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Using Drones to Study Human Beings: Ethical and Regulatory Issues

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Abstract

Researchers have used drones to track wildlife populations, monitor forest fires, map glaciers, and measure air pollution but have only begun to consider how to use these unmanned aerial vehicles to study human beings. The potential use of drones to study public gatherings or other human activities raises novel issues of privacy, confidentiality, and consent, which this article explores in depth. It argues that drone research could fall into several different categories: non-human subjects research (HSR), exempt HSR, or non-exempt HSR. In the case of non-exempt HSR, it will be difficult for institutional review boards (IRBs) to approve studies unless they are designed so that informed consent can be waived. Whether drone research is non-HSR, exempt HSR, or non-exempt HSR, it is important for investigators to consult communities which could be affected by the research.

Keywords

drones; research; privacy; confidentiality; consent; ethics; regulation

Introduction

Unmanned aerial vehicles, a.k.a. drones, are being increasingly deployed in various scientific disciplines, including ecology, wildlife biology, agronomy, and geology (Anderson and Gaston 2013, Marris 2013, Schiffman 2014). An advantage that drones offer as research tools is that they can inexpensively and safely collect data in remote or difficult to reach areas (Marris 2013). Scientists have used drones to track wildlife populations, monitor forest fires, map glaciers, and measure air pollution (Koh and Wich 2012, Marris 2013, Paneque-Gálvez et al. 2014). The use of drones in non-research activities has generated considerable controversy, however. Law enforcement use of drones for surveillance has raised issues concerning privacy and unreasonable searches (Cavoukian 2012, Finn and Wright 2012), and military use of drones has led to concerns about civilian casualties and accountability for

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unmanned weapons (Strawser 2013). People are also concerned that drones pose a threat to air traffic, and state and national governments have begun issuing regulations for safe drone use (Pogue 2015). These and other public concerns about drones may impact the use of these vehicles in research activities.

Researchers are only beginning to explore how drones might be used to study human activities (Birtchnell and Gibson 2015). Investigators at North Carolina State University and the Research Triangle Institute are partnering to develop ways of using drones in social science research (Research Triangle Institute 2015). For example, drones may provide accurate data on crowd sizes at public gatherings or the agricultural or hunting activities of human populations. Even when drones are not deliberately used to study human populations, the use of drones (to study wildlife, for example) may inadvertently capture data on human beings. Collecting data on human beings by means of drones raises issues of privacy, consent, and research oversight which need to be addressed. In this article, we will consider the ethical and regulatory issues related to using drones to conduct research on human beings.

Ethics and Regulation of Research with Human Subjects

The central ethical dilemma in human subjects research (HSR) is the potential conflict between protecting the rights and welfare of individuals and advancing scientific knowledge (Resnik 2018). The US and other countries have developed ethical and legal frameworks pertaining to HSR in response to abuses of human beings in research, such as the Nazi experiments on concentration camp prisoners and the Tuskegee Syphilis Study (Emanuel et al. 2000, Resnik 2018). Although we will focus on US oversight of HSR in this article, most of the conclusions we draw will apply to other countries with similar laws. This article will focus on regulations and guidelines most relevant to HSR in which drones are used to collect data.

A highly influential document published in 1979 known as the *Belmont Report* provides the ethical foundation for US federal regulation of HSR (National Commission for the Protection of Human Subjects of Biomedical or Behavioral Research 1979). According to the authors of the *Report*, three ethical principles apply to HSR: respect for persons, beneficence, and justice. Respect for persons implies that individuals who are capable of making autonomous decisions should have the right to consent to research participation and that individuals with compromised autonomy should be protected from risks; beneficence entails that the risks of research should be minimized and the benefits should be maximized, and justice implies that the benefits and burdens of research should be distributed fairly. Since these principles may conflict in some situations, for example, when data sharing threatens confidentiality, the authors of the *Report* held that one should judiciously balance and prioritize the principles when deciding whether a given study is ethical. The authors of the report also distinguished between research, which aims to develop generalizable knowledge, and medical therapy, which aims to benefit patients (National Commission for the Protection of Human Subjects of Biomedical or Behavioral Research 1979).

