



INSTITUTE FOR HOMELAND SECURITY



**Sam Houston
State University**

EXAMINING USE CASES FOR DRONES (UAS/RPAS) AT THE TEXAS MEDICAL CENTER

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Abstract

The Texas Medical Center (TMC) is the largest medical center in the world, with over 50 million square feet of developed land. With that size and notoriety come unique threats and challenges. As the TMC continues growth in size, and in technological advancement, an emphasis should be placed on how to utilize technologies already being integrated effectively in other critical sectors to support the growth of the TMC. One area of potential is the use of unmanned/un-crewed aircraft systems (UAS), more commonly known as drones, in supporting critical infrastructure inspection, testing, and preventative maintenance. Further, drone use for security of facilities, people, and high-risk areas is examined. This paper focuses on expanding on these potential use cases by exploring drone use in other industries that support the TMC (i.e., energy), and how to effectively integrate drone technologies while mitigating common concerns for safety and privacy.

1. Introduction and Overview

1.1. Defining drones in the current landscape

The common lexicon for the devices discussed in this paper is drone. However, understanding the some of the history and evolution of terminology will allow the reader to realize the difference between the remote-controlled model aircraft of the past, and come to terms with the technological feats of current remotely operated aircraft.

In the United States, the Federal Aviation Administration (FAA) utilizes the terminology of Unmanned (or Uncrewed) Aircraft Systems (UAS) to describe drones – system referring to the hardware, software, and human interaction required to make the aircraft fly. In other civil aviation authority (CAA) definitions, including Canada, they may be referred to as Remotely Piloted Aircraft Systems (RPAS).

The term drone has typically meant a flying object that does not have automation, advanced telemetry or guidance systems, and may not even be controlled upon flight. However, the use of drone has become the common term for any flying objects that do not include direct pilot intervention. Drone has even been embraced by the FAA and a pseudonym for UAS – ex. FAA “No Drone Zone” signage put around special events to inform the public that they cannot fly there.

One reason this author believes understanding the naming convention is important is that public perception is vital in the thought process of implementing the use of the technology discussed within this paper. The term drone may have negative connotations for some of the public and many of the practitioners evaluating their use.

Whether it is militaristic images, sensational scenes in television or movies, or even the personal nuisance of the hobbyist at the beach or local park buzzing around their family, these experiences create a public perception that undermines the incredible technology and use cases that this paper will explore.

This paper will address the national regulatory changes that attempt to outline the use of drones within our airspace and other legal considerations that commercial organization must consider. It is the hope of this author that this paper will offer perspectives on how other industries have effectively integrated drones, and how the healthcare industry can adapt rapidly.

1.2. Acknowledging moral, ethical, and legal concerns for security, safety, and the public at the Texas Medical Center

It must be acknowledged that all new technology brings concerns – from the public, from the regulators, and even from the adopters of said technology. Perhaps one issue with drones is that they are not new and thus have a complex history and misleading public perception associated with the word.

Drones have existed in some form since the early 1900s, or even the late 1800s. Both Samuel Langley and Nikola Tesla demonstrated unpiloted drone flight and remotely controlled watercraft, respectively, prior to the 1900s.¹

It was during the first world war that aerial drones began taking shape for use as target practice and weapons, leading to the use of evolving drone technology in combat for the past hundred years. Images of drones reigning missiles at terrorists, terrorists and militias using drones to film and attack their intended targets, and even the rapid deployment of commercial drones being militarized for warring nations in eastern Europe have inundated our media. These images and uses may lend pause to some on weather drones are safe for use amongst general population.

In 2012, The University of Texas - Austin, by request of the Department of Homeland Security, performed a remote takeover, or spoofing, of a drone over a research area at White Sands Missile Range.² The objective was to demonstrate how an autonomous or semi-autonomous UAV could be 'hacked' beyond just jamming the control frequencies and be intentionally taken over. Specifically, it highlighted issues with GPS receivers and radio frequencies used within the civil environment – critical components of nearly all drone systems. While this research is a decade old, the relative ease in which this feat was performed resonates with current operators, regulators, and security experts.

¹ Mirot, A., et al. (2017). Unmanned Aircraft Systems and safety: Textbook edition. Unmanned Safety Institute.

² <https://rnl.ae.utexas.edu/images/stories/files/papers/unmannedCapture.pdf>

Public and regulatory concerns also have led to states, including Texas, to pass legislation to counter the illicit use of drone technology and address security and privacy concerns.³ The Texas Government Code, Chapter 423 covers the use of drones within Texas including:

- Prohibiting use over correctional, detention, or critical infrastructure facilities;
- Prohibiting use over sports venues with >30,000 seats; and,
- Prohibition on capturing images of private property and/or owners/tenants for the purpose of surveillance.

The Texas laws attempt to clearly define each of those categories, as well as provide clear definitions of those who would be able to perform such actions lawfully – ex. someone contracted or commercially compliant with FAA regulations to perform inspections of a critical infrastructure or someone part of a governmental entity acting in official capacity. Yet, the mix of federal regulations, varying state laws, and local ordinances across the country create a confusing and complex set of operational considerations.

