



A Study of Gun Detection Accuracy in the Athena Security Artificial Intelligence System



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Executive Summary

Athena Security Corp is on a mission to end mass shootings, and mitigate risk through the use of computer vision. We have developed a method to detect and alert on visible guns, in order to generate an organized, responsive action. The first part of this mission is detection, and the focus of this paper. Can a system with cutting-edge artificial technology accurately detect a threatening shooter?

The artificial intelligence uses multiple levels of intelligence and sub-systems to quickly identify, categorize, classify, and alert. These systems include machine learning, deep learning, and a neural network to identify threats. Customers pre-configure a planned “Active Shooter” response. We offer real-time alerts to the proper authorities, as defined by each client.

The system understands weapons in three states: The state of “concealed” where the gun is not visible, the state of “holstered” where the gun is visible and on the waist, and the state of “drawn” weapon where the gun is visible. Concealed weapons have a higher rate of false positives with current sensor technology. We continue to evaluate these options. Holstered weapons are regularly spotted on the waist of police, military, or civilian security personnel. Many in the Athena office have the legal license to carry a concealed weapon in certain parts of the United States of America. Visible or drawn weapons are the main concern and focus of this detection. Drawn weapons indicate a dangerous scenario.

Drawn and visible weapons are the focus of this accuracy test. Can the system rapidly detect a drawn firearm?

Utilizing leading edge technology, the Athena System is built to detect trouble and alert the proper authorities with the ability to manage and minimize a catastrophic situation.

Lastly, to prevent alarm fatigue, the rate of false positives needs to be included in the accuracy testing, which is contemplated in this white paper.

Real-Time Threat Detection Using Computer Vision

Introduction

The world is facing very real threats against *soft targets* like schools, churches, crowded shopping malls, theaters, places of business, and busy city streets. Transportation areas like airports and bus terminals remain under constant threat.

Within the United States, current surveillance technology is inadequate to the nation's needs. Surveillance cameras provide good information post-incident, but they do little to prevent these types of crimes. Twitter has been the first indication to a parent that a school is on lock-down. First-responders may be notified by a panicked 911 call that *something* is happening and, perhaps, even where it is happening. Unfortunately, however, they are often not given contextual information in real-time. The training and technology are getting better, with heroic efforts by many.

The Athena Detection System is a prudent security layer to add in order to enhance the detection of weapons. The system has been designed in conjunction with security specialists to address the current need. Leading edge artificial intelligence, object detection and behavior detection, have been combined to create a security system that actively recognizes a threat, notifies authorities, and proactively communicates with them in real time.

Athena Security's innovative systems can help to reduce the threat that everyone may face each day in schools and workplaces, assist authorities in preventing escalation, and capturing perpetrators.

The Mission

Athena's mission is end mass shootings, avoid catastrophe, and help our customers mitigate risks.

The Team

Lisa Falzone is the CEO and co-founder of Athena Security. Lisa is a successful serial entrepreneur, having grown her last company Revel Systems to over 700 employees and \$200m in funding, with a successful exit. She is now taking this expertise of building companies to help save people's lives and make the world a safer place.

Awards and News:

- 2016: Named as a Top Female Entrepreneur by Ernst Young, listed as one of Business Journal's "Upstart 100", and named one of 40 Female Founders who crushed it in 2016 by TechCrunch.
- 2015: Recognized by Fortune Magazine as no. 19 on the 40 Under 40 list as well as the Forbes list of Eight Rising Stars.
- Featured on CNBC, ABC, and Bloomberg as a payment expert.
- A regular featured speaker at conferences from Forbes, Goldman Sachs, Collision, Fortune most Powerful Women, RSPA, Fortune Brainstorm Tech, Stanford University, and Money2020.

Chris Ciabarra is the CTO and co-founder of Athena Security. Chris is an expert in product development, technology, data security and corporate management. He is also an anti-hacking expert and founded Network Intercept, a security software firm. In his former role as co-founder and CTO of Revel Systems, Chris developed the technology behind Revel's award-winning iPad Point-of-Sale system. He partnered with Lisa to grow the company to one of the leaders in the point-of-sale space with a valuation of more than \$500 million and a clientele that includes Royal Dutch Shell, Goodwill, Cinnabon, and Tully's Coffee. Chris is now utilizing his technology and security expertise to transform the video surveillance and alarm system space.

Honors

- Member of the Forbes Technology Council, a community for the world's top CIOs, CTOs and technology executives.
- Writer for publications in the technology and marketing industries, including Payments Source.

Michael Green is the President and lead for enterprise clients, who joined in April 2019. He spent the last three years managing a team that built enterprise applications, mainly for large financial services companies. Prior, he ran and sold a specialty distribution business. 40 Under 40 Cincinnati Business Courier.

