Mechatronics in the Advancement of Public Safety Control

Brian Linhares
Vaughn College of Aeronautics and Technology, Flushing, NY, America, linhares_brian@hotmail.com

Sharifa Happy
Vaughn College of Aeronautics and Technology, Flushing, NY, America, sharifa.happy@vaughn.edu

Sehrish Butt
Vaughn College of Aeronautics and Technology, Flushing, NY, America, sehrish.butt@vaughn.edu

ABSTRACT

The rise of civilian violence against police and military forces has led to the growing need for public safety control. With emotions and human judgment as the primary cause for further violent outbursts, each crisis falls into a state of emergency which requires the interference of a neutral third party. Using mechatronics, a transformation of the social world is influenced into opening machine-guided paths for maintaining control during riots. In a scenario where machinery is used as a decoy, people are put out of harm's way, allowing the robot, rather than a person, to absorb the attacks. Our prime example would be our concept robot that has both autonomous and manual features, allowing it to possess artificial intelligence in addition to the guided operation of the controller. The anti-riot robot is equipped with nonlethal weaponry, making it vital in civilian and military protection. The structure and components of the robot fortify its ability to use anxiety and confusion as an efficient psychological means of sustaining public cooperation. Taking on an understanding for the need for precision, effectiveness, and safety, the incorporation of mechatronics in public safety control assists the robot in proficiently implementing its task of lessening violence.

KEYWORDS

Public Safety & Control, Innovation, Efficiency

1. INTRODUCTION

In the technological modernization of contemporary society, the infusion of mechanical systems with electrical components, which are guided by self-regulating features, has produced the new field of mechatronics engineering. This field has already been applied to various technological subject areas, from the machines that process food to the systems used in space (Degree Directory, 2010). Mechatronics has emerged as the link between mankind and machinery by simplifying the physical world and allowing both man and machine to collaboratively complete tasks. These tasks can vary in multiple fields, which include defense systems engineering where robots are used as a neutral third group to ease tensions amongst humans. This merging of mechatronics and the general public allows for the monitoring of social disorder in the territory while also using harmless weaponry in extreme cases. The nonjudgmental interference of the robot lessens injuries and casualties for both the citizens and the police forces.

2. PUBLIC SAFETY AND CONTROL

In an era where the upbringing of riots has increased due to rising civilian discontent, violent measures are taken and therefore require the need of safe and efficient means of preparing for the attacks. Using robotic technology,

police and military forces will have a shield which allows them to use a defensive approach against insurrections. Riots occur due to differences between people, but it is their human behavior and emotions that arouse and continue their aggressive resistance against authority. Such situations tend to lead to property damages, injuries, and in certain cases, deaths. It the clash between numbers of disagreeing groups that make it almost impossible for further human intervention without introducing more chaos.

The chaos that takes place emphasizes on the need for the impartial interference of a robot due to its lack of human emotion. As a third party, its task is to pacify the situation and reduce hostility without becoming a weapon for either side. The robot will not question its controller, but rather, only think and behave as it is programmed to do so. This way, it becomes a buffer during a riot by being sent out first to startle and confuse the attackers, replacing their anger with alarm and uncertainty.

1.1 MOBILITY

The technical modifications on the anti-riot robot shaped the idea that this artificially intelligent machine may be further improved by perfecting its mobility, allowing it to be navigated around humans and other obstacles with ease. Implementing a rack and pinion system, the robot will have four ATV wheels for better traction and speed. With two wheels in the back that are fixed in place, and the other two in the front, side to side movement is permitted by the system, containing a servo connected to a rod. The fixed rod aids in maintaining the wheel alignment so that they stay in place. This system is practical and conventional in that is it easier to fix using simple automotive skills, making it cost effective. Supposing that the robot enters the mass of oncoming attackers, consideration has to be taken for them as obstacles that cannot be harmed or ruptured. In addition, the terrain in which the robot will be maneuvered in is taken into account by the ATV wheels, which make it easier to adapt to various surfaces.

