

Robotic Applications to Enhance Transportation Security

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ABSTRACT

The international community has been very sensitive about security since 2001. Government agencies spend billions of dollars, yet a solution has not been found in which civilians feel safe while not feeling disrespected by inspection officials. Guard dogs, officers and military personnel can practically be found throughout the world guarding airports and other forms of mass transportation locations. But as previously mentioned, even with all of these resources, narcotics and explosives still manage to elude authorities. An autonomous robot with good public relations will provide security without a martial presence. Special sensors can work as a canine does; the sensors periodically take in air samples to find out if any highly used specific explosive chemicals are in the area. This tactic is used by American soldiers in Iraq, but has yet to be properly introduced for civilian applications. The idea would be to draw people closer with monitors displaying information, thus increasing the efficiency of the sensor greatly. Also with several ultrasonic sensors, the robot will be able to move through a crowd without injuring or causing a disturbance.

INTRODUCTION

Beneficial advancements have always had their military counterparts that can do harm to society. This concept came together with equipment that is currently available, creating something new and innovative. Security in airports and other forms of mass transportation is very important since those are locations that are more frequently targeted. Terrorists and drug smugglers all have one thing in common, they leave behind a trace that can be tracked with the right personel and equipment [1]. It usually starts with home made, over-the-counter products which are put together to make explosives, which if exposed leaves a miniscule trace in the air. Sensors exist that can detect specific chemicals in the air by taking air samples continously but are less sensitive with distance. We determined that the next step to help resolving this problem would be to make it autonomously mobile.

Attaching a chemical sniffing sensor to a robot that can easily roam a preset location without interfering or worrying travelers will allow security personel to have another set of eyes on the floor. This would also permit a greater area to be checked. The robot will have four screens on it that will feature saved data and could even be used to stream commercials if needed to lower costs. Technologically advanced security units could lead to several prosperous investments for the locality.

Frame and Electronics

People tend to bump into things when they are in a hurry, especially if they are late. This factor helped contribute to the shape of the frame and locations for the electrical components due to the nature of its purpose. The frame is set to have a low center of gravity to prevent it from toppling over easily. This was accomplished by placing most of the electrical components inside of the base. The remaining four LCD screens and the chemical sensors are located inside of the tower upper half. Power distribution to the top half is done by running electrical wires through the six inch aluminum pipe that secures it to the base. This in fact protects the wiring from liquids and other foreign agents that may be corrosive and damage the components [2].