The Problem

The FBI defined mass shootings as the death from a gun of 4 or more victims, not including the shooter. For the purpose of this paper, we are focusing on the problem of gun violence of one to many, as a perpetrator seems to unleash the furry without boundaries on many people. Catastrophes can be either premeditated or a chain reaction from a slippery slope of circumstances. No matter the category of intent in the perpetrator's psyche, no modern society accepts civilians attempting to slaughter others. In Active Shooter situations, dozens can die before the first squad car arrives on the scene. The Department of Homeland Security's *Active Shooter: How to Respond Educational Booklet* reports that **"the average duration of active shooter incidents in institutions of higher education within the United States is 12.5 minutes. In contrast, the average response time of campus and local law enforcement from the beginning of the incident to the scene is 18 minutes."**

The number of security cameras continues to increase. It's hard to know if the number of trained people watching these cameras is proportionally increase also. The security that is provided by the camera typically has no real-time accountability. Thus, the security is more about liability. Most employ "security" cameras hoping to reduce dangers and liability. But the only real function of those cameras is to investigate what happened after the fact and provide evidence in court and insurance companies.

Even highly trained security guards who monitor many screens may experience a phenomenon called "video blindness". **It's been suggested that a guard can only effectively monitor ONE screen for 40 minutes. *Security Oz Magazine* found that operators miss up to 45% of screen activity after 12 minutes of continuous monitoring, and this miss rate increases to 95% after 22 minutes.** When a trained guard cannot monitor a single camera for more than 40 minutes effectively, what chance do we have of securing every hallway and every classroom in every school in the country?

Law enforcement cannot act without accurate intel, and terrified victims calling from cell phones just cannot provide that. San Francisco's chief of police told how his officers are called on site without the information they need. The Chief said a crime could be documented on video, and yet "it could take up to a few days before [officers] get footage from the crime scene." Suspects cannot be held indefinitely waiting for that evidence, so dangerous offenders walk free thanks to bureaucratic delays.

While law enforcement contends with this lack of Intel, they are vilified for not reacting swiftly enough to shootings, and for overreacting to



MONITORING JUST DOESN'T
WORK

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perceived threats. We know that 911 calls are subject to bias and don't provide reliable information, and yet the officers who risk their lives daily to serve and protect have to rely on those calls. In these instances, our officers are setup to fail.

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The Solution

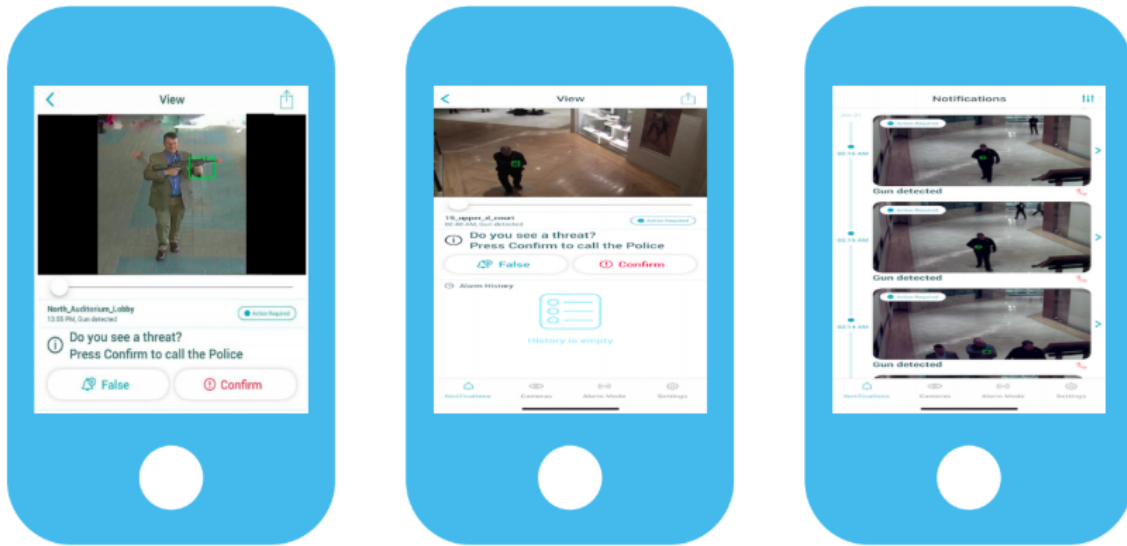
What if, instead of getting spotty information secondhand from a 911 operator, police were notified of the exact location of an incident, knew who the victims and criminals were, had an inventory of the weapons on site, and knew the real-time status of the threat---all from the time that the weapon was first spotted!

