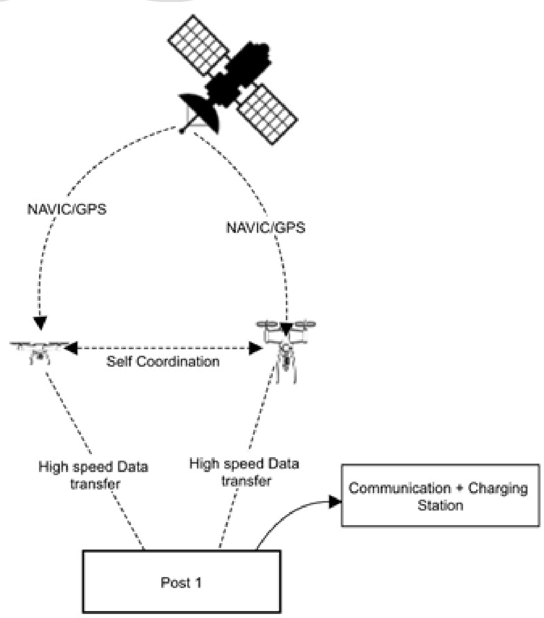

Figure 6. GPS system in UAVs and post description

In order to make the entire system autonomous, the UAV needs to derive its location through GPS (Global Positioning System). Real-Time Kinematic (RTK) on UAVs records the GPS coordinates and images with geotags during flight. RTK is the chief system for refining the accuracy of position data and autonomous UAV mapping, which incorporates several advantages such as higher accuracy, upgraded safety and reduced costs. William Pryor justifies the use of RTK to capture the positioning of UAV as RTK systems allow the entire procedure of laying ground-control points for mapping to be bypassed. It also makes use of the fixed base station which wirelessly sends out corrections to a moving receiver. Utilizing alternative methods, the NavIC (Navigation with Indian Constellation) satellite navigation system can also be employed as a substitute for GPS.

Apart from the UAV’s high endurance, every UDAAN station is fitted with a wireless charging facility for UAVs. Predominantly, there are two ways of charging the UAVs - the wired method and the wireless method. Charging through a wire is a classical approach where the pin gets connected automatically to the UAV as soon as it lands on the UDAAN station. In this mechanism, pins are programmed to move independently by sensing the UAV’s landing. It is a primitive as well as a cost-effective method which does not require any frequent maintenance. On the contrary, the wireless approach involves the UAV getting charged with the help of coils. It is not necessary for the UAV to maintain contact with the station as this mechanism is operable within a certain range and the UAV can acquire as much charge as it requires. This process of wireless charging is more conducive and efficient than the wired method.

To grasp the bigger picture, assume that ‘n’ number of stations are established in two adjoining regions each, to ensure better connectivity for the overall system. Also, there are a distinct number of UAVs garrisoned in both regions. If a patrolling UAV is at the verge of crossing its designated region, it will either send an updated flight plan to the control room via the station or will be called back within the bounds of its region. However, in a possibly dire situation, the UAV moving towards a new region can also be linked to the particular region's UDAAN station. As soon as the UAV switch takes place, the flight plan again gets updated, and the database of the control room simultaneously gets notified about the incoming UAV IDs and stations at the end of the transaction.

UDAAN is a simple demonstration of an efficient and reliable network for UAVs which delivers key services for drone deployment. UDAAN can either be built as a whole new infrastructure or can be installed on major traffic signals with solar panels to power it along with an optimal battery backup to be utilized for any night operations.

2.2.3. Control Room

Serving as the communication headquarters of ASPIRE, the chief purpose of the control room is to monitor the real-time ground conditions of a protest, through a live video stream which is taken as input from the UAVs via the UDAAN stations. The control room is equipped with cloud analytics (online storage system, for instance, S3) integrated with an offline database. Apart from its surveillance dynamics, the control room operators are also in charge of maintaining the links with the UAVs via the UDAAN station through a 5G network.

