Autonomous Indoor Mapping and Navigation of a 3D Printed Robot
(Technical Paper)

Unmanned Vehicles as Weapons Against Terrorism
(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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I. General Problem

How are unmanned vehicles utilized to achieve military goals?

Unmanned vehicles provide the means to execute front line military operations without placing the lives of soldiers in danger. The use of unmanned vehicles, or drones, has quickly gone from abnormal to the new normal, with extensive forces operated by the U.S. armed forces and covertly by the CIA. As with any emergent technology, the implications of such widespread adoption are largely unknown. The topics presented here are only part of a larger problem of predicting what the consequences of drone use will be, and how they should be used to best achieve the goals of foreign affairs.

II. Technical Research Problem: Autonomous Indoor Mapping and Navigation of a 3D Printed Robot

Development of a small robotic vehicle to provide autonomous indoor mapping abilities for the purpose of safe and efficient reconnaissance.

The MITRE Corporation has developed a prototype for a low-cost, 3d-printed robot for intelligence, surveillance, and reconnaissance applications. Such a system can be easily constructed, repaired, and modified by an operator in the field, without needing to stock a large inventory of parts. After constructing one of these robots, an operator would typically deploy it in an indoor environment and use it to explore the space. The purpose of this exploration is to create a map of the space and save the locations of objects or people of interest, while keeping the soldiers out of danger.

Our team has been tasked with updating this prototype's functionality to prepare it for a mission on the field. Currently, the robot creates a two-dimensional map while being controlled

by an operator from line of sight, and its autonomous capabilities are limited to head-on collision prevention. Each of these elements is an opportunity for improvement. First, line of sight operation is a severe limitation for keeping soldiers out of dangerous situations, so we will create the ability to control the robot remotely by investigating a first person view option that is robust in the face of latency issues. Second, the current 2D mapping technology creates a disconnect between what the operator sees and what the robot catalogs, which could detract from the meaningfulness of any saved locations on the map. To eliminate this disconnect, we will consider investing in an infrared camera to supplement the 2D mapping with 3D images of what the robot has seen. Third, stopping before a collision is a useful feature, but it has the potential to be frustrating to the operator and inhibit efficient exploration. Our goal for this stage is to program the robot to adjust its course to avoid barriers before it is on top of them, which is a step towards the ultimate project goal of automated reconnaissance.

All of these hopeful improvements will come as a result of integrating the robot's existing functional code base with various packages published for the Robot Operating System (ROS). One of the key packages is Google's cartographer, an algorithm that provides simultaneous localization and mapping in either a 2D or a 3D space. Once we are confident in the mapping capabilities, additional research must be performed surrounding networking principles and autonomous steering algorithms for communication and control. All developments will be tested in the Link Lab at the University of Virginia, where various blocks and furniture items will be arranged into arenas for the robot to explore. Testing will begin with the baseline functionality of the existing prototype, and compare each additional iteration to assess overall performance and shortcomings.

III. STS Research Problem: Unmanned Vehicles as Weapons Against Terrorism

Understanding the implications of the United States drone program as a counterterrorism strategy.

Introduction

Military strategy has been shaped by many disruptive technologies from automatic firearms and missiles, to the atom bomb, to satellite imaging. The most recent of these technologies are unmanned aerial vehicles, also known as drones. The dominant politico-military rationale for the use of drones in war is that the "drone stare"—a video feed in near real-time—allows the operator to see and strike with "surgical precision," not only minimizing civilian casualties but also eliminating the risk to one's own soldiers (Sandvik, 2015, p.55). These affordances of drone technology have already reshaped the socio-technical system of warfare and are pulling policy along with it.

The use of drone strikes for targeted killings began as a counterterrorism strategy under President Bush and expanded during President Obama's first term to non-war zones. While this technology has been effective in eliminating some high value targets, there are numerous unintended effects on other counterterrorism goals, such as removing extremists from their support systems or building the capacity of local governments. Investigation of case studies in Pakistan, Yemen, and Somalia will provide a comprehensive understanding of the impact of drone use by contrasting both the U.S.'s stated counterterrorism goals with the practice of targeted killing and the stated policy of limiting drone strikes and the practice of extending them to counterinsurgency efforts.