Athena Security launched in April of 2018 with paying customers for the new, proactive threat-detection and alert system that automatically detects guns in a real-time through a video feed. Athena Security Cameras employ artificial intelligence

Once Athena detects a threat, it sends critical information in real time to a monitoring service. That service validates the threat and only involves law enforcement when needed. Athena's AI-powered technology analyses multiple data points to detect crimes faster and more accurately than systems that rely solely on humans. Once an alarm is triggered, Athena offers the option to provide a lock down if the client chooses to integrate with access control. It could lock down elevators unless manual override key is inserted (fireman have a key by default), lock all classroom doors from outside access if a gun is detected, turn on lights, close all parking gates, and send text messages to selected third parties, and web application.

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The software is agnostic to camera manufacturer and works off an RTSP feed from the camera, NVR, or VMS. A local only, cloud only, and hybrid cloud version is available. Our hybrid cloud version is recommended for highest combination of speed and accuracy, and is the version tested here.



Testing

Every measure and precaution has been taken for safety during this testing for testing weapons that have been provided by the Athena Security Team. No ammunition or magazines were allowed on site. Weapons have been cleared and inspected prior to handling. Cleared weapons have been marked with yellow tape or orange tip. Local PD has been advised of the test and invited to participate or observe. Tenants were advised during the day that a training exercise will occur after hours. Signs were placed near the testing area alerting the public. An announcement has been made prior to testing. White tape has been placed on the ground at 5 foot intervals up to 30 feet approaching each test camera to determine effective distance of the video AI Gun Detection analytic. Due to the large volume of testing and some anticipated guest attendance, yellow highlighted rows have been completed first so that each aspect of the tests could be seen. Testing staff included: Test Director, Results Capture, Product Specialists, and Role Players. The Lighting was 140 Lux or more.

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The testing images and database consists of two types of objects:

- Weapons, which are considered dangerous and should be detected. In the following test cases "1" in each cell means a successful detection has occurred. "1" in case of a weapon means a successful detection has occurred and an alert has been made.
- Non-weapon objects, which are not dangerous and should not be detected as a weapon. In the following test cases "1" in each cell means a successful detection has occurred. "1" in case of a non-weapon means a successful detection has occurred that the object is not a weapon and no alert has been made.

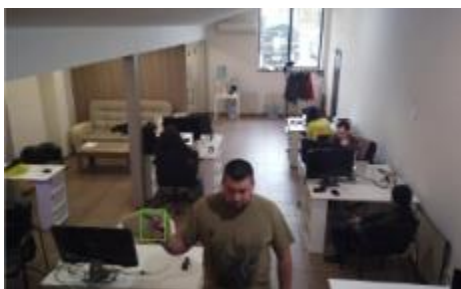
Testing Images And Examples

Following are few sample images for different scenarios taken during testing:

5 Feet from the camera, Person standing with hand gun out

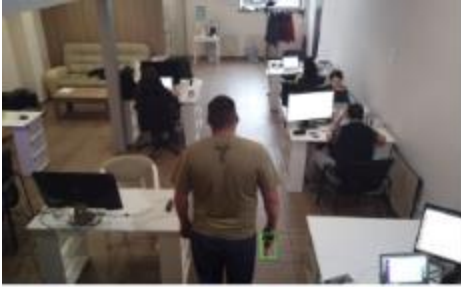


5 Feet from the camera, Person standing with hand gun pointed out



5 Feet from the camera, Person standing with hand gun out

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5 Feet from the camera, Person standing with hand gun pointed downwards



10 Feet from the camera, Person standing with hand gun out



10 Feet from the camera, Person standing with hand gun pointed out



10 Feet from the camera, Person standing with a hand gun pointed upwards

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15 Feet from the camera, Person standing with hand gun out



15 Feet from the camera, Person walking with a hand gun pointed sideways



20 Feet from the camera, Person standing with hand gun out



20 Feet from the camera, Person walking with a hand gun pointed out

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20 Feet from the camera, Person walking with a hand gun pointed sideways



20 Feet from the camera, Person standing with a hand gun pointed upwards



25 Feet from the camera, Person standing with a hand gun pointed upwards

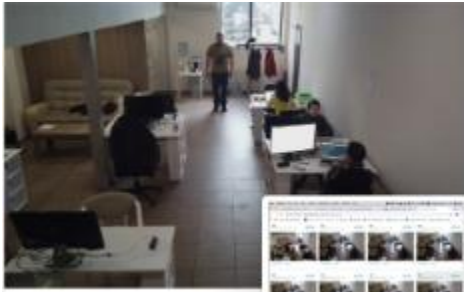


25 Feet from the camera, Person standing with a hand gun pointed sideways

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25 Feet from the camera, Person walking with a hand gun pointed sideways



25 Feet from the camera, Person standing

Testing Results with different variables and objects

In the below test results, "1" in each cell means a successful detection has occurred.

The following results are for testing in a scenario where the object carried is a **handgun** and there is a person with weapon/object **away from body**.