In essence, the control room is a central and dynamic repository of data that supervises the operation of the core functions of ASPIRE. It sends flight plans to UAVs, oversees communication between the UDAAN stations, manages data analytics, and gives explicit instructions to ground personnel, UAVs and UDAAN stations. It is imperative to comprehend data analytics in the control room. Right from the initial phase of predictive analysis to the current phase of the protest or riot, the data is subjected to detailed analysis on different aspects and levels such as speech recognition, face recognition and so on within the confines of the control room.

This phase of analytics is very crucial as it thoroughly structures the raw data into comprehensive information in the form of a detailed report which can be directly submitted to the police and higher authorities. Speech recognition is performed on the audio input procured from the ASAR phase in order to transcribe and predict any plausible forms of violence or protests going out of control. Video analytics run a detailed analysis of the live-streamed video to get in-depth information about every minuscule occurrence in protests and riots. Similarly, face recognition is also conducted to obtain the details of offenders which is then entered into a database for the authorities.

Surveillance is also done as an aftermath of the riots to assess any casualties, incidences of fires, or significant damages caused to life and property. Results of the surveillance are directly intimated to the nearest concerned authorities who can then take swift actions to bring the situation under control and prevent any further losses. For instance, reports of fires at any place are sent to the respective fire department as per the jurisdictional constraints. Similarly, any casualties or wounded, and damages are reported to the nearest hospitals and police stations, respectively.

2.3. First-Person-View

The penultimate phase of ASPIRE takes into account the different piloting modes (or views) offered by the UAV system. Since the process of vigilance can be gruelling and diverse factors need to be scrutinized from various perspectives, the UAV system renders two forms of piloting modes, namely Third Person View (TPV) and First Person View (FPV). TPV chiefly focuses on roughly calculating the position and orientation of the UAV with respect to the nearby objects in order to avert obstacles. This feature comes pre-programmed in UAVs as the default pilot mode and provides a third-person perspective of the situation to the observer. Conversely, FPV, also known as RPV (Remote-Person View) and eye-view, is an approach that remotely controls a UAV from the pilot's viewpoint via an onboard camera. UAVs can be controlled using FPV goggles, which send video feeds directly from the UAV camera to the control room through a wireless medium.

FPV is notably an indispensable feature of the UAV system and is based on a mixed reality environment - a combination of a virtual and a real environment. However, the primary cynosure of FPV is that although the entire UAV system functions autonomously, it can also be independently operated for conducting surveillance using FPV. FPV is both convenient and pragmatic for superior officials and higher authorities to straightaway analyze the overall state of affairs during a protest that might also involve extreme chances of protests turning into riots. If used optimally, FPV has the potential to ameliorate the process of creating and compiling ground reports. Ground reports, though meticulous, drain considerable time as well as personnel and may still overlook specific details that are imperative to study the developments leading to the protests resulting in deferred decisions.

FPV limits such delays in compiling reports by directing control room administrators as well as providing the higher authorities with real-time glimpses into the events unfolding during the protest. It facilitates an expeditious investigation of the protests by the higher authorities who can accordingly, take appropriate actions before the situation worsens. The fifth-generation network plays a vital role in incorporating FPV for enhanced observation through UAVs as it has almost zero latency with the best possible picture quality. FPV goggles are made available at the control room in order to make the entire process of ASPIRE more transparent and efficient for the higher authorities.