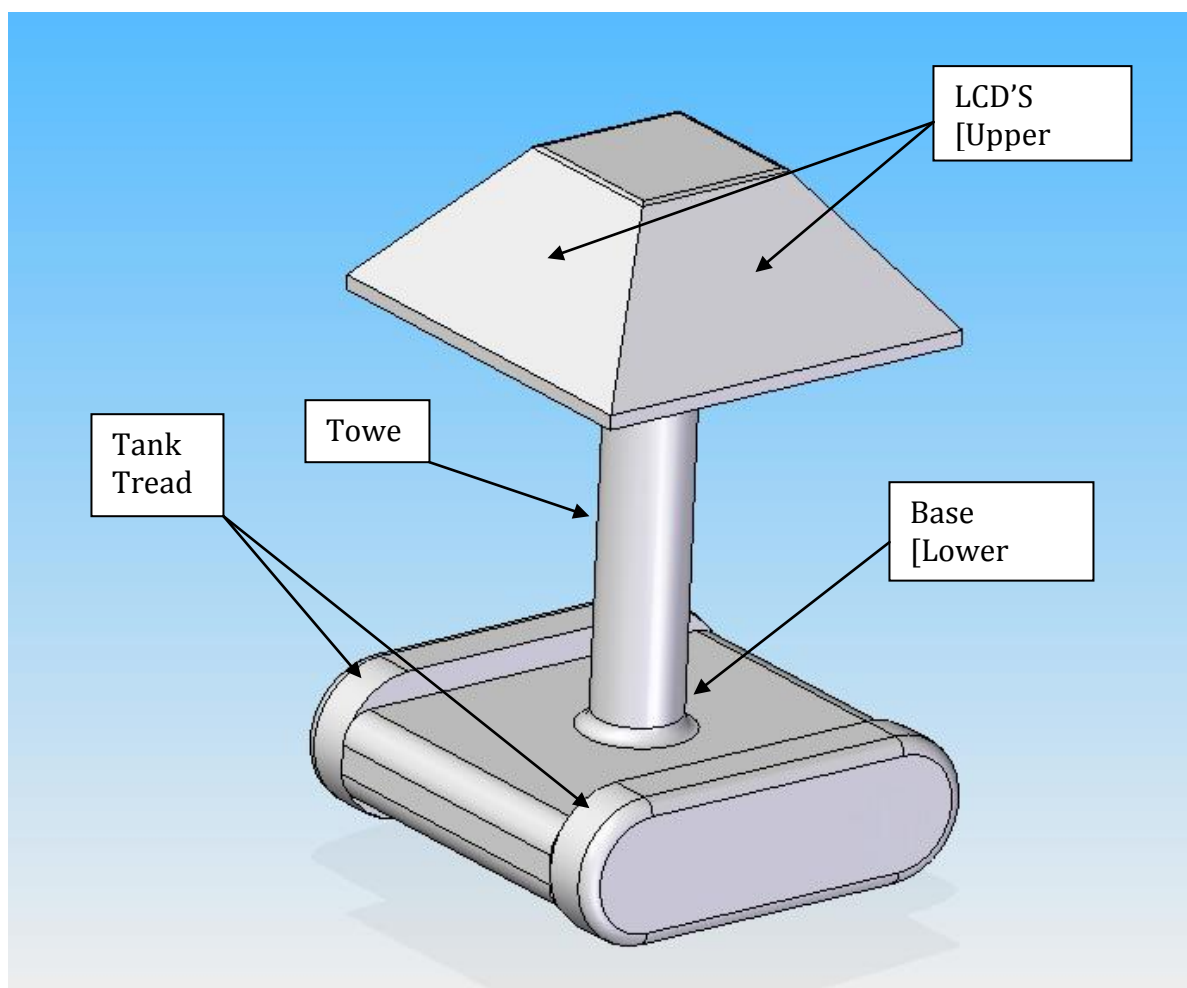


Figure 1: Frame and Electronics

The top half structure is mainly made up of four LCD screens which are held together by aluminum sheets and brackets keeping it sturdy yet light to remain having a low center of gravity and a chemical sensor located underneath the top half platform.. With the addition of the chemical sensor, this should place the weight of the upper half above the tower at more or less 20 pounds. The bottom half will consist of electrical components such as the 12 volt battery, micro processor, and the ultrasound sensors. The aluminum beams making up the rectangular frame will also have supports to place the motors that will power the tank treads. The center aluminum pipe will be held in place by three L shaped brackets that will be attached directly to the lowest level of the rectangular frame. This allows that a second level of three L shaped brackets be connected to the pipe a little higher connecting it to the top cross beam section of the rectangular frame.

Sensors and Programming

Chemical sniffing sensors are innovative and are being used by the American military. The sensor that our group has found most interesting would be the Triacetone Triperoxide sensor. Triacetone Triperoxide is usually used for shoe bombs and is extremely hard to detect. Since it can be made easily with readily available components, it is being widely used by terrorists. Therefore if further advancements are made, this sensor can be used which will help in detecting this specific chemical that is suspect to investigation [3].

The robot will be autonomous requiring some form of sensor to prevent it from running into obstacles or falling down a flight of stairs. This is where ultrasonic, bumper, limit switches, and potentiometer sensors come into play, which are inexpensive and are very efficient [4]. The potentiometer is an analog sensor which collects info from something physically moving which in this case would be the motors for the tank treads. The following sensor would be the bumper switch which is activated through touch, activating a preset program which could allow the robot to back away in case it unfortunately hits an obstacle. Limit switches operate in the same form as a bumper switch but are much more sensitive.