Scenario Name: Handgun	1 Person with Weapon Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Handgun, Glock 9mm, point to left 90 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to left 45 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to right, 90 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to right, 45 degrees	1	1	1	1	1	1
Handgun, Glock 9mm point straight	1	1	1	1	1	0
Handgun, Glock 9mm walking	1	1	1	1	1	1
Handgun, Glock 9mm running	1	1	1	1	1	1
Handgun, Glock 9mm subject turning clockwise	1	1	1	1	1	1
Handgun, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	8
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	88.89%

It is observed that the weapon has been detected in all the cases except when the handgun, a Glock 9mm is pointed straight and is 30 feet from the camera.

So the percentage of accuracy when the weapon is 30 feet away from the camera is 88.9% and in the rest of the cases it is 100%.

The percentage of accuracy for all the cases above together is 98.15%

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The following results are for testing in a scenario where the object carried is a **handgun** and there is a person with weapon/object **close to body**.

Scenario Name: Handgun	1 Person with Weapon Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Handgun, Glock 9mm, point to left 90 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to left 45 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to right, 90 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to right, 45 degrees	1	1	1	1	1	1
Handgun, Glock 9mm point straight	1	1	1	1	1	0
Handgun, Glock 9mm walking	1	1	1	1	1	1
Handgun, Glock 9mm running	1	1	1	1	1	1
Handgun, Glock 9mm subject turning clockwise	1	1	1	1	1	1
Handgun, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	8
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	88.89%

It is observed that the weapon has been detected in all the cases except when the handgun, a Glock 9mm is pointed straight and is 30 feet from the camera.

So the percentage of accuracy when the weapon is 30 feet away from the camera is 88.9% and in the rest of the cases it is 100%.

The percentage of accuracy for all the cases above together is 98.15%

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The following results are for testing in a scenario where the object carried is a handgun and there is a person with weapon/object, and Multiple-Bystanders.

Scenario Name: Handgun	1 Person with Weapon, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Handgun, Glock 9mm, point to left 90 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to left 45 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to right, 90 degrees	1	1	1	1	1	1
Handgun, Glock 9mm, point to right, 45 degrees	1	1	1	1	1	1
Handgun, Glock 9mm point straight	1	1	1	1	1	0
Handgun, Glock 9mm walking	1	1	1	1	1	1
Handgun, Glock 9mm running	1	1	1	1	1	1
Handgun, Glock 9mm subject turning clockwise	1	1	1	1	1	1
Handgun, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	8
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	88.89%

It is observed that the weapon has been detected in all the cases except when the handgun, a Glock 9mm is pointed straight and is 30 feet from the camera.

So the percentage of accuracy when the weapon is 30 feet away from the camera is 88.9% and in the rest of the cases it is 100%.

The percentage of accuracy for all the cases above together is 98.15%

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Testing Object: Assault Rifle

The following results are for testing in a scenario where the object carried is an Assault Rifle and there is a person with weapon/object away from body.

Scenario Name: Assault Rifle	1 Person with Weapon Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Assault Rifle, point to left 90 degrees	1	1	1	1	1	1
Assault Rifle, point to left 45 degrees	1	1	1	1	1	1
Assault Rifle, point to right, 90 degrees	1	1	1	1	1	1
Assault Rifle, point to right, 45 degrees	1	1	1	1	1	1
Assault Rifle point straight	1	1	1	1	1	0
Assault Rifle walking	1	1	1	1	1	1
Assault Rifle running	1	1	1	1	1	1
Assault Rifle, subject turning clockwise	1	1	1	1	1	1
Assault Rifle, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	8
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	88.89%

It is observed that the weapon has been detected in all the cases except when the Assault Rifle is pointed straight and is 30 feet from the camera.

So the percentage of accuracy when the weapon is 30 feet away from the camera is 88.9% and in the rest of the cases it is 100%.

The percentage of accuracy for all the cases above together is 98.15%

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The following results are for testing in a scenario where the object carried is an Assault Rifle and there is a person with weapon/object close to body.

Scenario Name: Assault Rifle	1 Person with Weapon Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Assault Rifle, point to left 90 degrees	1	1	1	1	1	1
Assault Rifle, point to left 45 degrees	1	1	1	1	1	1
Assault Rifle, point to right, 90 degrees	1	1	1	1	1	1
Assault Rifle, point to right, 45 degrees	1	1	1	1	1	1
Assault Rifle point straight	1	1	1	1	1	0
Assault Rifle walking	1	1	1	1	1	1
Assault Rifle running	1	1	1	1	1	1
Assault Rifle, subject turning clockwise	1	1	1	1	1	1
Assault Rifle, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	8
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	88.89%

It is observed that the weapon has been detected in all the cases except when the Assault Rifle is pointed straight and is 30 feet from the camera.

So the percentage of accuracy when the weapon is 30 feet away from the camera is 88.9% and in the rest of the cases it is 100%.