1.3. Drones throughout industries – Snapshots of success

As previously noted, drones may tend to lead to thoughts of military use cases. Further, the complexities of regulation and legal concerns may seem overwhelming to those not already operating in the drone space. However, over the last decade the rapid increase in technological capabilities, accessibility, and a more nationally standardized regulatory framework have allowed drones to proliferate across many critical sectors in the United States. The commercial drone market is expected to exceed \$82 billion (USD) by 2025.⁴

The energy sector, especially within the oil and gas arena, has largely embraced the use of drones to perform everything from preventative, maintenance inspection, testing and project management all the way to deploying on large type one explosions, fires, and spills. Drones can be used to quickly perform digital terrain/surface model (DTM/DSM) mapping that aids in the production of fire plans, spill contingency plans, and environmental impact assessments. This data, combined with already widely used geographic analysis tools, is all designed to aid with regulatory compliance and occupational health and safety initiatives. Additionally, tasks such as exterior, interior, and even non-destructive testing – typically labor intensive and potentially hazardous – are being augmented using drones scaled across global operations of large energy producers.⁵

Other sectors have embraced drones over the recent years include construction, marketing firms, commercial and private real estate, and insurance assessment

³ <https://statutes.capitol.texas.gov/Docs/GV/htm/GV.423.htm>

⁴ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6174005/>

⁵ <https://markets.businessinsider.com/news/stocks/exxonmobil-selects-huvrdata-to-digitize-drone-inspectionsand-reporting-1028820241>

companies.⁶ Consider a real estate agent being able to produce professional grade photography, video, and even flythroughs of their properties to give prospective buyers a chance to see the property completely from the comfort of their couch. Imagine an insurance adjuster being able to conduct a post storm roof assessment without ever stepping foot off the ground or a construction site manager being able to send daily site updates from an aerial perspective. Think from the perspective of a marketing team being able to produce Hollywood level videography that flies you through the venue and to your prospective seats or event space being viewed through your email or social media account.⁷

2. Gap Assessment or Problem Statement

2.1. Extending existing use cases to healthcare facilities

Healthcare facilities, especially those with large footprints such as TMC, have tremendous amounts of infrastructure – high-rise buildings, water chillers, above and below ground fuel tanks, parking garages, skybridges, emergency generators, central plants, etc. – required to ensure world class clinical, research, and educational operations. These operational challenges, including the cost of maintenance, the hazards to those responsible for maintenance, and the risk to the overall enterprise if any of these critical aspects fails, are massive.

Use cases from other industries that have an application within the TMC would be to utilize drones to conduct critical infrastructure inspections. Consider the ability to fly drones around a bed tower to inspect exterior surfaces. Regular inspections conducted by drones on a monthly basis could result in change detection of exterior conditions.

The data collected from such flights can be rapidly processed create a catalog the structural photos that can be further processed to aid in change detection. This data, and the methods used to capture it, can also then be interpreted further by contractors performing repair work by aiding them to identify the scope of work more accurately or be processed in emerging artificial intelligence platforms – cost savings and reduced downtime may be benefits, as well as the ability to predict future outages with change detection software.⁸

Beyond the physical infrastructure, reputational or financial impacts, and legal risks lies another concern regarding the safety and security of the healthcare workforce, patients, and all who interact within the walls or streets within the TMC.

⁶ <https://www.dronedeploy.com/blog/drones-helping-build-stadiums-construction>

⁷ <https://maxsemo.com/drone-marketing/>

⁸ <https://www.mdpi.com/2075-5309/11/4/150>

2.2. Why drones are “scary” in a sector that embraces technological advances.

The medical and healthcare sectors utilize incredible technology and research methods to advance treatments and create cures. However, medical executives and clinical leaders may be hesitant to introduce additional perceived risk for technology that may be seen by employees and patients alike. Some of this concern may surround the unknowns, while others may be directly related to various research and real-world concerns over drones – remote hijacking, use as a kinetic weapon, unwarranted surveillance, and simply the risk of malfunction.

Research on the use of drones in commercial applications, and how the public perceives such uses, may offer insights into why industries may approach framing discussions around integrating drones into their operations.

Research conducted by PwC in the UK prior to 2020 indicated that over one-third of business leaders believed negative public perceptions prevented their industries from adopting drones while two-thirds of public respondents highlighted a 2018 incident at Gatwick Airport, involving unidentified drones operating within the perimeter fence, as negatively impacting their view on drone operations.⁹ Fast forward to research released in 2021 from Virginia Tech’s Mid-Atlantic Aviation Partnership, also focusing on the UK, and we see that the global pandemic positively impacted respondents, with 58% stating that their opinion of drone delivery services increased.¹⁰

Leaders of industries, including healthcare, have an opportunity to be a part of the discussion for integrating drones into their normal operations. However, the ecosystem surrounding drones will continue to become more complex as capabilities outpace regulatory frameworks. As will be demonstrated in additional sections of this paper, there are quick wins that should be explored to ensure that healthcare has a seat at the table and does not fall farther behind other industries in adapting drone technology.

3. Topic Discussion

3.1. Drones as aircraft – Integration in complex airspace

The FAA passed the landmark rules for commercial drones in what has become known as Part 107 in the summer of 2016, with the first operational rules going into effect just shy of FY2017. These rules, while continuing to be modified and expanded every year, helped lay the groundwork for proliferation of non-hobby drone use across the United States.

⁹ <https://dronelife.com/2019/06/07/pwc-research-public-perception-a-barrier-to-drone-adoption/>

¹⁰ <https://dronelife.com/2021/04/23/public-perception-of-drone-delivery-new-research-from-virginia-tech-revealswhat-people-really-think/>

Other civil aviation authorities have also been tackling the integration of drones with a wide degree of variance between nations. These variances can create headaches for those working to implement or manufacture drones. This can be especially true when advanced use cases are observed in other parts of the world, with lesser restrictions, but cannot be easily adapted domestically. As with many technologies, the rapidly expanding technological capabilities are constantly being scrutinized against a lagging legal and regulatory framework.

