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A Critical Review on Unmanned War Vehicles

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Abstract: The usage of unmanned war vehicles is increasing rapidly in the recent past due to the inherent advantages like consistency, reduced human risk factor, repeatability, improved efficiency and productivity etc. The current research reviews the evolution of unmanned vehicles and the possibility of their use in war zones so as to reduce the human involvement in warfare. The scope of the review also includes the discussion of benefits, limitations and applications of unmanned war vehicles.
Keywords: Unmanned, Capability increase, Security Vulnerabilities.

I. INTRODUCTION

Military technology is a field driven by change, the constant pursuit to be better, faster, and stronger. Certain technological achievements like guns and planes have happened in the purview of the public and have revolutionized the world of war as we know it. Yet many technological changes have occurred under the radar, in military labs and private test fields, with the majority of citizens unaware of the leaps and bounds of progress. Robotics is one such modern military technology advancement that has largely escaped public attention to date. Combining the most advanced electronic, computer, surveillance, and weapons technologies, the robots of today have extraordinary capabilities and are quickly changing the landscape of battle and dynamics of war [1]. The history of military robots can be traced back to the times of World War II. During the time of World War II and the Cold War, these robots were in the form of German Goliath tracked and Soviet teletanks. It is also believed that military robots history can be dated back to the 19thcentury, precisely in 1898. The history begins with the invention of radio controlled boat intended for military use by Nicola Tesla. The next important step that gives a turning point in the history of military robots was in 1930s in the Soviet Union. Soviet Union made a remote controlled tank called as 'teletank'. Later on, the control system was modified such that the tank's electric relays were controlled through radio signals. Depending on weather conditions, teletank could be controlled from 500-1500m away. The teletank was equipped with machine guns, flamethrowers and smoke container to provide a smokescreen. The use of Goliath which is a mobile landmine in World War II by the Third Reich's forces also marked a turning point in the history of military robots. Goliath was roughly 1.50 m long, 0.85m wide and 0.6 m high. The first version of Goliath was Sd. Kfz. 302 (Goliath E). This goliath version has two battery-driven 2.5 KW electro motors. However, the second version of Goliath i.e. Sd.Kfz.303 or "Goliath V" was equipped with a gasoline engine since it could provide greater range and was cheaper [2]. The first use of unmanned air technology can be traced back to the First World War, where radio-controlled unmanned aircraft were used as "flying bombs" by the United States (US). Thereafter, such early Unmanned Aerial Vehicles (UAVs) were developed as targets for training and as decoys. UAVs were utilized for reconnaissance purposes in the 1960s and by the 1970s, the US experimented with them for active combat purposes. However, it was not until the 1990s that Unmanned Combat Aerial Vehicles (UCAVs) were developed and used in operations, with the advancement of more reliable communication links [3].

In the United States there has been a long tradition of applying innovative technology in the battlefield, which has often translated into military success. The Department of Defense ("DOD") naturally extended this approach to robotics. Primary motivators for the use of intelligent robotic or unmanned systems in the battlefield include:

A. Force multiplication: With robots, fewer soldiers are needed for a given mission, and an individual soldier can now do the job of what took many before.
B. Expanding the battle space: Robots allow combat to be conducted over larger areas than was previously possible. Extending the warfighter's reach – robotics enable an individual soldier to act deeper into the battle-space by, for example, seeing farther or striking farther.
C. Casualty reduction: Robots permit removing soldiers from the most dangerous and life-threatening missions. The initial generations of military robots generally operate under direct human control, such as the "drone" unmanned aerial vehicles being used by the U.S. military for unmanned air attacks in Pakistan, Afghanistan, and other theaters [4].

II. NEED FOR AUTOMATION IN WARFARE

Following are the main reasons for introducing the military robots in warfare [5]:

A. Protection of human (soldier) life.
B. Higher level of efficiency and effectiveness of robotic systems.
C. Armed forces attractiveness, increasing with regard to the recruitment goals.
D. Modernization of armed forces.