The percentage of accuracy for all the cases above together is 98.15%

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The following results are for testing in a scenario where the object carried is an Assault Rifle and there is a person with weapon, and multiple-Bystanders

Scenario Name: Assault Rifle	1 Person with Weapon, and Multiple-Bystanders					
	5'	10'	15'	20'	25'	30'
Distances						
Assault Rifle, point to left 90 degrees	1	1	1	1	1	1
Assault Rifle, point to left 45 degrees	1	1	1	1	1	1
Assault Rifle, point to right, 90 degrees	1	1	1	1	1	1
Assault Rifle, point to right, 45 degrees	1	1	1	1	1	1
Assault Rifle point straight	1	1	1	1	1	0
Assault Rifle walking	1	1	1	1	1	1
Assault Rifle running	1	1	1	1	1	1
Assault Rifle, subject turning clockwise	1	1	1	1	1	1
Assault Rifle, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	8
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	88.89%

It is observed that the weapon has been detected in all the cases except when the Assault Rifle is pointed straight and is 30 feet from the camera.

So the percentage of accuracy when the weapon is 30 feet away from the camera is 88.9% and in the rest of the cases it is 100%.

The percentage of accuracy for all the cases above together is 98.15%

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The following results are for testing in a scenario where the object carried is a Laptop and there is a person with weapon/object away from body.

Scenario Name: Laptop	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Laptop, facing left 90 degrees	1	1	1	1	1	1
Laptop, facing to left 45 degrees	1	1	1	1	1	1
Laptop, point to right, 90 degrees	1	1	1	1	1	1
Laptop, point to right, 45 degrees	1	1	1	1	1	1
Laptop point straight	1	1	1	1	1	1
Laptop walking	1	1	1	1	1	1
Laptop running	1	1	1	1	1	1
Laptop, subject turning clockwise	1	1	1	1	1	1
Laptop, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Laptop and there is a person with weapon/object close to body.

Scenario Name: Laptop	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Laptop, facing left 90 degrees	1	1	1	1	1	1
Laptop, facing to left 45 degrees	1	1	1	1	1	1
Laptop, point to right, 90 degrees	1	1	1	1	1	1
Laptop, point to right, 45 degrees	1	1	1	1	1	1
Laptop point straight	1	1	1	1	1	1
Laptop walking	1	1	1	1	1	1
Laptop running	1	1	1	1	1	1
Laptop, subject turning clockwise	1	1	1	1	1	1
Laptop, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

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The following results are for testing in a scenario where the object carried is a Laptop and there is a person with weapon/object, and Multiple-Bystanders.

Scenario Name: Laptop	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Laptop, facing left 90 degrees	1	1	1	1	1	1
Laptop, facing to left 45 degrees	1	1	1	1	1	1
Laptop, point to right, 90 degrees	1	1	1	1	1	1
Laptop, point to right, 45 degrees	1	1	1	1	1	1
Laptop point straight	1	1	1	1	1	1
Laptop walking	1	1	1	1	1	1
Laptop running	1	1	1	1	1	1
Laptop, subject turning clockwise	1	1	1	1	1	1
Laptop, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, a laptop which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

The following results are for testing in a scenario where the object carried is a Water Bottle and there is a person with object away from body.

Scenario Name: Water Bottle	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Water Bottle, facing left 90 degrees	1	1	1	1	1	1
Water Bottle, facing to left 45 degrees	1	1	1	1	1	1
Water Bottle, point to right, 90 degrees	1	1	1	1	1	1
Water Bottle, point to right, 45 degrees	1	1	1	1	1	1
Water Bottle point straight	1	1	1	1	1	1
Water Bottle walking	1	1	1	1	1	1
Water Bottle running	1	1	1	1	1	1
Water Bottle, subject turning clockwise	1	1	1	1	1	1
Water Bottle, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

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The following results are for testing in a scenario where the object carried is a Water Bottle and there is a person with object close to body.

Scenario Name: Water Bottle	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Water Bottle, facing left 90 degrees	1	1	1	1	1	1
Water Bottle, facing to left 45 degrees	1	1	1	1	1	1
Water Bottle, point to right, 90 degrees	1	1	1	1	1	1
Water Bottle, point to right, 45 degrees	1	1	1	1	1	1
Water Bottle point straight	1	1	1	1	1	1
Water Bottle walking	1	1	1	1	1	1
Water Bottle running	1	1	1	1	1	1
Water Bottle, subject turning clockwise	1	1	1	1	1	1
Water Bottle, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Water Bottle and there is a person with object, and Multiple-Bystanders.