In 1981, federal agencies adopted regulations that incorporated many of the *Report's* insights. The regulations consist of the Food and Drug Administration (FDA) Regulations and regulations adopted by 16 federal agencies known as the Common Rule. The Common Rule applies to federally funded HSR; the FDA regulations apply to HSR involving FDA-regulated products, such as new drugs, biologics, or medical devices. These two sets of regulations are virtually identical with respect to issues involving review and oversight of human studies and informed consent rules. Many academic institutions have decided to apply the Common Rule to all HSR conducted on campus, irrespective of the source of funding (Resnik 2018). Two agencies that have adopted the Common Rule, the Environmental Protection Agency (EPA) and the Department of Education (DEA), have also developed special protections for vulnerable populations. This article will focus on the Common Rule, because most drone research involving humans is likely to be funded by entities that employ those regulations. The principles proposed here can be adapted in cases where other regulations apply.

The Obama Administration revised the Common Rule in 2017 (Department of Homeland Security et al. 2017), but the Trump Administration has delayed the effective date of these changes until July 19, 2018 (Department of Health and Human Services 2018). Since our paper may not appear in print until after the revisions become effective, our references will cite the new version of the Common Rule.

The Common Rule requires institutions to establish committees, known as institutional review boards (IRBs), to oversee HSR. IRBs have the authority to review, approve/disapprove, require changes to, and audit research. IRBs consist of individuals of varying backgrounds and appropriate expertise and must include at least one non-institutional member and one non-scientific member (Department of Homeland Security et al. 2017). To approve a research study, an IRB must determine that it meets the following criteria:

1. Risks to subjects are minimized...
2. Risks to subjects are reasonable in relation to anticipated benefits, if any, to subjects, and the importance of the knowledge that may reasonably be expected to result...
3. Selection of subjects is equitable...
4. Informed consent will be sought from each prospective subject or the subject's legally authorized representative...
5. Informed consent will be appropriately documented...
6. When appropriate, the research plan makes adequate provision for monitoring the data collected to ensure the safety of subjects...
7. When appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality¹ of data...

¹Privacy is a broader concept than confidentiality. Privacy includes the right to be protected from unwanted invasions of one's body, private space, or private information. Confidentiality refers to the protection of private information (Hodge and Gostin 2008).

8. When some or all of the subjects are likely to be vulnerable to coercion or undue influence, such as children, prisoners, pregnant women, mentally disabled persons, or economically or educationally disadvantaged persons, additional safeguards have been included in the study to protect the rights and welfare of these subjects (Department of Homeland Security et al. 2017 at 45 CFR 46.111).

The Common Rule includes definitions, rules, and procedures for proportioning research oversight to the degree of risk. The most basic part of risk-based oversight is determining whether a data collection activity should be classified as HSR, since the Common Rule does not apply to activities that are not HSR. The Common Rule defines research as “a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge” (Department of Homeland Security et al. 2018 at 45 CFR 46.102(l)).

Assuming that an activity counts as research, the next question to ask in determining whether it qualifies as HSR is whether it involves human subjects. The Common Rule defines a human subject as “a living individual about whom an investigator (whether professional or student) conducting research: (i) Obtains information or biospecimens through intervention or interaction with the individual, and uses, studies, or analyzes the information or biospecimens; or (ii) Obtains, uses, studies, analyzes, or generates identifiable private information or identifiable biospecimens (Department of Homeland Security et al. 2017 at 45 CFR 46.102(e)(1)).”

The Common Rule clarifies that private information:

[I]ncludes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place, and information that has been provided for specific purposes by an individual and that the individual can reasonably expect will not be made public (e.g., a medical record). Identifiable private information is private information for which the identity of the subject is or may readily be ascertained by the investigator or associated with the information (Department of Homeland Security et al. 2017 at 45 CFR 46.102(e)(5)).

Under the Common Rule, research that collects information in a context in which someone can reasonably expect that observation or recording is taking place would not be HSR. For example, a study that collects data about people shopping at a department store would not be HSR because shoppers reasonably expect that observation or recording is taking place since department stores have clearly marked surveillance cameras. Research that collects information which does not individually identify people would also not be HSR. For example, a study that collects data on the personal income, gender, and race of home mortgage applicants but does not collect names or other identifying information would not be HSR.

If a study qualifies as HSR, it may still be classified as exempt from the Common Rule. We will consider only the exemption most relevant to HSR involving drones as data collection tools:

Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 11.111(a)(7)(Department of Homeland Security et al 2017 at 45 CFR 46.104(d)(2)).

If a study is not exempt, it may still not require review by the full IRB, since an IRB Chair or designated IRB member can review minimal risk HSR on an expedited basis. The Common Rule defines minimal risk as: "the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests (Department of Homeland Security et al. 2017 45 CFR 46.102(j))." Even when HSR undergoes expedited review, the reviewer must still determine whether it meets the criteria for approval (noted above).