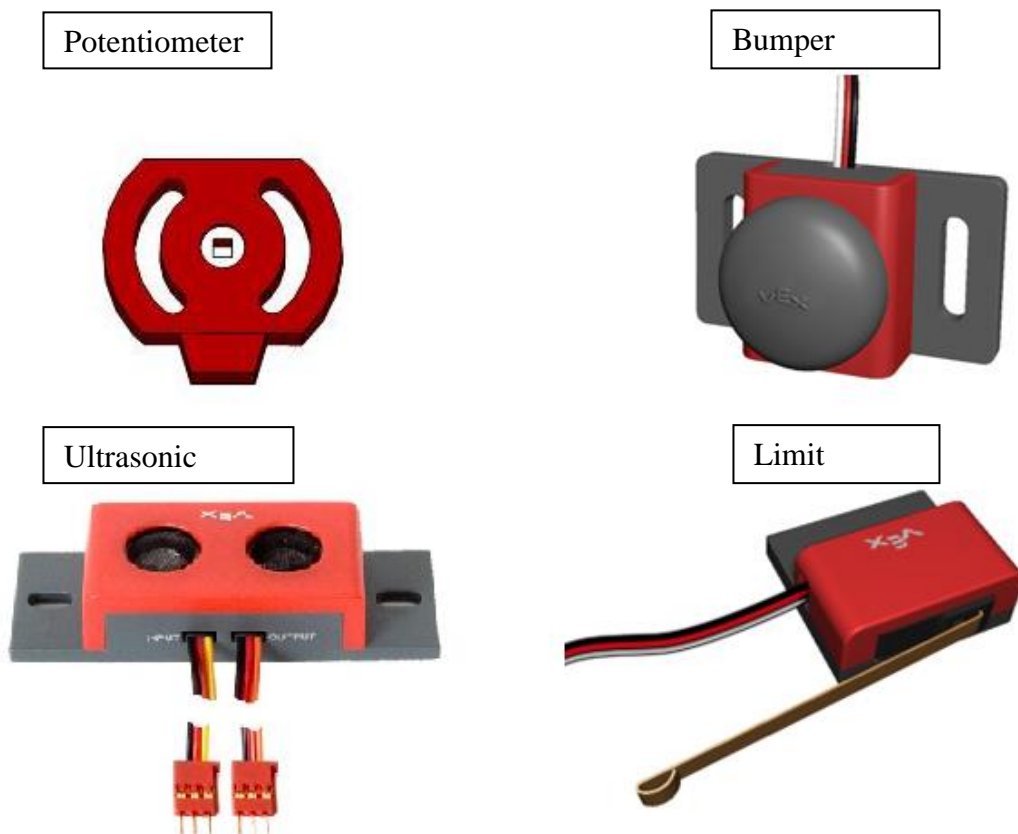


Figure 2: Sensors

The ultrasonic sensor is a key feature in this design since it will prevent the robot from falling down stairs and would also prevent any collisions with obstacles by sending out an ultrasonic wave and picking up how fast it returns. If the ultrasonic sensor produces a value lower than a preset value than this will indicate that an obstacle is near. Presently we are using ultrasound sensors. Sensors can be mounted using small bolts that are 1/8 of an inch in diameter and about 1/4 of an inch in length including the head. Since the bolt will be attached directly to the sensor, no nuts are required. Our Mechatronics group constructed a small robot with all four of these sensors and noticed that whenever one sensor did not pick up something, the other would act as a back up. This greatly increased its success in not bumping into any obstacles that we laid out for it.