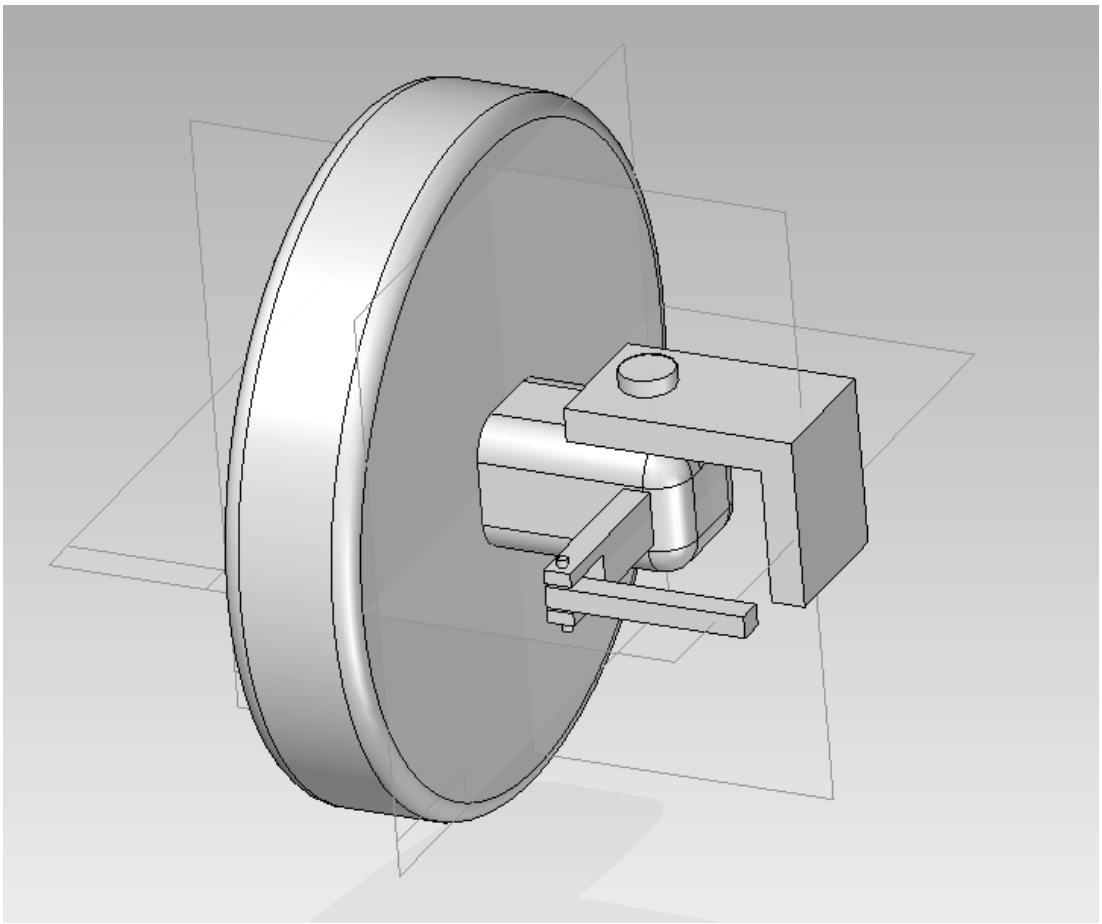

Figure 2: Wheel for Rack and Pinion System

1.2 PRECISION

As the eyes and ears for its controller, the robot can explore the territory, gathering information for the police forces. By allowing the police to keep a distance from their attackers and learning their approach, the police can later enter the scene with better preparation, and thus potentially save lives. With a camera and ultrasonic sensor as the robot's main sensing guides, the controller is able to precisely examine the territory and measure the pace of movements proceeding towards it. This allows for rapid, more accurate aim of the non-lethal gun turret that is placed at the top of the robot and is used for only severe cases.

The robot is equipped with two mounted cameras for optimal view of the surrounding area; one is placed in the front, and the other in the back. Both cameras are protected by a plexiglass encasing, and are mounted on a servo pad which include two servos, spinning the camera around for complete 360-degree viewing range in all three dimensional axes. This allows the controller to make precise movements around the people and terrain.