The Common Rule includes informed consent provisions that specify types of information that must be shared with subjects, such as the nature of the research, the procedures used, risks and benefits of the research, alternatives to participation, confidentiality protections, and whom to contact with questions; and conditions and procedures for obtaining and documenting consent (Department of Homeland Security et al. 2017). The Common Rule also includes exceptions to the informed consent requirements. An IRB may waive or alter some or all of these requirements if it determines that:

- (i) The research involves no more than minimal risk to the subjects; (ii) The research could not practicably be carried out without the requested waiver or alteration; (iii) If the research involves using identifiable private information or identifiable biospecimens, the research could not practicably be carried out without using such information or biospecimens in an identifiable format; (iv) The waiver or alteration will not adversely affect the rights and welfare of the subjects; and (v) Whenever appropriate, the subjects or legally authorized representatives will be provided with additional pertinent information after participation (Department of Homeland Security et al. 2017 at 45 CFR 46.116(e)(3).

Applying the Common Rule to Drone Research

In applying the Common Rule to drone research, the key questions to ask are whether studies fall into the category of HSR and, if so, whether they are exempt or not. If studies do not qualify as HSR, the Common Rule does not apply to them. An additional question to

consider in cases of non-exempt HSR is whether informed consent can be waived. Assuming that drone data collection activities constitute research, the crucial criterion under the Common Rule for determining whether a study counts as HSR is whether it collects identifiable private information. Most people would agree that information collected in a public setting (such as a park or commercial area) is not private, but what about information collected when flying over someone's private property? Human subjects could be involved if drones collect identifiable private information about people. For example, a drone equipped with a camera could record a person's behavior on his or her private property. If the camera records a picture of the person's face, then this would make that information identifiable.

Private Information

Would personally identifiable information collected when a drone flies over someone's property be considered private information? The US Supreme Court has ruled on some cases that indirectly address this question. The 4th Amendment to the U.S. Constitution protects individuals against unreasonable searches or seizures. A key test in determining if a search is reasonable (or not) is whether it violates a person's reasonable expectation of privacy. What counts as a reasonable expectation of privacy depends on societal values (California v. Ciraolo 1986). If there is no reasonable expectation of privacy concerning some information about a person, then law enforcement does not need a warrant (or other legal justification) to collect that information. In 1986, the U.S. Supreme Court ruled that law enforcement's use of a private airplane to photograph hidden marijuana plants growing in a person's backyard without a warrant did not constitute an unreasonable search because the airspace above a person's private property is public and the plants were in plain view (California v. Ciraolo 1986). However, the court ruled in 2001 that using a thermal imaging device to collect information from above a person's home constituted a search requiring a warrant because the imaging device acquired information that was not in plain view (Kyllo v. United States 2001). These rulings imply that using a drone to collect information on private property without a warrant does not constitute an unreasonable search as long as the information is in plain view. Many commentators and organizations have expressed concerns about these legal rulings (Cavoukian 2012). The American Civil Liberties Union (ACLU) has recommended that to protect privacy there should be strict rules in place governing the use of drones for government surveillance (Stanley and Crump 2011).

Based on the legal rulings mentioned above, one could conclude that drone research that collects information in plain view on private property does not involve human subjects because the information is not private. It is worth noting that the Common Rule frames the privacy issue somewhat differently than the Supreme Court. Under the Common Rule, the question is not "is the information collected in plain view?" but "can one reasonably expect that no observation or recording is taking place?"² However, one might argue that these questions, though worded differently, are not substantially different, since if information can be collected from plain view one cannot reasonably expect that no observation or recording is taking place. If I dance in the nude in my house with my windows open, it would be

²We note that the Common Rule revisions do not change the definition of private information (Department of Homeland Security et al. 2017 at 45 CFR 46.102e).

reasonable for me to assume that my naked body is in plain view from outside and that someone could observe or photograph it.

Although the Supreme Court's interpretation of privacy with respect to the possibility of police surveillance implies that using drones to photograph people on their private property for a research study is not HSR, one might argue that the privacy standards for HSR should be higher than those for law enforcement. One could formulate an argument for this position based on two premises: 1) infringements on individual rights should be proportional to the level of expected social value (Childress et al. 2002); and 2) law enforcement has greater social value than scientific research.