To briefly summarize some of the key components of the Part 107 rules, the FAA attempts to outline how pilots become certified through education, testing, and re-currency requirements. The rules also lay out the base requirements to ensure aeromedical fitness of the pilot, basic safety management system principles that should be applied to drone operations, and broad requirements for the maintenance and airworthiness of the drones themselves.

Further part 107 outlines the minimum requirements for certain operational modes of flight as well as limits on how those operations can be conducted to remain consistent with the rules. Rules that are currently being implemented and evaluated for further expansion of operations include the use of remote ID, effective in September 2023 as of this paper, which will essentially serve as a form of transponder to monitor drone activity.



Figure1. Remote ID Rule (Source: FAA)

The 2023 FAA Reauthorization Act also seeks to review one of the most discussed operational needs - beyond visual line of sight (BVLOS) rules.¹² Part 107 operators are generally required to maintain a visual sight of the aircraft in flight. While provisions under the current rules allow for the use of trained visual observers to assist with the visual line of sight requirements, it is still highly restrictive for operations over long distances and for highly developed areas, including the TMC. The drone industry is rapidly moving towards technology for autonomous operations that would expand the legal framework and safety cases required to fly BVLOS.

¹¹ https://www.faa.gov/uas/getting_started/remote_id

¹² <https://www.crowell.com/en/insights/client-alerts/faa-reauthorization-legislation-2023-where-are-we>

Many hospitals, especially within the context of a medical center such as TMC, sit amongst large metropolitan areas, such as Houston. Complex and congested airspace becomes a significant factor in the safe application of drone technology. Overlapping regulations for drones from sporting venue rules, restrictions on operations over people, and flight during certain environmental conditions further increase complexities for drone operators.

Expanding on airspace complexity is the challenge of integrating with air ambulance operations. The TMC has more than six helipads, most located on elevated rooftops, and resides within surface-level Class B airspace. The ceiling for pre-approved Low Altitude Authorization and Notification Capability (LAANC) drone operations is 50ft – creating issues for flying drones on a regular basis where a significant portion of the campus is multi-story high-rise buildings. Careful consideration of vertical and horizontal separation, pre-established flight routes, and contingency plans for emergencies must be developed to safely operate in such an airspace environment.

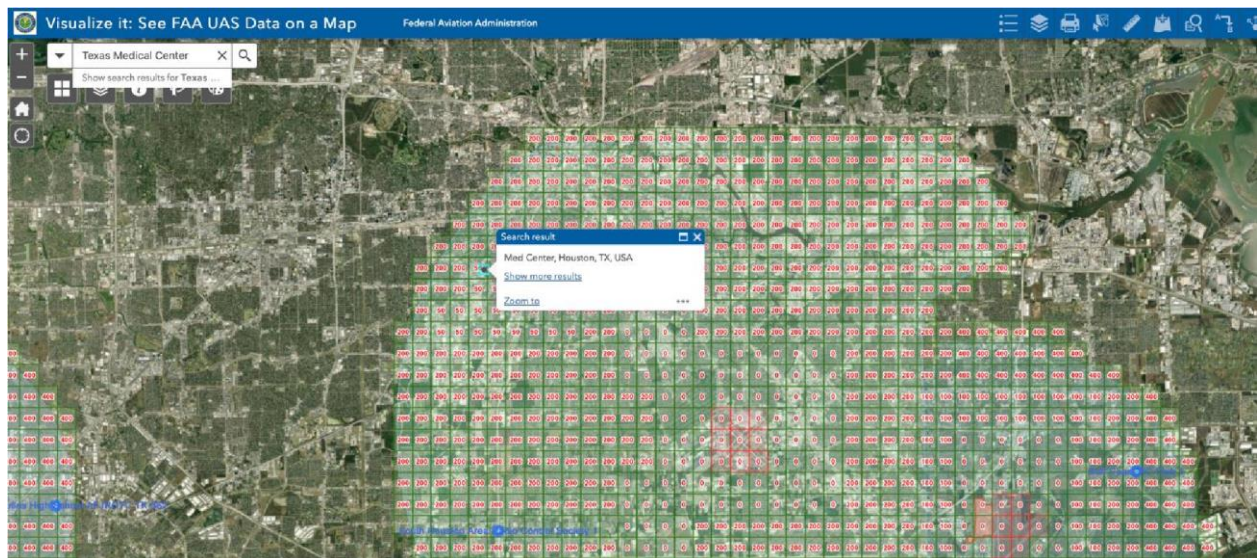


Figure 2. LAANC airspace layer (Source: FAA UAS Facilities Map)¹¹

This paper will attempt to highlight use cases that are generally accepted under the current drone regulations of the United States and address certain operational rules that may be eligible for waivers or authorizations from the FAA. However, there remains a significant gap between capabilities and the regulatory environment that continue restrict compliant operators, or at worst, prohibit otherwise qualified operators from integrating or expanding drone programs in industries such as healthcare. Effective partnerships amongst regulatory agencies, TMC tenants, and law enforcement will be needed to work towards standards of operations and assess, mitigate, or eliminate potential airspace

¹¹ <https://faa.maps.arcgis.com/apps/webappviewer/index.html?id=9c2e4406710048e19806ebf6a06754ad>

integration issues with the FAA and existing aviation elements operating around within the TMC.