Scenario Name: Water Bottle	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Water Bottle, facing left 90 degrees	1	1	1	1	1	1
Water Bottle, facing to left 45 degrees	1	1	1	1	1	1
Water Bottle, point to right, 90 degrees	1	1	1	1	1	1
Water Bottle, point to right, 45 degrees	1	1	1	1	1	1
Water Bottle point straight	1	1	1	1	1	1
Water Bottle walking	1	1	1	1	1	1
Water Bottle running	1	1	1	1	1	1
Water Bottle, subject turning clockwise	1	1	1	1	1	1
Water Bottle, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, a water bottle which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

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The following results are for testing in a scenario where the object carried is a Broom and there is a person with object away from body.

Scenario Name: Broom or Floor Maintenance Item	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Broom, facing left 90 degrees	1	1	1	1	1	1
Broom, facing to left 45 degrees	1	1	1	1	1	1
Broom, point to right, 90 degrees	1	1	1	1	1	1
Broom, point to right, 45 degrees	1	1	1	1	1	1
Broom point straight	1	1	1	1	1	1
Broom walking	1	1	1	1	1	1
Broom running	1	1	1	1	1	1
Broom, subject turning clockwise	1	1	1	1	1	1
Broom, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Broom and there is a person with object close to body.

Scenario Name: Broom or Floor Maintenance Item	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Broom, facing left 90 degrees	1	1	1	1	1	1
Broom, facing to left 45 degrees	1	1	1	1	1	1
Broom, point to right, 90 degrees	1	1	1	1	1	1
Broom, point to right, 45 degrees	1	1	1	1	1	1
Broom point straight	1	1	1	1	1	1
Broom walking	1	1	1	1	1	1
Broom running	1	1	1	1	1	1
Broom, subject turning clockwise	1	1	1	1	1	1
Broom, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

**ATHENA SECURITY CORP WHITE PAPER:
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The following results are for testing in a scenario where the object carried is a Broom and there is a person with object, and Multiple-Bystanders.

Scenario Name: Broom or Floor Maintenance Item	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Broom, facing left 90 degrees	1	1	1	1	1	1
Broom, facing to left 45 degrees	1	1	1	1	1	1
Broom, point to right, 90 degrees	1	1	1	1	1	1
Broom, point to right, 45 degrees	1	1	1	1	1	1
Broom point straight	1	1	1	1	1	1
Broom walking	1	1	1	1	1	1
Broom running	1	1	1	1	1	1
Broom, subject turning clockwise	1	1	1	1	1	1
Broom, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, a broom which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

The following results are for testing in a scenario where the object carried is an Umbrella and there is a person with object away from body.

Scenario Name: Umbrella	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Umbrella, facing left 90 degrees	1	1	1	1	1	1
Umbrella, facing to left 45 degrees	1	1	1	1	1	1
Umbrella, point to right, 90 degrees	1	1	1	1	1	1
Umbrella, point to right, 45 degrees	1	1	1	1	1	1
Umbrella point straight	1	1	1	1	1	1
Umbrella walking	1	1	1	1	1	1
Umbrella running	1	1	1	1	1	1
Umbrella, subject turning clockwise	1	1	1	1	1	1
Umbrella, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is an Umbrella and there is a person with object close to body.

Scenario Name: Umbrella	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Umbrella, facing left 90 degrees	1	1	1	1	1	1
Umbrella, facing to left 45 degrees	1	1	1	1	1	1
Umbrella, point to right, 90 degrees	1	1	1	1	1	1
Umbrella, point to right, 45 degrees	1	1	1	1	1	1
Umbrella point straight	1	1	1	1	1	1
Umbrella walking	1	1	1	1	1	1
Umbrella running	1	1	1	1	1	1
Umbrella, subject turning clockwise	1	1	1	1	1	1
Umbrella, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is an Umbrella and there is a person with object, and Multiple-Bystanders.

Scenario Name: Umbrella	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Umbrella, facing left 90 degrees	1	1	1	1	1	1
Umbrella, facing to left 45 degrees	1	1	1	1	1	1
Umbrella, point to right, 90 degrees	1	1	1	1	1	1
Umbrella, point to right, 45 degrees	1	1	1	1	1	1
Umbrella point straight	1	1	1	1	1	1
Umbrella walking	1	1	1	1	1	1
Umbrella running	1	1	1	1	1	1
Umbrella, subject turning clockwise	1	1	1	1	1	1
Umbrella, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, an umbrella which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

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GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is a Car keys and there is a person with object away from body.

Scenario Name: Car Keys	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Car Keys, facing left 90 degrees	1	1	1	1	1	1
Car Keys, facing to left 45 degrees	1	1	1	1	1	1
Car Keys, point to right, 90 degrees	1	1	1	1	1	1
Car Keys, point to right, 45 degrees	1	1	1	1	1	1
Car Keys point straight	1	1	1	1	1	1
Car Keys walking	1	1	1	1	1	1
Car Keys running	1	1	1	1	1	1
Car Keys, subject turning clockwise	1	1	1	1	1	1
Car Keys, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Car keys and there is a person with object close to body.