An argument for the second premise would be that law enforcement more directly and immediately impacts people's lives than scientific research. Although scientific research involving human subjects often has numerous socially valuable impacts (e.g. medical treatments, improvement in public health, etc.), it may take years for scientific research to generate practical applications, yet police surveillance activities may lead directly to the apprehension of criminals who pose a direct threat to society. "Reasonable expectations of privacy" should therefore be higher in research than in law enforcement and using a drone to collect identifiable information about a person on his or her private property should be classified as HSR.

There are two potential objections to this argument. First, one might claim that law enforcement is not more socially valuable than scientific research because the practical applications of research, though usually slow to unfold, often have high impact. For example, social science research on large public gatherings could lead to improvements in crowd containment methods, which could save hundreds of lives. Second, one could argue that reasonable expectations of privacy should not vary with the context of the data collection. The standards should be the same in police surveillance and in scientific research because using context-dependent standards could lead to inconsistent and confusing legal rulings and ethical guidance.

As one can see, there are coherent arguments on both sides of the issue of whether drone data collection over private property constitutes an infringement on privacy such that it should be regulated as HSR. However, there may be technological means of dodging these ethical and legal issues concerning privacy. Researchers could equip drone digital cameras with facial recognition software programmed to redact human facial images from the data. Redaction could occur by blurring, pixelating, masking, or scrambling (Senior and Pankanti 2011). A potential drawback of this technological solution is that the software might also obscure other important features that researchers are attempting to record, which would compromise its usefulness as a form of data collection. Also, the software might inadvertently fail to redact facial images in some cases (Senior and Pankanti 2011). Further developments in facial image redaction methods may help to address these issues.

Exempt Research

Assuming that some drone research on human behavior would be treated as HSR, the next question to ask would be whether it would qualify as exempt. Drone data collection does not involve educational tests, survey procedures, or interviews, but it might involve the observation of public behavior if the human subjects are in a park, city street, or other public place. Under the Common Rule, this exemption applies only if the data is recorded in such a way that individuals are not personally identifiable, or, if they are identifiable, disclosure of their information outside of the research context would not reasonably place them at a risk of various harms, such as criminal or civil liability, or damage to their financial standing, employability, or reputation; or appropriate confidentiality protections are in place (Department of Homeland Security et al 2017 45 CFR 46.104(d)(2).). Observing behavior that occurs on private property would not qualify for this exemption, however.

Whether a drone study would qualify for this exemption depends on the type of data collection methods used and the type of data that would be collected. If the investigators use data collection methods that redact facial images (see discussion above), then the research would a) not qualify as HSR, or b) would qualify as exempt HSR. If the data collection methods do not redact facial images and individuals can be personally identified, the research could qualify as exempt HSR (under the old version of the Common Rule) if the information obtained would not reasonably place them at a risk of various harms, such as criminal or civil liability, and so on. While studies that use drones to collect data are not likely to place people at risk of various harms, it is conceivable that a drone could capture an image of a person engaging in illegal behavior (such as property destruction) that would place them at risk of criminal or civil liability.

Thus, an IRB could classify a drone study that involves only observation of public behavior as exempt HSR or as not HSR, because the data collected would not be private. If an IRB determines that a study is not HSR, then the exemption issue never arises. Given these implications, we find the “public observation of behavior” exemption to be logically self-contradictory, because if a study involves public observation it is not HSR, so it cannot be exempt HSR. IRBs may have to work through these logical inconsistencies when evaluating proposed studies involving drones.³

Expedited Review

If a drone study is treated as non-exempt HSR, it might qualify for expedited review as a study that imposes no more than minimal risk on human subjects. While it is conceivable that a drone crash could injure human subjects, the chief risks of drone research would relate to the potential loss of confidentiality or privacy if the data collected by drones is improperly disclosed. For example, people might face criminal liability if their behavior is disclosed to law enforcement officials. Indigenous populations living in remote areas might face significant risks if their hunting, religious, or cultural practices are publicly released (Whyte

³It is worth noting that this logical inconsistency is not unique to drone research but occurs whenever one applies the Common Rule to observations of public behavior.

forthcoming). The best way to protect against risks like these is to use security measures, such as encrypting data, removing personal identifiers, and controlling access. In some cases, it might also be necessary for researchers to formulate a plan for handling the disclosure of sensitive or incidental findings (Wolf et al. 2008). When these measures are in place, the risks of improper disclosure of information can be regarded as minimal in most cases. The relevant comparator for minimal risk would be the risks of “daily life” standard in the definition cited above. In daily life, we often face risks related to inadvertent loss of privacy or confidentiality. We routinely share private information with banks, insurers, health care providers, and other entities, and take the risk that our confidentiality may be breached as the result of hacking, employee mistakes, and other security problems. The privacy/confidentiality risks faced by human subjects in drone studies would be similar to these risks.