Safety is paramount in any discussion, but especially involving healthcare and emerging technologies. Many hospitals utilize the concept of High Reliability Organizations, promoted by The Joint Commission (TJC), focused on promoting an organizational culture of safety through leadership commitment and empowered employees.¹² The FAA also uses an approach called the Safety Management System (SMS), focused on four key areas of safety culture:

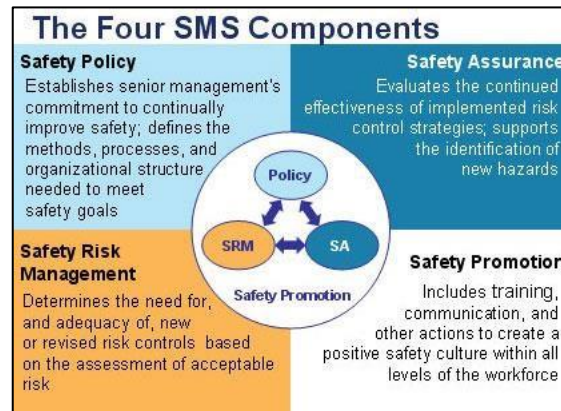


Figure 3. Safety Management System (Source: FAA)

Bridging existing safety culture in health care to the required SMS components will be vital to successful integration of drones into airspace around the TMC. Straying from the SMS components could have adverse effects on the acceptance of drones operating within the airspace used by air ambulance services and delay FAA approvals for operational waivers/authorizations required.

3.2. Drones as tools – The case that drones, within the larger context of robotics technology, are here to stay.

Drones for use in healthcare have been explored around the world. Typically, the healthcare use cases most often referenced in literature involve the use of drones for delivery of critical medical supplies, pharmaceuticals, or medical surveillance of rural populations. Some of the cited uses of drones also includes the ability to deploy lifesaving tools, including AEDs or Epi pens, to areas that first responders may have difficulty accessing. The Covid-19 pandemic led to a sort of industry race for applying drone technology to emerging healthcare needs, especially in remote or underserved parts of the world.¹³

¹² <https://www.jcrinc.com/what-we-offer/high-reliability/>

¹³ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9612140/>

Within the TMC some of the lessons learned from these applications of drones can be applied to such task as moving medical supplies, laboratory specimens, blood, and warehouse items across campus through aerial means. The dense vehicular traffic, road and building construction, and unpredictable impacts to the transportation network can create significant delays in the timely transport of critical items within TMC. Beyond the TMC, many of these use cases could be applicable to our remote and underserved populations. Advancements in geo-tagging and RFID technology in warehouse operations is already seeing big wins in the use of robotics to manage inventory and make deliveries across hospital campuses.¹⁴

One area in which autonomous and semi-autonomous robotic technologies are being applied within public spaces is in wayfinding. Several hospitals across the TMC and broader healthcare community have leveraged roving robots to build out virtual maps of hallways and corridors to assist patients and employees in navigating the massive campus.¹⁵ Elements of the technology used to provide such a service can be integrated with drones to further the use cases into operational processes which will be examined in the next section of this paper.

3.3. Drones as data collectors – Practical applications of drones for operational security and safety.

One of the most significant aspects in the decision of drone usage, especially when evaluating use-cases, cost, and training requirements, is the payload itself. Sensor systems once only available on large aircraft or ground-based systems can now be scaled to fit on to drones.

The most basic sensor system for be a standard high-resolution camera like your phone camera or portable digital video camera used to film your vacation moments. Drones solely possessing a high-resolution camera are still extremely powerful tools for uses well beyond taking a photo for marketing material or a video of a construction site. The photo and video meta-data, coupled with the data stored on the drone itself, provide many of the critical points of information needed for highly accurate geographic information that can be readily used for multiple end states.

For an example, consider a notional new clinic is built in the TMC. While photos and videos were taken of the new facility during construction, the existing geographic data available to the organization is outdated. Security wishes to have updated imagery for access control plans while facilities leadership would like to have accurate site data for

¹⁴ https://locusrobotics.com/industry_solutions/healthcare-medical/

¹⁵ <https://www.goziohealth.com/platform/healthcare-wayfinding>

assessing infrastructure needs and establishing baselines for pre-storm damage assessments. Figure 4 shows the existing data available via open-source platforms.



Figure 4. Open-source satellite imagery of sample location in NW Houston (Author's elaboration).

To gather more updated imagery, the entity could purchase costly satellite imagery from commercial operators, commission an aircraft at thousands of dollars an hour to do overflights or wait for the open-source imagery to be updated – possibly taking years. Another option is to deploy a drone over the site. Figure 5 shows the updated imagery collected and processed in less than a day. 109 images were captured in less than 10 minutes of flight and processed via a cloud-based platform. The resulting output is referred to as an orthomosaic image than can be overlaid onto existing GIS layers or exported to a multitude of other formats used across an organization.



Figure 5. Orthomosaic drone capture of Figure 1 location in current state (Author's elaboration).

Now consider a hurricane has passed through and a rapid damage assessment is needed to begin outlining recovery requirements for contractors, insurance, and/or for FEMA Public Assistance projects. Figure 6 shows the ability to compare data on a commercially available SaaS platform that could provide hospitals of all sizes the ability to conduct rapid assessments of their sites with the most up to date imagery – a process that can be replicated as needed.