III. THE MAIN FACTORS INFLUENCING MILITARY ROBOTICS DEVELOPMENT

The main factors influencing the development of military robotics are as follows:

A. Value of human life: If the higher value of human life is accepted, the quick pace of growth will be reached.
B. Costs of military professionals training: If we take into account all the direct and indirect costs of military professionals training, it may be claimed that in some cases they are comparable with the procurement and maintenance costs of selected military robots.
C. Future development and the achievable size of military robotics market: This factor is mainly influenced by the level of competition, the level of monopoly and the range of state intervention.
D. State and future development of public finance and budgets: This factor is crucial at present. State budgets burdened with debts result in the reduced capacity of national governments to fulfill their missions
E. Security, economic development and social agreement

Changes in the above-mentioned agents and factors directly influence the development of military robotics. Economic aspect of nearly all the above mentioned agents and factors is of a high importance. Robots have been successfully used in several industrial applications like material handling, material transfer, processing, inspection & quality control. The advent of autonomous system architectures gives us the opportunity to develop a complete new range of equipment based on small smart machines that can do the right thing, in the right place, at the right time in the right way. Environmental problems are also steadily gaining importance in the political stakes of industrialized countries, especially with respect to industrial and agricultural activities [6].

IV. SALIENT FEATURES OF UNMANNED VEHICLES

1) *Capability Increase:* Force Multiplier Unmanned systems can provide a capability increase to forces through expanded surveillance capabilities and all-weather operations. Armed drones can “loiter, observe and strike, with a far more precise application of force.” The possibility of deploying more than one unmanned system per human operator can also be a force multiplier, especially during force projection. At the same time, the task and load capacity of soldiers can also be increased with the aid of unmanned systems [7].
2) *Risk Reduction:* Unmanned systems can help reduce unnecessary risk to humans. They are ideal for filling roles that are known in the field as the “Three Ds”: Dull, Dirty and Dangerous. Unmanned systems are able to reduce operational risks to soldiers such as Chemical, Biological, Radiological and Explosive (CBRE) threats or the breaching of obstacles, especially while under enemy fire.
3) *Situation Awareness and Intelligence Gathering:* Unmanned systems can provide heightened situation awareness and are highly suitable for intelligence gathering. According to LG David Deptula of the United States Air Force (USAF), “the next phase will enable a single drone to provide as many as 60 simultaneous live video feeds directly to combat troops. Some new drones will be as small as flies, others walk, all appear destined to work with decreasing human input” [8].
4) *Consistency:* Unmanned systems are consistent in performance as compared to humans who may be affected by fatigue, stress and other distractions. On the other hand, poorly programmed unmanned systems can also be consistently bad.
5) *Efficiency and Productivity Increase:* Like robots, unmanned systems can replace humans in low level, manual jobs, thus freeing manpower for higher value jobs. According to Lance Winslow, “it is estimated that for every soldier or airmen on the front line or participating at the tip of the sword, there are 20-25 military personnel in the command and control and logistical supply chain. Military robotics clearly increases efficiency and productivity.”10 Singer suggests that “unlike humans, robots can perform boring tasks with unstinting accuracy for long periods of time.”

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V. TECHNICAL CONSTRAINTS OF UNMANNED ROBOT

Compared to humans in warfare, the advantages of using military robots are Humans soldiers need food, sleep, water, oxygen etc. and are hence autonomous up to only a certain point. It also makes human soldiers vulnerable and their deployment costly. Also humans need clothing and body armor, adding to the overall weight to carry around, reducing battle speed and ammunition supply. Re-supply for humans needs to be found locally or brought in. Robots are less demanding to that effect, but still depend on on-board energy supply to run its motion and weapon systems. Current battery capability is a limiting factor and the more robots are equipped with sensors and weapon system their energy demand will go up. In case of Prevention Robots and Reconnaissance Robots this is not a crucial factor

VI. CURRENT MILITARY ROBOTS IN USE

Following are some of the unmanned war vehicles in use [9];

A. Talon

It is a potent, lightweight, versatile robot designed for missions ranging from reconnaissance to weapons delivery. Its large, quick-release cargo bay accommodates a variety of sensor payloads, making TALON a one-robot solution to a variety of mission requirements. TALON was initially designed to scout ahead of ground troops and detect and disable improvised explosive devices but its roles were broadened over time. It became one of the most used robots in Iraq and Afghanistan.