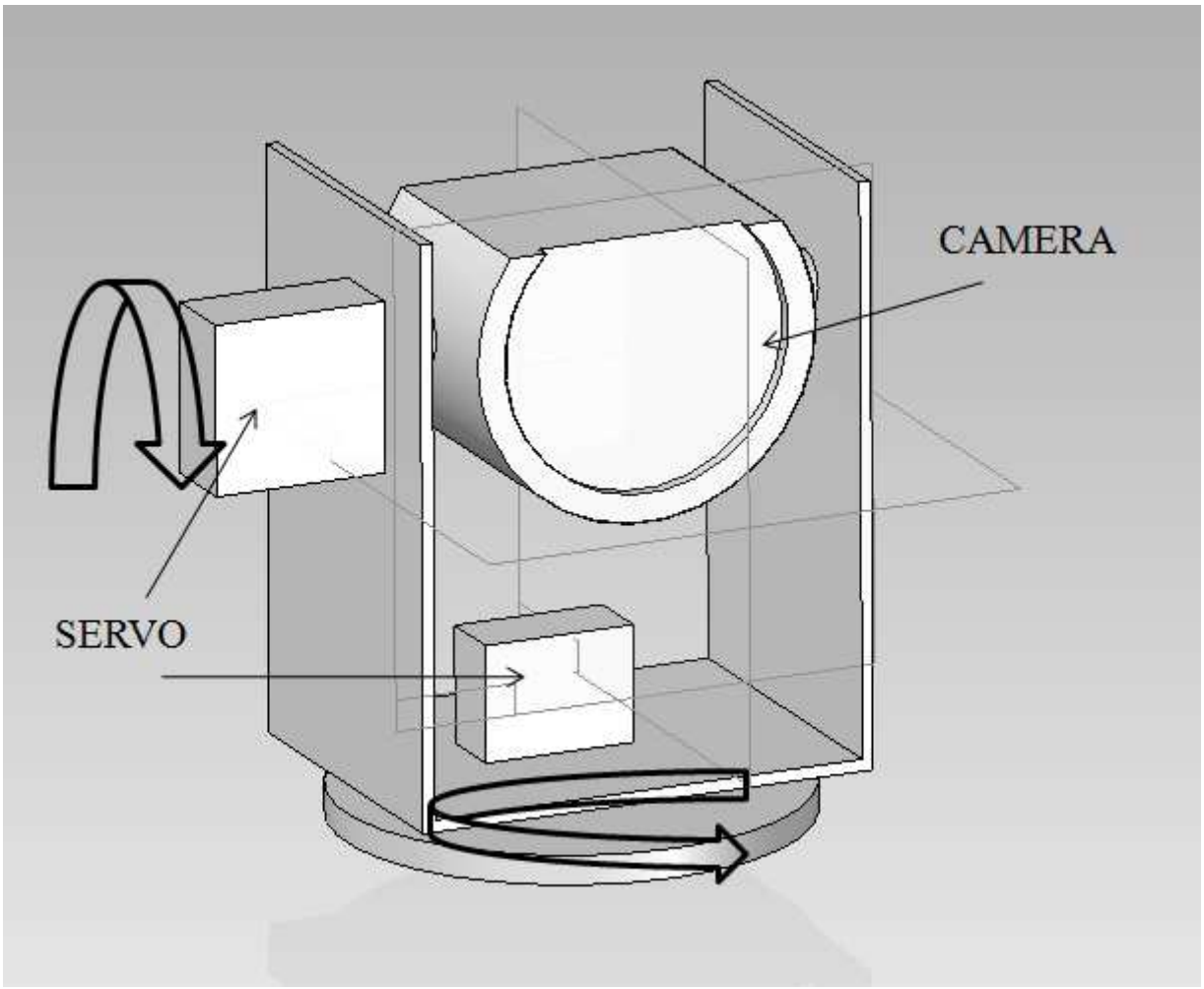

Figure 1: Camera for Optimal View

As the only physical weapon on the machine, the gun turret is designed to be safe and harmless when used, since its primary function is to intimidate attackers without actually causing them any injury. The turret is encased in a cone shell for protection and is positioned just like the camera, allowing for more precise and effective aim. It uses rubber bullets to maintain a result of minimum injury towards others. In addition, ultrasonic sensors are placed in fixed positions around the robot, measuring the distance away from another object by emitting a pulse and calculating the time it takes for the pulse to come back. By continuously measuring the distance between