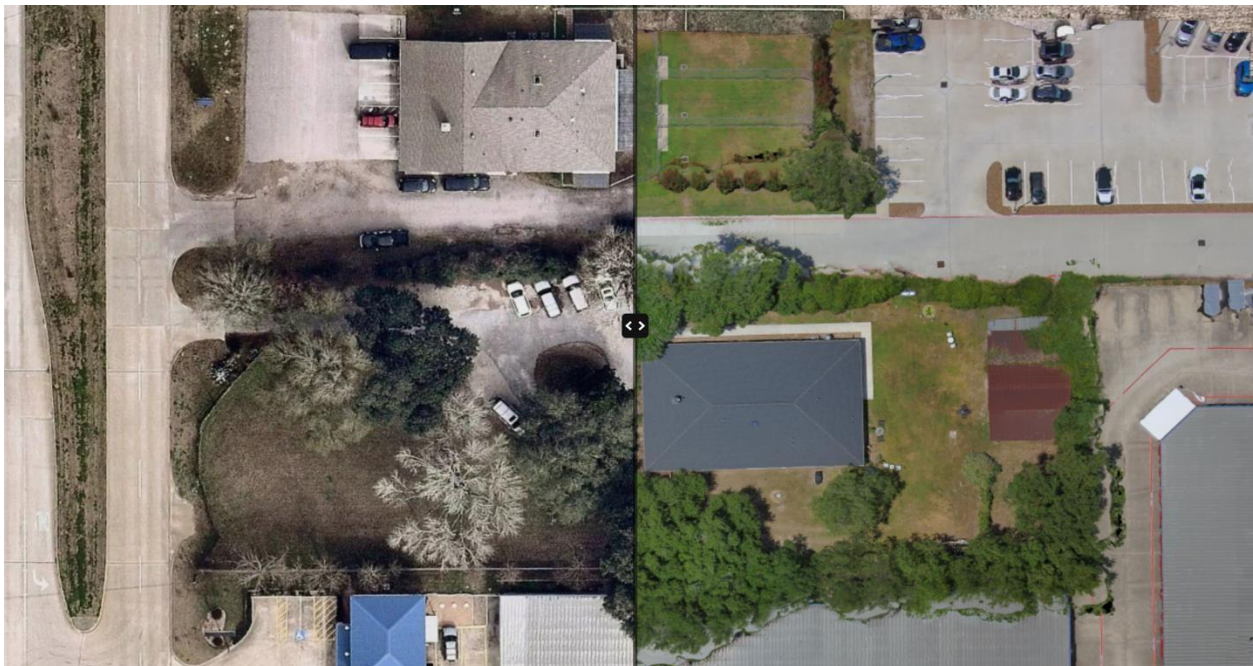


Figure 6. Comparison of open-source data to drone data (Author's elaboration).

The next sensor of significant interest is light detection and ranging, or LiDAR. LiDAR sensors send out pulses of lasers that are either reflected or refracted. The sensor system uses the return data to build a point cloud that can be rendered into 3D outputs. The LiDAR data, when combined with visual sensors, can create a photo-realistic image true to scale.

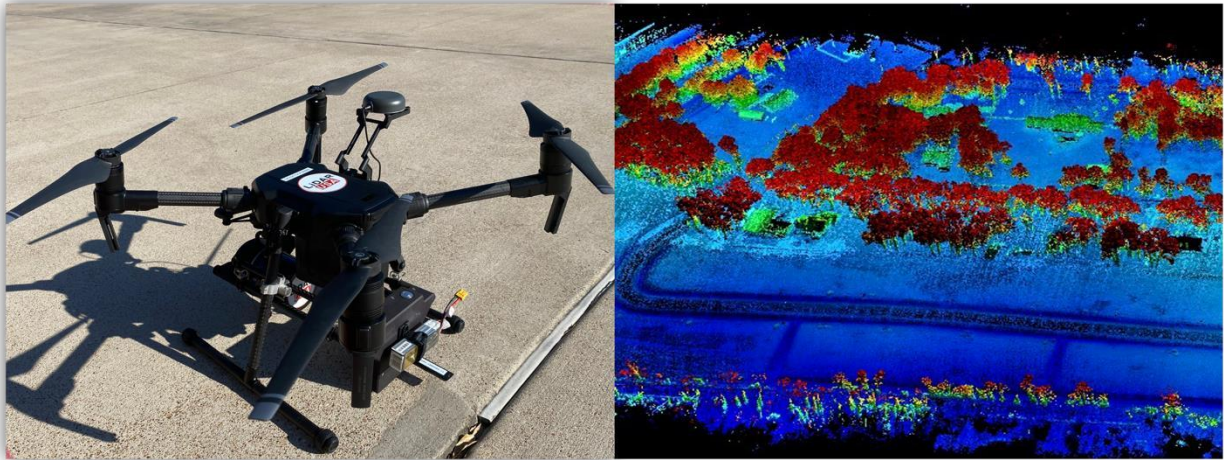


Figure 7. Example of a LiDAR equipped drone and the data captured over a large residential development area (Author's elaboration).

Figure 8 demonstrates the use of a handheld (iPhone13 Pro) LiDAR sensor to capture a model of the drone used by the author to complete the orthomosaic project previously discussed. The image on the left represents the LiDAR point cloud being processed, the center being the LiDAR and photo data rendered as a 3D model, and the right showing the ability to utilize the model for measurements or other analysis.