B. Swords

Special Weapons Observation Reconnaissance Detection System is an armed variant of TALON, carrying a machine gun or a grenade launcher and serving more for defense purposes rather than offensive actions. These robots can perform autonomous actions such as return to a previous position if they lose connection but haven't been authorized to automatically attack targets. It is always controlled by a human operator.

C. Packbot

It is a smaller, lighter and tougher version of TALON. Like TALON, it can be used to reveal and remove explosives but is more apt for locating enemy soldiers. Packbot's chassis has a GPS system, an electronic compass and temperature sensors built in. It also uses flippers to get over obstacles and even stairs. Even this type of robot has to be remotely controlled by an operator.

D. Bigdog

It is a mule-sized robot designated to assist soldiers carry loads through rough terrain. It uses four legs to get over obstacles and stabilize itself. A stereovision system allows it to follow a specific person and to create a 3D model of the terrain surrounding it. "This model enables the robot to identify a safe path forward, but can also enable BigDog to calculate the distances of any gaps or caverns and whether or not they could be cleared safely with a jump. In laboratory testing, the BigDog successfully jumped 1.1 metres with a full payload". It can climb up a35 degree hillside, withstand being suddenly pushed, recover from slipping onice or run as fast as kmph. All while fully loaded.

E. MK 15 Phalanx CIWS (Close-IN Weapons System)

Phalanx CIWS is a weapon system mounted on ships providing close-ranged efense against anti-ship missiles, aircraft and even small boats. Having been introduced in late 1970s, it's being used by many countries after several modifications. It serves as the last line of defense if other defense systems fail and consists of a radar system and a 20-millimetre rapid-fire machine gun. It's fully autonomous, from target acquisition to firing RQ-11 Raven One of Small Unmanned Aerial Vehicles (SUAV), provides overview of the battlefield over short range. "It delivers real-time colour or infra-red imagery to the ground control and remote viewing stations via three different cameras attached to the nose of the plane. It can be used to locate and target combatants. Being small sized, it can be carried by a single man and launched off hand. It's easy-to-use and there for every popular, plus doesn't require any special personnel.

VII. APPLICATIONS

Some practical applications of war robots are;

A. Used to perform low intensity conflict Operations

B. To perform operations under Hazardous events like bomb diposals, Neutralization of deployed bombs
C. Used for constant Surveillance to perform operations like detecting of explosive material, scanning of suspicious objects (luggage's , bags)
D. Used to detect Improvised Explosive Devices (IED's)
E. UAV(Unmanned Aerial Vehicle) – Netra, Rustom
F. ROV(Remote Operated Vehicle) – Daksha
G. UGV(Unmanned Ground Vehicle) –Muntra
H. Unmanned Combat Air Vehicle – Ghatak

VIII. BENEFITS OF USING UNMANNED VEHICLES

Following are some of the benefits of unmanned vehicles;

A. No loss of human lives by replacing dangerous human task and/or removing humans from hazardous theatre
B. Reduce possible injuries or "Casualty Aversion"
C. Subsequent effect of casualty aversion is reducing/eliminating the need for case vac and further medical intervention and/or lengthy revalidation
D. High level of delivery accuracy by robots (they do not get tired.)
E. Robotics do not experience "fear" or morale issues and can hence be more effective in combat
F. Overall effectiveness due to use of technological skills vs**.** human skills
G. Less or no extensive training needed
H. Less dependence on supplies (robots do not need food, warmth, oxygen or sleep)
I. Maintaining home support for operations
J. Improve battlefield intelligence.
K. Increase battlefield communication speeds
L. Higher adaptive rate to terrain and conditions.
M. Better resistance to NBC conditions.
N. Mere economics, value for money, expendability