Scenario Name: Car Keys	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Car Keys, facing left 90 degrees	1	1	1	1	1	1
Car Keys, facing to left 45 degrees	1	1	1	1	1	1
Car Keys, point to right, 90 degrees	1	1	1	1	1	1
Car Keys, point to right, 45 degrees	1	1	1	1	1	1
Car Keys point straight	1	1	1	1	1	1
Car Keys walking	1	1	1	1	1	1
Car Keys running	1	1	1	1	1	1
Car Keys, subject turning clockwise	1	1	1	1	1	1
Car Keys, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is Car Key and there is a person with object, and Multiple-Bystanders.

Scenario Name: Car Keys	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Car Keys, facing left 90 degrees	1	1	1	1	1	1
Car Keys, facing to left 45 degrees	1	1	1	1	1	1
Car Keys, point to right, 90 degrees	1	1	1	1	1	1
Car Keys, point to right, 45 degrees	1	1	1	1	1	1
Car Keys point straight	1	1	1	1	1	1
Car Keys walking	1	1	1	1	1	1
Car Keys running	1	1	1	1	1	1
Car Keys, subject turning clockwise	1	1	1	1	1	1
Car Keys, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, a car keys which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

The following results are for testing in a scenario where the object carried is a Coffee Mug and there is a person with object away from body.

Scenario Name: Coffee Mug	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Coffee Mug, facing left 90 degrees	1	1	1	1	1	1
Coffee Mug, facing to left 45 degrees	1	1	1	1	1	1
Coffee Mug, point to right, 90 degrees	1	1	1	1	1	1
Coffee Mug, point to right, 45 degrees	1	1	1	1	1	1
Coffee Mug point straight	1	1	1	1	1	1
Coffee Mug walking	1	1	1	1	1	1
Coffee Mug running	1	1	1	1	1	1
Coffee Mug, subject turning clockwise	1	1	1	1	1	1
Coffee Mug, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is a Coffee Mug and there is a person with object close to body.

Scenario Name: Coffee Mug	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Coffee Mug, facing left 90 degrees	1	1	1	1	1	1
Coffee Mug, facing to left 45 degrees	1	1	1	1	1	1
Coffee Mug, point to right, 90 degrees	1	1	1	1	1	1
Coffee Mug, point to right, 45 degrees	1	1	1	1	1	1
Coffee Mug point straight	1	1	1	1	1	1
Coffee Mug walking	1	1	1	1	1	1
Coffee Mug running	1	1	1	1	1	1
Coffee Mug, subject turning clockwise	1	1	1	1	1	1
Coffee Mug, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Coffee Mug and there is a person with object, and Multiple-Bystanders.

Scenario Name: Coffee Mug	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Coffee Mug, facing left 90 degrees	1	1	1	1	1	1
Coffee Mug, facing to left 45 degrees	1	1	1	1	1	1
Coffee Mug, point to right, 90 degrees	1	1	1	1	1	1
Coffee Mug, point to right, 45 degrees	1	1	1	1	1	1
Coffee Mug point straight	1	1	1	1	1	1
Coffee Mug walking	1	1	1	1	1	1
Coffee Mug running	1	1	1	1	1	1
Coffee Mug, subject turning clockwise	1	1	1	1	1	1
Coffee Mug, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, a coffee mug which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is a Book and there is a person with object away from body.

Scenario Name: Book	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Book, facing left 90 degrees	1	1	1	1	1	1
Book, facing to left 45 degrees	1	1	1	1	1	1
Book, point to right, 90 degrees	1	1	1	1	1	1
Book, point to right, 45 degrees	1	1	1	1	1	1
Book point straight	1	1	1	1	1	1
Book walking	1	1	1	1	1	1
Book running	1	1	1	1	1	1
Book, subject turning clockwise	1	1	1	1	1	1
Book, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Book and there is a person with object close by body.

Scenario Name: Book	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Book, facing left 90 degrees	1	1	1	1	1	1
Book, facing to left 45 degrees	1	1	1	1	1	1
Book, point to right, 90 degrees	1	1	1	1	1	1
Book, point to right, 45 degrees	1	1	1	1	1	1
Book point straight	1	1	1	1	1	1
Book walking	1	1	1	1	1	1
Book running	1	1	1	1	1	1
Book, subject turning clockwise	1	1	1	1	1	1
Book, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is a Book and there is a person with object, and Multiple-Bystanders.

Scenario Name: Book	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Book, facing left 90 degrees	1	1	1	1	1	1
Book, facing to left 45 degrees	1	1	1	1	1	1
Book, point to right, 90 degrees	1	1	1	1	1	1
Book, point to right, 45 degrees	1	1	1	1	1	1
Book point straight	1	1	1	1	1	1
Book walking	1	1	1	1	1	1
Book running	1	1	1	1	1	1
Book, subject turning clockwise	1	1	1	1	1	1
Book, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, a book which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

The following results are for testing in a scenario where the object carried is a Black Pack and there is a person with object away from body.