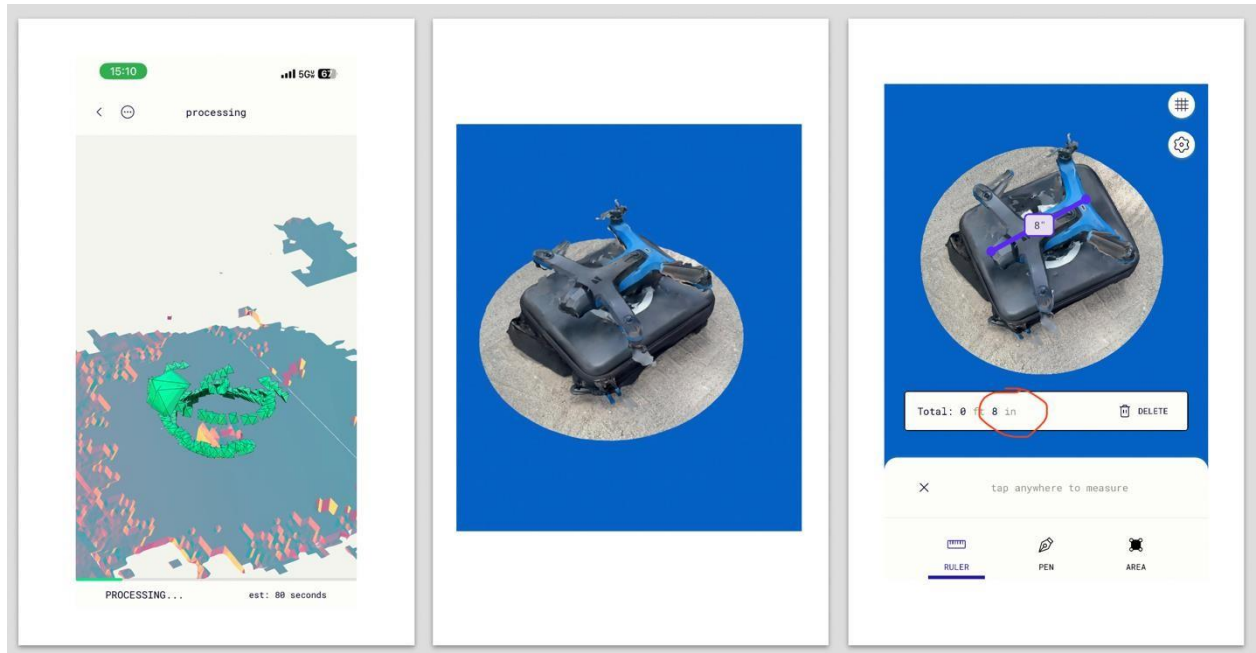


Figure 8. Mobile LiDAR capture and render for digital twin of drone (Author's elaboration).

As previously mentioned, LiDAR is already being used in healthcare to develop wayfinding tools. Integrating ground and aerial-based LiDAR across an organization allows expanded data sets to create full digital twins of facilities. Applying the previous two sensors further to security and safety one may consider applications including incident documentation or virtual and augmented reality training.

Figure 9 depicts a blend of LiDAR and visual data used to capture a notional crime scene at a clinical space. Capturing data from both handheld and indoor drones allows for the development of animated rooms and 3D photo-realistic overlays – ex. The dummy active shooter can be placed into the digital twin of a room based on specific scenarios.

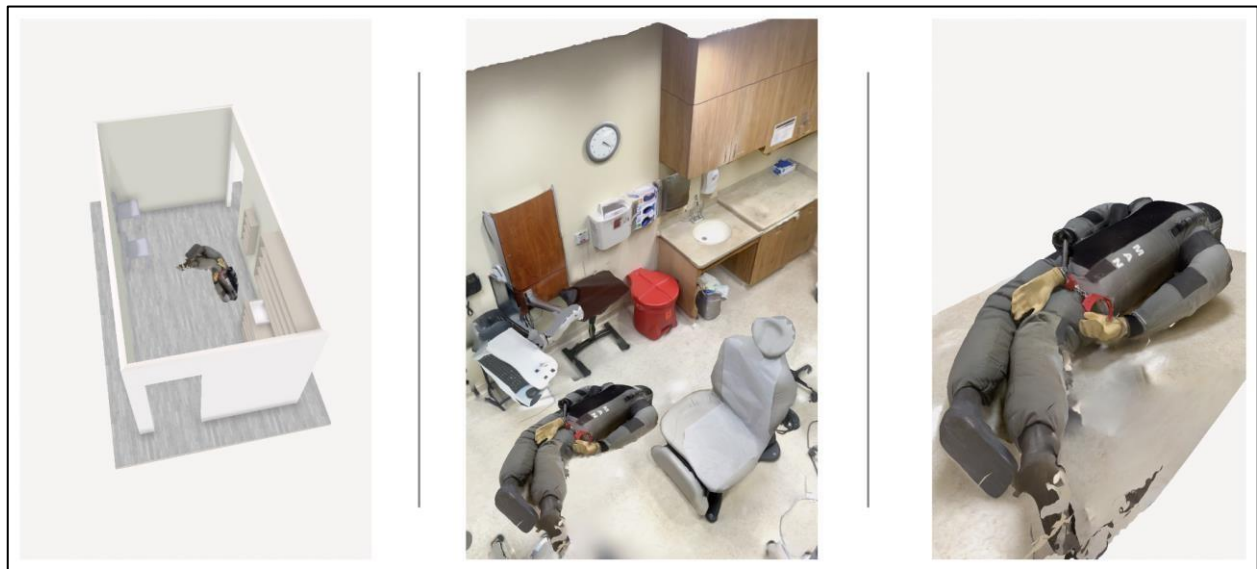


Figure 9. Example of overlaying LiDAR and visual imagery for clinical training and incident recreation (Author's elaboration).

The previous two use cases and capabilities demonstrated can be scaled for specific needs. High-rise rooftops, elevated platforms, and skybridges exist throughout the TMC campus. Critical systems such as HVAC, water and gas lines, and communications towers require constant inspections involving personnel. Employing drones to perform inspections mitigates, or even eliminates, certain occupational hazards resulting in less task time, reduced permit work, and decreased workplace injuries. Creation of digital twins using drones, and other technology integrations, promotes the ability to build awareness and develop realistic training.