IX. LIMITATIONS

While the aforementioned advantages of unmanned systems seem numerous, they are not perfect. The following are some of the disadvantages [3]:

1) *Human Dependency and Lack of Intelligence:* The main disadvantage of robots is that while they can replace human mechanical work very easily, they cannot replace human intelligence. Robots are only good at what they are programmed for, thus they remain dependent on the human programmer to initiate the process. Furthermore, missions that require the use of human intuitive reasoning are still beyond the ability of unmanned systems.
2) *Power and Energy Dependence:* While many of our power and energy sources have increasingly greater capacity, unmanned systems cannot last infinitely and are still plagued by the need to be recharged. Power and energy remains an outstanding and critical issue.
3) *Security Vulnerabilities:* Just like computers, unmanned systems may be susceptible to cyber-attacks. Two years ago the Wall Street Journal reported that "Iran-funded militants in Iraq were able to hack into US drone live-video feeds with $26 off-the-shelf software." In another unnerving incident, Wired reported in October that a fleet of USAF drones was infected with a computer virus that recorded all the keystrokes used when operators issued commands. The military was not able to determine how the drones got infected and even the USAF cyber security team did not know about the virus until they read about it online. Command network vulnerabilities could therefore be an avenue for the enemy to disable or take control of unmanned systems.
4) *Cost:* A recent Pentagon report noted that "crashes and component failures are driving up the cost of unmanned air vehicles and limiting their availability for military operations. Of particular concern are those that have become useful tools of war—the Predator and the Global Hawk among them. Reliability issues have sparked disagreements among military and civilian experts, amid congressional criticism that UAVs are becoming too expensive." According to USAF Secretary Michael Donley, "paying for the labor—both military personnel and contractors—associated with unmanned aircraft operations has become "unsustainable."

5) *Reliability Issues:* It is possible that technical glitches or errors may result in malfunctions and cause accidental casualties. Indeed, "the Defense Department's 2002 UAV Roadmap confirms a mixed history of Class A mishaps—those causing loss or severe damage to an aircraft—especially when compared to manned aircraft. Officials noted, however, that comparing UAV mishap rates against manned aircraft may not be entirely fair, because commanders take risks with UAVs that they typically would not with piloted airplanes.
6) *Situation Bias:* According to Lora Weiss, "testing poses a challenge because there is no realistic way to subject an unmanned system to every conceivable situation it might encounter in the real world. Moving to smarter and more autonomous systems will place an even greater burden on human evaluators and their ability to parse the outcomes of all this testing. They will never be able to assess all possible outcomes, because this would involve an infinite number of possibilities. Robots are only good at what they are programmed for, thus they remain dependent on the human programmer.

X. SECURITY & RISK FACTORS WITH UNMANNED VEHICLES

Several issues pertinent to security and risk happened due to unmanned vehicles. Following are some of them [9];

A. In 1996, the Phalanx CIWS on a Japanese destroyer accidentally shot down a U.S. aircraft during target practice. Both pilots survived. A human error was later found out to have been the cause of this incident.
B. During a training in South Africa in 2007, a malfunction of an automatic antiaircraft cannon caused 9 deaths and 14 injuries.
C. In 2011, UAV operators authorized an attack on two U.S. soldiers in Afghanistan as they considered them to be Taliban fighters. It was the first time a UAV killed friendly units.
D. A number of accidents involving deaths of civilians have been reported mainly from Pakistan. These incidents and fear from what future fully autonomous robots would and, more importantly, wouldn't be able to do lead to calls for international laws concerning military robots and even a worldwide ban on these robots.

XI. CONCLUSION

Unmanned war vehicles can be a potential replacement for the manual vehicles due to the inherent advantages like consistency, reduced human risk factor, repeatability, improved efficiency and productivity. Though there are some limitations in implementing the unmanned technology in vehicles, they can be easily overcome with the advancements in the fields of science and technology. The usage of the latest IoT (Internet of Things) technology can also help the evolution of the unmanned technology. Several companies like Google, IBM etc are working actively in this area and mankind can see this technology in implementation in the near future.