While a non-exempt drone study would probably be classified as minimal risk and therefore be eligible for expedited review, an IRB chair might decide to send the study to the full board for review, due to the novelty of the privacy and confidentiality issues related to the use of drones in research. The decision to send a minimal risk drone study to the full board for review would be within the chair’s prerogative, since the regulations permit but do not require minimal risk studies to be reviewed on an expedited basis. One advantage of sending a drone study to the full board would be to get the input from non-scientific and non-institutional members on the IRB, who might have a different perspective on the ethical issues than scientific or institutional members. They might be more concerned about invasions of privacy or violations of confidentiality, for example.

Waiving Informed Consent

If an IRB treats a drone study as non-exempt HSR, then it must determine whether informed consent will be sought. Obtaining informed consent from individuals in drone studies could be an onerous and practically impossible task, since an indefinite number of potential human subjects would need to be contacted. For example, it would probably be impossible to obtain consent from everyone in a crowd at a public area or all residents of homes in a community. Fortunately, the Common Rule allows an IRB to alter or waive consent requirements if it makes specific determinations, described above (Department of Homeland Security et al. 2017 at 45 CFR 46.116(e)(3)).

Two of the determinations are likely to be easily met, since drone research is arguably minimal risk in most cases (if adequate confidentiality protections are in place) and not implementable without a waiver or alteration of consent. Unconsented drone research probably would not adversely impact the rights or welfare of the research subjects, due to its low risk level. There would probably be no need to provide subjects with additional information after participation, since it might not be possible to identify all (or even most of the subjects) in many cases.

Community Consultation

Whether drone research is treated as not HSR, exempt HSR, or HSR, it likely would be conducted without consent from the participants, due to the practical problems with obtaining their permission, noted above. However, in most cases it would still be prudent for researchers to consult with community members before the research takes place to assure them that their privacy, confidentiality, and welfare will be protected. Researchers could inform community members about proposed studies and methods used to protect privacy and confidentiality, such as redaction of personal identifiers and security measures, and give community members an opportunity to ask questions. These consultation activities could also allow community members to inform the researchers about sensitive information that might be collected and that would be important to handle with care. This is likely to be especially important in international contexts where the researchers might not understand all the cultural concerns of the communities being observed. Community consultation is not a substitute for informed consent, but it can help to establish trust and cooperation among community members and make researchers more sensitive to community concerns (Dickert and Sugarman 2005).

Inadvertent Human Subjects Research

It is important to note that when scientists use drones to study wildlife, pollution, crops, or other non-human phenomena they might inadvertently collect data on human beings. For example, a drone that photographs animals in a forest might also take pictures of people. If these images can be used to identify individuals, then data collection might be considered HSR for reasons stated above. Scientists who are conducting research that might inadvertently capture individually identifiable human data should consider the ethical/regulatory issues implicated by their studies. They may be able to manage the HSR issues by using technological means (such as redaction of facial images) to avoid collecting individually identifiable human data. If they do not implement this strategy, then they may have to submit their research for approval by an IRB (or other oversight committee), which may decide that it is not HSR, is exempt HSR, or it is non-exempt HSR but consent can be waived.

Conclusion

Scientific research that uses drones to collect information on human beings raises novel issues pertaining to privacy, confidentiality, and consent.⁴ Investigators who conduct this research should submit their proposals to an IRB or other appropriate oversight committee to ensure compliance with ethical and regulatory standards. IRBs should determine whether research involving drones counts as HSR, whether it is exempt, and whether informed consent can be waived. Investigators should take appropriate steps to protect the privacy and confidentiality of individuals who may be monitored by the research, whether or not they are considered to be human subjects or would be asked to provide consent. Investigators who

⁴It is worth noting that drone research raises some issues beyond the scope of this paper. For example, an authoritarian government might use drone research to gather information to stop or disrupt peaceful demonstrations. However, such a government would probably not be concerned about protecting the rights and welfare of human subjects in any case.

are conducting drone research involving human beings may also wish to consult with community members prior to implementing their studies to secure their cooperation and trust and assure them that their privacy and confidentiality will be protected. Investigators who are using drones to study non-human phenomena should also consider whether their research may inadvertently collect data that identifies individuals and seek appropriate review and oversight or their studies.

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