Hazards exist across the TMC including hazardous materials, radiological devices, bulk fuel storage, and utility lines. Further, hazards exist to daily facility operations personnel such as confined spaces, high-elevation platforms, and response to critical alarms. Utilizing drones to perform or supplement as a tool could result in less intensive labor, reduced risk from putting staff on elevated scaffolding or other lift devices and reducing their exposure to potential hazardous materials or weather conditions.

Certain drone manufacturers have developed assets tied specifically to internal infrastructure inspections. Drones can be caged with pliable material allowing use in confined spaces. These drones, equipped with bright LED lights, high-definition cameras, and redundancies for control linkage and navigation systems allow for workers to remain outside of the confined area while inspecting interior elements.¹⁶ *Note: The utilization of drones solely for indoor applications does not require FAA certification or approval.*

¹⁶ <https://www.unmannedsystemstechnology.com/expo/indoor-drones/>

Sensors, such as thermal/infrared, can be used to conduct roof inspections.¹⁷ Optical gas imaging (OGI) cameras can detect emissions and gas leaks from elevated pipes, storage tanks, or other infrastructure.¹⁸ Air monitoring drones can help assess the environment your staff and patients are in, while serving as important response tools during hazardous material incidents.¹⁹

Several manufacturers have also expanded the autonomous nature of drones with permanent docking stations that can be installed across a campus, either in areas with frequent inspection needs or in areas lacking persistent security presence.²⁰ A campus the size of TMC is prone to both petty crime and felonious activity. Some institutions at TMC have piloted 'lone worker' programs that integrate GPS tracking through a phone application allowing an employee to activate panic alarms or report their location if concerned for safety.²¹

Figure 10 depicts a potential security use case for autonomous drones utilizing docking stations on pre-established emergency call boxes found around the TMC. These stations could be integrated with lone worker applications to aid dispatch in deploying the nearest drone to gain situational awareness. Further, docked drones could serve as sentries around sensitive sites such as research labs, radiological components, and data centers.

¹⁷ <https://ctleng.com/pioneering-the-use-of-drones-for-roof-inspections-and-thermal-imaging/>

¹⁸ <https://infraredcameras.com/industries-served/optical-gas-imaging/>

¹⁹ <https://news.mit.edu/2021/tackling-air-pollution-with-autonomous-drones-0624>

²⁰ <https://www.thedronegirl.com/2023/03/22/drone-docks-dji-dock/>

²¹ <https://interfacesystems.com/blog/lone-worker-safety-policy/>

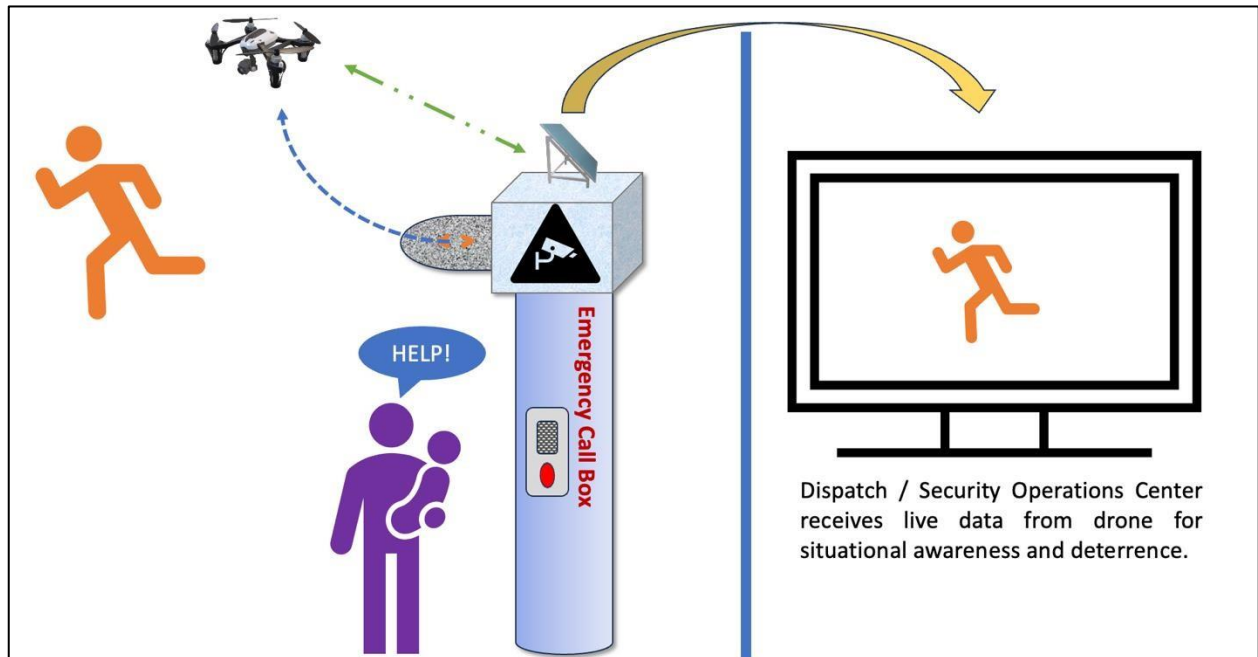


Figure 10. Representation of a docked drone station providing situational awareness to a dispatch center (Author's elaboration).