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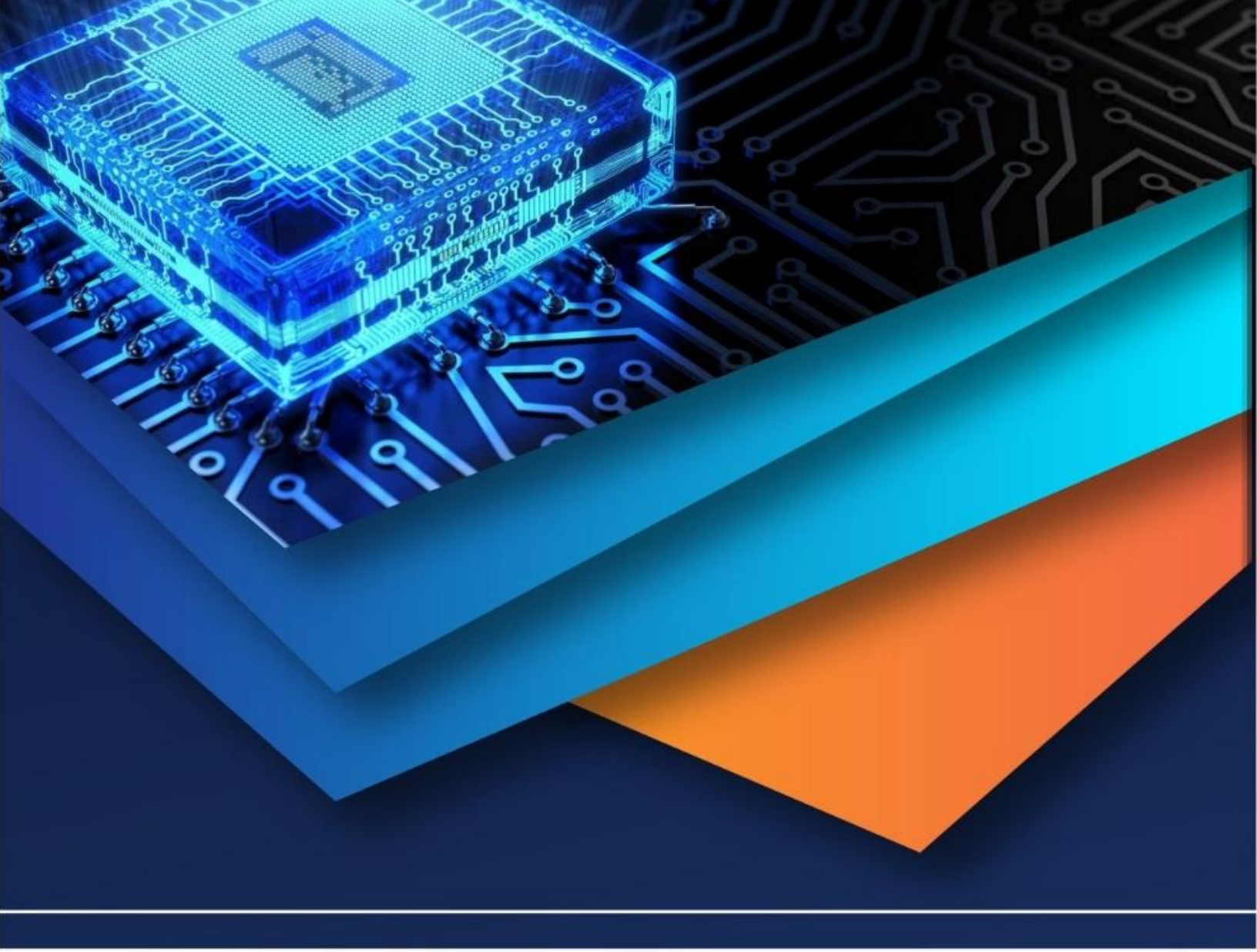

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