Scenario Name: Back Pack	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Back Pack, facing left 90 degrees	1	1	1	1	1	1
Back Pack, facing to left 45 degrees	1	1	1	1	1	1
Back Pack, point to right, 90 degrees	1	1	1	1	1	1
Back Pack, point to right, 45 degrees	1	1	1	1	1	1
Back Pack point straight	1	1	1	1	1	1
Back Pack walking	1	1	1	1	1	1
Back Pack running	1	1	1	1	1	1
Back Pack, subject turning clockwise	1	1	1	1	1	1
Back Pack, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is a Black Pack and there is a person with object close to body.

Scenario Name: Back Pack	1 Person with Object Close to Body					
	5'	10'	15'	20'	25'	30'
Distances						
Back Pack, facing left 90 degrees	1	1	1	1	1	1
Back Pack, facing to left 45 degrees	1	1	1	1	1	1
Back Pack, point to right, 90 degrees	1	1	1	1	1	1
Back Pack, point to right, 45 degrees	1	1	1	1	1	1
Back Pack point straight	1	1	1	1	1	1
Back Pack walking	1	1	1	1	1	1
Back Pack running	1	1	1	1	1	1
Back Pack, subject turning clockwise	1	1	1	1	1	1
Back Pack, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Back Pack and there is a person with object, and Multiple-Bystanders.

Scenario Name: Back Pack	1 Person with Object, and Multiple-Bystanders					
	5'	10'	15'	20'	25'	30'
Distances						
Back Pack, facing left 90 degrees	1	1	1	1	1	1
Back Pack, facing to left 45 degrees	1	1	1	1	1	1
Back Pack, point to right, 90 degrees	1	1	1	1	1	1
Back Pack, point to right, 45 degrees	1	1	1	1	1	1
Back Pack point straight	1	1	1	1	1	1
Back Pack walking	1	1	1	1	1	1
Back Pack running	1	1	1	1	1	1
Back Pack, subject turning clockwise	1	1	1	1	1	1
Back Pack, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried, a back pack which is not a weapon did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is a Purse and there is a person with object away from body.

Scenario Name: Purse	1 Person with Object Away From Body					
Distances	5'	10'	15'	20'	25'	30'
Purse, facing left 90 degrees	1	1	1	1	1	1
Purse, facing to left 45 degrees	1	1	1	1	1	1
Purse, point to right, 90 degrees	1	1	1	1	1	1
Purse, point to right, 45 degrees	1	1	1	1	1	1
Purse point straight	1	1	1	1	1	1
Purse walking	1	1	1	1	1	1
Purse running	1	1	1	1	1	1
Purse, subject turning clockwise	1	1	1	1	1	1
Purse, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following results are for testing in a scenario where the object carried is a Purse and there is a person with object close to body.

Scenario Name: Purse	1 Person with Object Close to Body					
Distances	5'	10'	15'	20'	25'	30'
Purse, facing left 90 degrees	1	1	1	1	1	1
Purse, facing to left 45 degrees	1	1	1	1	1	1
Purse, point to right, 90 degrees	1	1	1	1	1	1
Purse, point to right, 45 degrees	1	1	1	1	1	1
Purse point straight	1	1	1	1	1	1
Purse walking	1	1	1	1	1	1
Purse running	1	1	1	1	1	1
Purse, subject turning clockwise	1	1	1	1	1	1
Purse, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

**ATHENA SECURITY CORP WHITE PAPER:
GUN DETECTION ACCURACY IN THE ATHENA ARTIFICIAL INTELLIGENCE SYSTEM**

The following results are for testing in a scenario where the object carried is a Purse and there is a person with object, and Multiple-Bystanders.

Scenario Name: Purse	1 Person with Object, and Multiple-Bystanders					
Distances	5'	10'	15'	20'	25'	30'
Purse, facing left 90 degrees	1	1	1	1	1	1
Purse, facing to left 45 degrees	1	1	1	1	1	1
Purse, point to right, 90 degrees	1	1	1	1	1	1
Purse, point to right, 45 degrees	1	1	1	1	1	1
Purse point straight	1	1	1	1	1	1
Purse walking	1	1	1	1	1	1
Purse running	1	1	1	1	1	1
Purse, subject turning clockwise	1	1	1	1	1	1
Purse, subject turning counter clockwise	1	1	1	1	1	1
Number of Detections	9	9	9	9	9	9
Percentage of Accuracy	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

It has been observed that the object carried a purse, which is not a weapon and did not cause any false detections. So the percentage of accuracy for all the cases above together is 100%.

Conclusion

The proposed Athena Gun Detection System performed in the 99th percentile for accuracy across positives and false positive testing. Continuous research and development is needed to continue improvements.