itself and another object, the robot is able to compute the speed at which an attacker is coming towards it, thus autonomously being able to guide it away from the person or shoot the rubber bullets. This last resort measure makes it easier for the controller since he or she will already be preoccupied with the movements of the robot and the need to avoid collision with humans and other foreign objects.

3. INNOVATION

Retracing back in history, we have seen how the innumerable causes for riots continue to increase, thereby resulting in rising numbers of casualties. With a natural tendency for change, the need to revolutionize due to our societal troubles brings us on a cyclic ride of ongoing battles between people. Whether the cause for the dilemmas are economical, political, or social, all revolutions are backed by the strong basis of one side arguing that the need for change is due, while the other struggles to maintain their contemporary standings. Applying this technique of revolution to the anti-riot robot, we can prevent chaos and injuries by altering the way we approach delicate societal situations.

Statistics show that every year, the number of riots increase, leading to more injuries and deaths. Police forces attempt to contain the violence by entering the chaos and defending themselves against the people. However, human emotion and judgment springs further tension against them, creating larger amounts of chaotic fighting. With the innovative technology of using robots as shields, a revolutionary point is met between the people and the police where they turn to civil disobedience, rather than an aggressive approach.

Table 1: Global Injuries and Casualties During Riots (Wikipedia Contributors, 2010)

Year	City, Country	Number Injured	Number Arrested	Number of Deaths
2000	Bogota, Columbia	-	-	26
2001	Buenos Aires, Argentina	-	-	26
2002	Asuncion, Paraguay	-	-	5
2002	Montevideo, Uruguay	-	20+	-
2003	La Paz, Bolivia	-	-	70
2003	Santiago, Chili	-	130+	-
2006	Sao Paulo, Brazil	-	-	30+
2007	Caracas, Venezuela	11+	-	-
2009	Bagua Grande, Peru	-	-	54
2009	Albina, Republic of Suriname	24	35	7
2009	Pittsburg, America	-	190+	-

Technology plays the role of the underlying cause for change and peaceful rioting through several components on the anti-riot robot, including smoke canisters and LED lights around the entire robot. The smoke canisters are used to take away the vision of the civilian attacker, thereby confusing them and decreasing their anger, which in turn reduces violence. The smoke canister launcher will be connected to the rubber bullet gun so that it can be angled at different points for better range and efficiency. The canisters will be electrically ignited and released

before the police forces enter the scene so that the rioters will be limited in their vision and confused, thus leading to a faster break-up.

The greatest innovative aspect of the anti-riot robot is its possession of autonomous control, which increases the robot's ability to protect the lives of both residents and military forces. Already used in defense systems, the incorporation of mechatronics and its aspect of artificial intelligence through computer programming have led to more efficient means of making a situation safer for humans. For example, the MQ-1 Predator Drone is an unmanned aerial vehicle which inspects and monitors a certain territory, permitting the military to be aware of the conditions they will be heading into (Wikipedia contributors, 2010). However, whereas the Predator Drone is used for an offensive approach, the anti-riot robot is used for strictly defense. Features of the Predator Drone consist of various cameras, including infrared and color, for surveillance, taking into account of the environmental conditions around it. It is directed by a control center away from it so that the people guiding the drone will be in a safe location during the entirety of the fighting. The Predator Drone is equipped with arsenal to prevent military casualties, whereas the anti-riot robot uses smoke and LED lights to confuse oncoming attackers and ward them off and preventing future riots from occurring. Furthermore, independent aspects like the ultrasonic sensors reduce the risk of harm and fatalities by putting fewer lives on the line. Overall, if any harm is to come, it would be towards the robot, rather than the irreplaceable life of a human being.