Drones provide efficiencies when integrated with the correct payloads and proper training. More frequent inspections may be conducted leading to improved prioritization of work orders based on trend analysis or actual detection of anomalies. The ability for first responders to use drones in response to alarms, such as leaks or criminal activity, decreases the hazards to the responders and the public.

One last, but increasingly important, element applicable to any use case or sensor system being deployed is data management. Small projects, such as demonstrated in this paper, may be completed using a device as small as a smart phone or your normal work laptop, especially if leveraging cloud-based SaaS programs. However, as the scale of projects increases, and the amount of data needing processing becomes overwhelming for typical business computers, developing methods for the management and use of data will become vital. Data integrity is vitally important whether for normal operations and maintenance, and especially for law enforcement or life safety events.

The next section of this paper will attempt to outline elements of successful drone programs in other industries and further challenge the healthcare industry to assess how best to use drones in the future.

4. Way Forward

4.1. Slow is smooth, smooth is fast.

One major issue facing any industry implementing a drone program is how does one go about introducing and scaling their use in a safe and effective way? An important first step may be to identify who is going to be responsible for the program. A drone program buried into a very isolated use case may prevent the organization from harnessing drones as tools with wide applications. Similarly, drone programs directed solely from the top of the enterprise may create too many layers of bureaucracy to make it worth a department's time.

In industries that already have aviation programs, such as oil & gas, it seems a natural fit. This could be seen as an opportunity for healthcare systems with air ambulance services to run drone operations as part of that existing aviation program. However, an alternate argument is that the technology, data being captured, and the ever-increasing autonomy of such systems tips to program to being better suited for facilities operations or other technology or engineering teams. One other place may be with security, or if part of your organization, a law enforcement entity. All of these options have benefits, but siloing a drone program under any specific department could be detrimental to future applications.

An option that appears much more suitable to ultimately ensuring the widest application of drone technologies is to blend multiple approaches together. If a corporation or system does not have any policies on drones, then it may consider bringing in third party contractors with a background in FAA regulations and legalities for insurance needs surrounding drone use.

Another step, when addressing the TMC specifically, could be to leverage existing partnerships between tenant institutions to create a layer of transparency, standardized language, and benchmarks towards success. Partnerships such as the Southeast Texas Regional Advisory Council (SETRAC) that focus on preparedness and response, TMC Innovation institute that is working to develop world-class technological breakthroughs in healthcare, and even the academic and research centers that already exist on campus through university affiliations can bring unique perspectives to such discussions.²²

Texas universities, many represented at TMC, have already established themselves as leading the pack in integration of drones across the nation. Research is being done on developing obstacle avoidance technology, geofencing drone 'highways' in metropolitan areas, and further defining airworthiness standards needed to ensure air to air and air to ground safety.²³

²² <https://www.tmc.edu/innovation/>

²³ <https://www.tamucc.edu/lone-star-uas/research/index.php>

There are leading insurance and liability providers already well adapted to drone operations within critical infrastructure. These entities can assist in framing the discussion with corporate risk, compliance, and policy leaders while establishing cost-effective ways to transfer business risk over policies scaled to the use cases.²⁴

The bottom line is that drones are not new to Houston, to Texas, or even to healthcare. While there are still many unknowns within the drone ecosystem, established precedent from other industries, coupled with the innovative minds in healthcare, should persuade at least some of the organizations to consider such technology as part of their path forward.

4.2. Conclusion

It is the hopes of this author that the potential for drone use in the TMC, and more broadly, healthcare in general is not a far-fetched idea. Drones are already used across many industries that healthcare relies on. Drones and other robotic technologies are already being used in healthcare to some degree. As previously stated, technological advancements can be scary and complicated. This is especially true when the technology integrates so many other technologies from hardware to software.

Lessons learned from researching this paper and observing actual uses of drones internationally can be applied. The top five take ways a reader should consider:

1. Does the organization already have policies, procedures, insurance, and other elements of a drone program laid out?
2. What partnerships exist, or can be developed, to frame the discussion and set a foundation for integrating this technology?
3. Are drones already being used by others to support activities our organization performs?
4. What data requirements already exist that could be more efficient, accurate, and/or more safely obtained via the use of drones?
5. Are there “quick wins” that our organization can pursue internally or with third parties to demonstrate the capabilities of drones?

²⁴ <https://www.global-aero.com/unmanned-aircraft-safety-risk-management-and-insurance/>

Author's Bio

Bryce Allen is a former military officer in the US Army and Texas Army National Guard as a helicopter pilot and operations officers. Bryce's military service intersected with emergency management and continuity operations including as a Domestic Operations liaison officer and pilot during numerous incidents across Texas. In 2013 he deployed as the contingency planning officer supporting non-combatant evacuation operations and regional security plans across the Middle East.

Upon leaving the military after nine years of active-duty service, Bryce served as the CoChair of a Local Emergency Planning Committee in Vermont while working as the Security & Safety Coordinator at a ski resort. He returned to Texas in 2018 as an emergency management consultant and program manager for integration of unmanned aircraft in response applications. Bryce served as an Air Operations Branch Director and Planning Section Chief for multiple international responses to spills, hurricanes, and Covid-19. He came to the University of Texas MD Anderson Cancer Center in 2021 and is currently the Manager of Emergency Management. Bryce has presented on operational continuity at the 2022 SETRAC Regional Healthcare Preparedness Coalition Symposium.

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Note: The author knows of no competing interests to declare. The author is affiliated with The University of Texas System, Association of Continuity Professionals, International Association of Emergency Managers, Disaster Recovery Institute, and Sam Houston State University Institute of Homeland Security.

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