Background

In his second year in office, President Obama stated that in order to protect the US "we must use all elements of our power to defeat [al Qaeda and its affiliates] (Obama, 2009, n.p.). The drone became the weapon of choice, as he oversaw 355 drone strikes over the next few years (Cole, 2016, n.p.). Political and military leaders praised this weapon for being both effective and moral to an unprecedented degree, subscribing to what Hugh Gusterson terms "drone essentialism" – the assumption that the technical capability of drones to discriminate determines their use in practice, therefore sparing civilian casualties is inherent in the technology (Gusterson, 2016, 92–93). This is a flawed view because it fails to take context into account. The US gives the impression that drones are used for "personality strikes", in which the target comes from a known list of terrorists, when in actuality most drone strikes are "signature strikes", in which individuals are targeted because they exhibit the appearance or behavior associated with insurgents (Klaidman, 2012, n.p.). This profiling becomes more difficult in a war in which the enemy does not wear uniforms, so any male of military age is considered a militant unless there is evidence proving otherwise (Hamid, 2013, n.p.). These definitions along with other factors have led to far more casualties than US officials will admit, but the Bureau of Investigative Journalism estimates 411 to 884 civilians have died in US drone strikes in Pakistan in 2011 alone (Hamid, 2013, n.p.).

The surprising number of casualties is part of a larger problem with the drone strategy that lies in its inability to support friendly relationships with the Muslim world. To the people on the ground in targeted areas, the seemingly randomness of the drone strikes as well as their tendency to linger overhead for hours or days creates a well-founded fear of the US drones, one that often exceeds the fear of the terrorists among them (Gusterson, 2019, n.p.). Additionally,

drone strikes against al Qaeda and the Taliban have been found to incite retaliation terrorist attacks against civilians (Jaeger & Siddique, 2018, n.p.). This does not bode well for the Muslim view of America. Yemeni journalist Farea al-Muslimi wrote, "With the public frenzy over the planes hovering over Sanaa and the rapid-fire drone strikes in the countryside, any remaining credibility of the US government's stated intentions to take a comprehensive approach to Yemen's economic and political development has now evaporated" (Gurcan, 2013, p.163). Establishing good will in the Muslim world is critical if the US wishes to improve the capacity of middle eastern states to counter terrorism on their own, but these relationships may be undermined if drone use is not limited.

Late in his second term, president Obama released standards for drone strikes outside zones of armed conflict, limiting the power of drone strikes while simultaneously cementing it as a strategy for the U.S. and other nations around the world. The administration consistently painted its practices as complying with international laws of war, arguing targeted killings of combatants are justified in the context of war as a mechanism of self-defense. However, because the war on terror is not confined to a battle between states but spreads as far as al Qaeda and its affiliates, novel interpretations of law must be made. The norms created by the US have implications for our own counterterrorism goals, but are also important as precedent for all nations pursuing drone technology (Birdsall, 2018, n.p.).

Evidence and Data Collection

This research will investigate three case studies of counterterrorism and counterinsurgency efforts in Pakistan, Yemen, and Somalia. Multiple sources of scholarly literature and investigative journalism will be used to determine effects of drones in these countries, including the number of targets killed, the number of casualties, the impact on terrorist

activity, and the impact on the local opinion of governments. It will also be necessary to investigate the goals, publicized information, policy changes, and public opinion of both the military and the CIA counterterrorism operations.

Methods for Data Analysis

The above data will provide the means to analyze the mutual shaping of drones and military strategy. The three case studies will enable a timeline analysis of national goals and the use of targeted drone killings, which will have two major insights. First, what are the factors that contribute to drone policy? For example, it may be possible to determine if a specific decision to limit drone strikes was motivated more by ineffectiveness in the region or public disapproval of the strikes from home. Second, if the increased presence of drones has the effect of creating distrust and undermining the strategies of the United States. Ultimately, it would be beneficial to understand what the United States can expect from the drone programs in terms of policy changes and effects on terrorism.

Conclusion

Although the use of drones is becoming commonplace in areas of military operations, surveillance, and security, it is still a relatively new technology. The use of drones for targeted killings in the middle east is an example of policy and strategy reacting to technology practice, which could have dangerous implications for American people and the populations caught in our cross hairs. As a trend setting international power, the decisions of the US will influence the practice of many other nations in the coming years, so they should not be taken lightly.

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