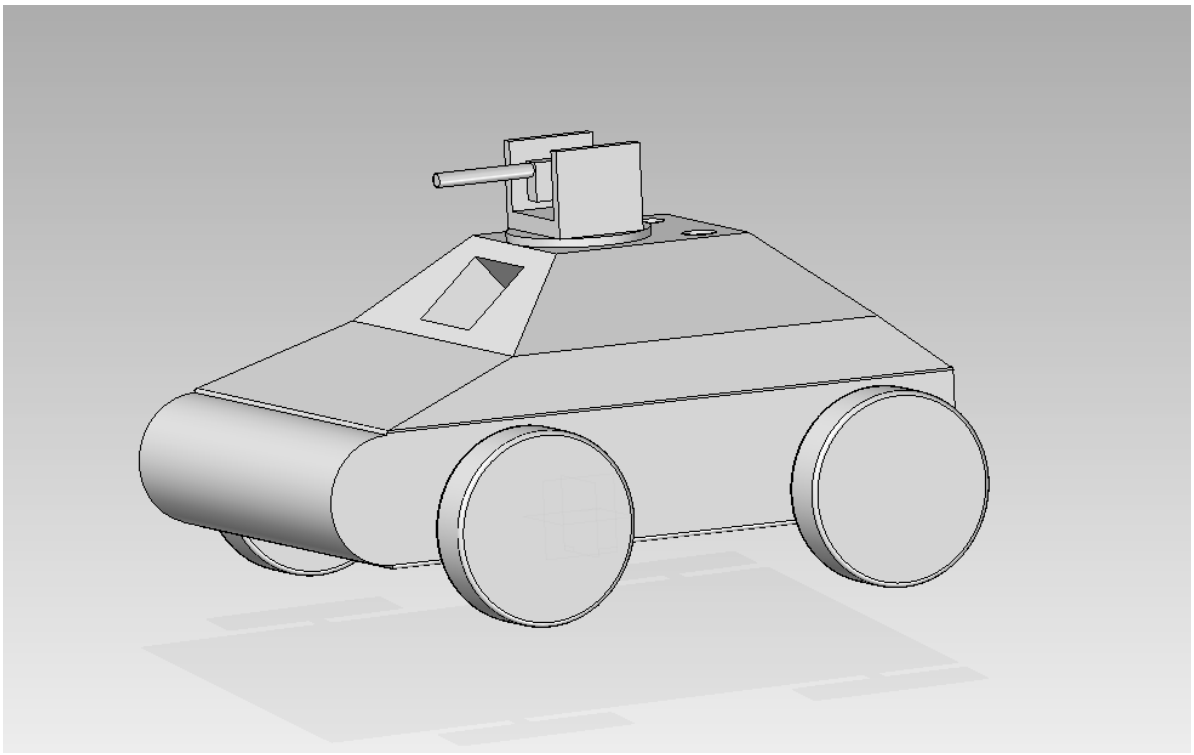

Figure 3: Anti-Riot Robot

4. EFFICIENCY

In maintaining the beneficial and innovative aspects, the anti-riot robot is made to be economically efficient. To decrease damage from projectiles, the anti-riot robot is plated in angled armor to deflect the majority of the attacks towards it. Already applied in the physical world, including cases such as the game of billiards, the angle of incidence equals the angle of reflection (Theatrice, 2004), therefore allowing for greater deflection. The plates will be divided into sections and arranged throughout the robot, based on where the most protection is needed. Additionally, the arrangement of the plates makes it easier for detachment and reconnection, making it more cost-effective.

To obtain power for operation, the anti-riot robot is equipped with a 12-volt battery as its primary power source. The battery will be located towards the back of the robot to increase its rear weight, thus also increasing traction. As an optional feature, a gasoline engine with an attached generator can be added to produce a power supply for the electrical components. This way, the robot is able to maintain its efficiency without raising the cost of its production and use.