Efficiency

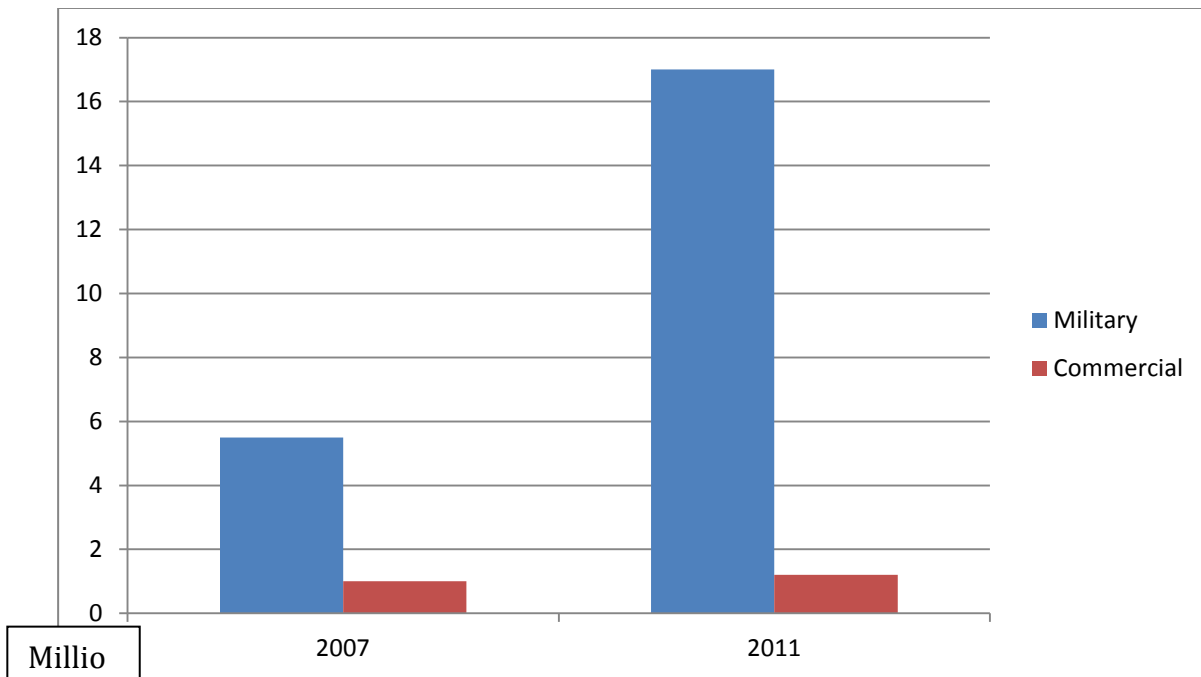


Figure 4: Robotic Division

As shown in the above graph [5], the use of robots are skyrocketing in the military service due to the fact that the army has recognized the full potential of robotics. This alone should be relevant information when trying to figure out how to better prepare security at a civilian facility.

The robot is fitted with sensors that can detect a specific and potentially hazardous chemical, without alerting the perpetrator. This robot is compact and takes minimal amount of space to store. As it has four screens which are inclined at an angle, passengers could have easy access to gate or flight information. If a potential threat is noticed, it will automatically alert the security workers while following the trace of Triacetone Triperoxide from where the threat is coming. If an emergency situation arises, it could be equipped with an alarm system which will start and will signal people that something is occurring which will lead them to pay more attention to any announcement.

Design

The design of the robot is simple yet complex at the same time, the structure and components allow it to freely roam around without hindering anyone. Counterweights are placed at certain locations to prevent toppling over and ultrasonic sensors are placed in particular sections of the robot to prevent bumping into and also falling down a opening or flight of stairs. Aluminum sheets are used to weight reduction and to also protect internal components by acting as a skin for the robot. Aluminum beams are used to provide a sturdy base and a aluminum pipe is used to support the top half of the robot. The processors and other important components are located in easily accessible positions with panels to replace when necessary.

Mobility

The mobility of the robot is the foundation of its operation. The decision to apply tank treads to this mobile lab came from the basis that tight corners will not allow a simple rack and pinion system which is seen in automobiles to work. The application of the tank tread is to allow mobility in large and tight locations also allowing maneuverability over various types of terrain such as dirt and mud. Taking into consideration that various airports have smooth floors, the tank tread system is made of metal to

withstand the tension put out by the motors but the top half of the belt that comes in contact with the floor has a rubber cap to allow better movement.

The simplicity of the assembly also helps in future maintenance that could easily be done by someone with simple automotive skills further reducing maintenance costs. This design demands that the belt be four inches wide and be able to sit on two, nine inch diameter tracks placed 10 inches apart from center to center. The belt may be made out of aluminum links to help reduce weight but still maintain strength to withstand the tension created by torque and friction. The rubber caps that will be placed on the metal belt links can be attached in by a strong adhesive or by standard thin bolts.