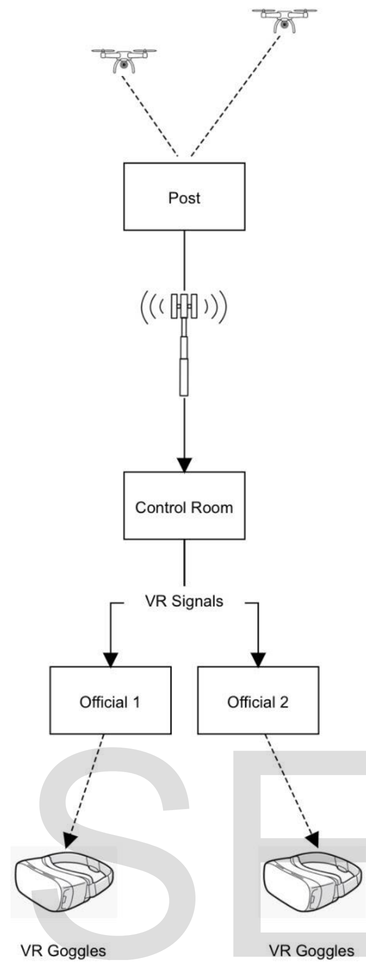

Figure 7. Working of FPV in ASPIRE

2.4. Aftermath

Although people participate in protests to raise their voices against specific issues prevailing in society or to hold the Government authorities liable for their policies and actions, the other side of the coin portrays the catastrophic brunt that protests and riots have on people's lives. Past occurrences depict the social and economic impacts of protests and riots on the livelihood of people. Following the 2019-2020 Anti-Citizenship Amendment Act (CAA) protests in India, the terrifying after-effects of the recalcitrant riot came into light. According to verified sources, altogether fifty-three casualties were reported in the national capital of New Delhi, including police officers. Over two hundred people got maimed or injured, which includes protesters, civilians, police officers, activists, and journalists alike. An economic loss of record twenty-five thousand crores in business and property is also guesstimated during this riot.

In this context, the concluding phase of ASPIRE deliberates on the repercussions of violent protests and riots. An undeniable fact persists that the consequences of riots can be as intricate as their roots. This makes it crucial to measure the extent of damages inflicted upon people and property to study further the developments that ensued from the initial phases of the protest. In ASPIRE, UAVs survey and determine any casualties, wounded, occurrences of fires, any significant harm to property, to name a few. The results of surveillance are notified to the nearest concerned authorities, which can then take appropriate steps to bring the situation under control and minimize any further losses. For instance, any incidences of property damage such as vandalism and looting are reported to the police station having jurisdiction over that region without delay via the control room, following which the authorities can then strategize their course of action at a much shorter notice.

3.0. Future Scope and Other Use Cases

The framework of ASPIRE takes several factors into account to provide a systemized real-time situation assessment capability for protests and riots to law enforcement authorities. However, there can always be further amelioration to broaden the horizons of this model. For instance, the predictive analysis phase focuses solely on Twitter; however, the model can also incorporate other growing social media platforms such as Telegram, Facebook, and discussion forums. It shall help to augment analysis and obtain higher accuracy of prediction before a protest or riot. Furthermore, the autonomous UAV system can be made more efficient by embracing various other features, such as introducing control strategies for robust disturbance rejection and complex near-ground manoeuvres to upgrade the surveillance capabilities. Likewise, the dependence of UAVs for obtaining its coordinates can be shifted from GPS to NavIC. Developed by India, NavIC shall deliver higher precision of coordinates when utilized particularly in Indian settings.

Furthermore, it is feasible to implement ASPIRE in other spheres to assist the Government and law enforcement authorities. One such instance is autonomous curfew monitoring, where the Government and police department can use an entirely autonomous UAV system to track and monitor an area under curfew so that people’s movements can be kept in check and suitable actions can be taken. Similarly, crime control can be another likely field of interest since ASPIRE can conduct its operations even after nightfall. The UAVs are well-equipped with thermal sensors which endow them with night vision capabilities as well as an adept facial recognition system to identify and apprehend the criminals. Along the same lines, autonomous vehicle tracking is also plausible through the bird eye-view provided by ASPIRE to keep track of vehicles used for committing crimes or for other unlawful activities. In the wake of the ongoing world pandemic and any such future cases, an autonomous thermal screening system can be delivered by ASPIRE. It can be highly beneficial for recognizing affected individuals and taking the necessary steps to curb the spread of such fatal outbreaks.

4.0. Conclusion

The emergence of radical ideas in the society coupled with inept actions of the authorities leads people to raise their voices in the form of protests and riots. Despite several measures, a well-integrated and systematic framework is required to ensure that such protests do not take a violent turn or cause harm to the public and their property. ASPIRE aims to achieve this through an environment-friendly and an entirely autonomous approach. To the best of the authors’ knowledge, the incorporated algorithms and specific features in distinct phases of the model are unique and present an overall efficient surveillance system to keep protests and riots under the constant vigil of law enforcement authorities.

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