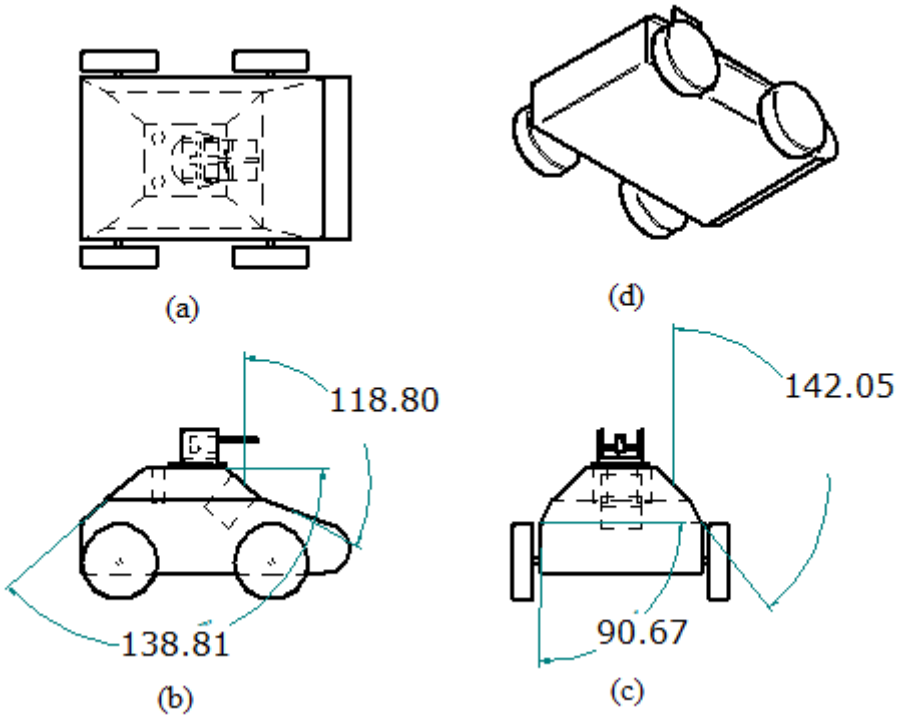

Figure 4: Orthographical Views of Anti-Riot Robot and Angles for Attack Deflection (a) top view (b) right side view (c) front side view (d) complete view

5. CONCLUSION

As the bridge between the artificially intelligent aspects of technology and the emotions and judgments of people, mechatronics has advanced in revolutionizing our approach towards public safety control. Although it is a broad field of engineering, its applications are innumerable, making it possible for the modernization of various subject areas. The guided operation of the anti-riot robot allows its controller to maintain his or her power over the machine at all times, rather than replacing each other. Opening doors for future innovations, the collaborative work of man and machine through a series of components serves a purpose of improving safety and control over the general public.

REFERENCES

What is Mechatronics? Degree Directory. 2010. <http://degreedirectory.org/articles/What_is_Mechatronics.html>

Columbia Prison Riot Leaves 26 Dead. Los Angeles Times. 2000. <http://articles.latimes.com/2000/apr/29/news/mn-24674>

Wikipedia contributors. "December 2001 riots in Argentina." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 29 Dec. 2009. Web. 20 Feb. 2010. <http://en.wikipedia.org/wiki/December_2001_riots_in_Argentina>

Dozens Injured in Paraguay Riot. Telegraph, 2002. <http://www.telegraph.co.uk/news/1401549/Dozens-injured-in-Paraguay-riots.html>

Wikipedia contributors. "2009 Albina, Suriname riots." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 2 Jan. 2010. Web. 20 Feb. 2010. <http://en.wikipedia.org/wiki/2009_Albina,_Suriname_riots>

Wikipedia contributors. "MQ-1 Predator." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 16 Feb. 2010. Web. 20 Feb. 2010. <http://en.wikipedia.org/wiki/Predator_drone>

Brown, Theatrice . *Pool Angles Trainer*. <http://www.freepatentsonline.com/5520581.html>

AUTHORIZATION AND DISCLAIMER

Authors authorize LACCEI to publish the paper in the conference proceedings. Neither LACCEI nor the editors are responsible either for the content or for the implications of what is expressed in the paper.