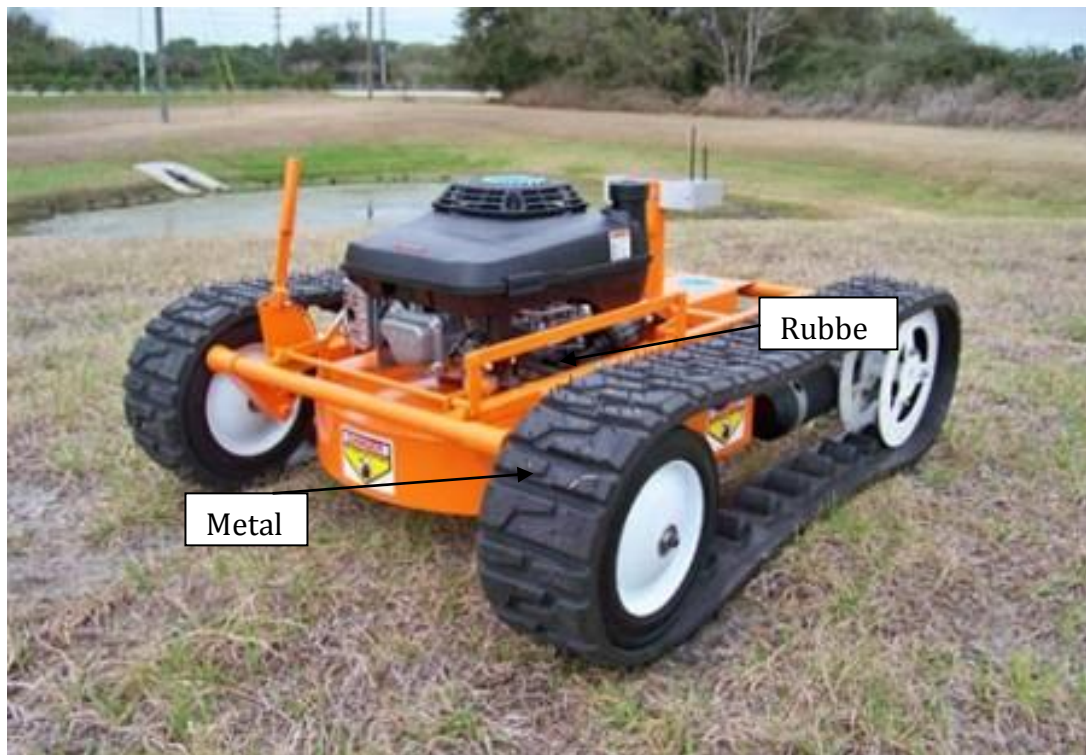


Figure 5: Track Assembly Example

Public Acceptance

Due to the design, the robot will be a short term investment that will prove inexpensive to the consumer given that companies will want to advertise their products more directly to travelers at an airport on the LCD's built on the robot. The robot features four LCD flat screens which will be used to not only display flight information, but also ads.

The non-martial appearance will give travelers a more comfortable traveling experience to and from airports more frequently, which could increase tourism leading to higher airport revenues. Presently, travelers are met with searches due to security especially in America, and many don't seem to like the TSA for it. Passengers tend to get alarmed with the sight of military personnel patrolling with heavy weapons such as the M-16 assault rifle. Our robot will give passengers more peace of mind knowing that there is something patrolling alongside the security personnel making it safer which is always a priority.

Conclusion

Artificial intelligence is the intelligence of machines and the branch of computer science that aims to create it. This robot can be classified as "the study and design of intelligent agents" where an intelligent agent is a system that perceives its environment and takes actions that will maximize its chances of success. John McCarthy, who coined the term in 1956, defines it as "the science and engineering of making intelligent machines." Our robotic agent accomplishes its goals autonomously without disturbing the public. This in turn shows that if there is a military counterpart to every beneficial creation then there must be a counterpart to every military creation that will be beneficial to society. The military have run successful tests showing that their bomb sniffing robots accomplished their set tasks, thus aiding soldiers in the battlefield.

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