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LASER RANGE FINDERS IN FORENSIC FIREARMS EXAMINATION

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TECHNICAL MEMORANDUM

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NOTE: Further information about this report can be obtained by calling the CPRC information number (613) 998-6343

The following evaluates modern laser range finding equipment in order to determine its potential for use in the field of forensic firearms examination.

The Canadian Police Research Centre would like to thank Alan Voth for his permission to reproduce and distribute the paper.

Dans cet article, l'auteur évalue un appareil moderne de télémétrie à laser pour déterminer s'il pourrait servir à l'examen judiciaire des armes à feu.

Le Centre canadien de recherches policières remercie Alan Voth pour lui avoir permis de reproduire et de distribuer cet article.

LASER RANGE FINDERS

IN

FORENSIC FIREARMS EXAMINATION

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PURPOSE

The purpose or objective of this research project has been to evaluate modern laser range finding equipment to determine its potential for use in the field of forensic firearms examination. This project has been designed to evaluate both the emerging technology of using lasers to determine distance measurements and then also to evaluate the usefulness such instruments might have to a firearms examiner. Accordingly this report examines first the current state of the available technology and then discusses its application.

METHODOLOGY

To become better informed in this area and to determine what work had been previously done in this regard a literature search was commenced. Nothing could be found that related directly to laser range finding devices and Forensics however a number of 'evaluation' type magazine articles were located that discussed the pro's and con's of individual makers products. These were normally found in sporting or firearm type magazines and ranged from poor to good in the effort and integrity that the authors put into their work. These are listed in the References section of this report.

In the process of researching literature a list was compiled of manufacturers that produced products that would appear to have some application for forensic firearms examiners. Four different manufacturers were identified and their representatives contacted and requested to supply an instrument on a loan basis for evaluation and testing. Of these, three were able to provide something within the time frame allotted for this project. These were Bushnell Corporation, Laser Technology Inc. and Leica Canada.

Bushnell provided two different items from their product line, Laser Technologies also provided two and Leica one. It should be noted that these companies are constantly conducting research and bringing out new products and what I tested was what they had available at the time of the request. Additionally, other companies with no products in this field are now coming out with laser range finding instruments.

Once received, all five devices were examined and evaluated in regards to a number of criteria. These included size, weight, minimum and maximum usable range, power requirements, magnification, low light operation, accuracy, warranty, cost, features and ease of operation. Individual evaluations of these units are included in the Unit Tests portion of this report.

LASER BASICS

Generally speaking there are four things which affect the ability of a laser to range a distant target: they are the emitting laser source itself, the sensor which detects the reflected light, the amount of beam divergence present and the nature of the target.

Light from a laser is of course coherent, in phase, and all of the same wavelength. It does not get materially weaker the further away it gets from its source but the beam does get progressively wider the further it travels. This propensity to spread is called beam divergence. A unit with a large beam divergence expands more as the range increases than does a laser with a small beam divergence. While military lasers use YAG (yttrium argon gas) technology, consumer market lasers use a diode type which emits something close to infrared light (not visible and eye safe). Diode lasers typically have a wide beam divergence which can range from 0.3 to 4.0 milliradians (one milliradian is equal to 1 yard of divergence at 1000 yds). The smaller the beam divergence the more accurate and sensitive (and expensive) the laser is likely to be. Some companies, notably Bushnell, have however now refined their sensor technology to the point that they feel they are a long way toward compensating for a wide beam divergence.

The nature of the target is an important consideration in determining how far and reliably a laser ranging device will function. The best targets are those that are large, light reflective, smooth surfaced and perpendicular to the lasers beam. These include such objects as road signs and metal buildings. The poorest targets are those that are small, light absorbing, rough surfaced and angled to the lasers beam. They can include sloped roofs covered in cedar shakes or a flat grassy field.

Additionally, atmospheric conditions can affect a laser's ranging capability. Heavy rain, fog, snow or smoke can materially reduce some instruments ability to range a target.

CALIBRATION

In light of the impending requirement of Lab accreditation that all measuring instruments be calibrated against a known standard, this particular aspect deserves some special comment. If there is no means of calibrating a measuring instrument it cannot then be used to conduct distance measurements that form any part of a formal conclusion.

My inquiries about this matter led me to the Northern Alberta Institute of Technology's Survey School where the staff proved most helpful in answering my questions. I learned that laser technology is how high precision distance measurement is now done in the surveying industry. They need to calibrate their instruments as well and to this end the government has built and maintains four calibration sites in the province. These are officially known as Electronic Distance Measuring Calibration Baselines. The Baseline I used near Edmonton consists of six concrete pillars set at varying distances that when used in combination provide

twelve (12) different distance measurements from 120.2094 metres to 2357.5778 metres. According to school staff similar Baselines exist in all provinces.

Each of these pillars has a five-eighth inch bolt imbedded into its top surface. In use, the operator mounts a reflective "target" on one pillar, the measuring device is mounted on another pillar and a measurement is then taken. To utilize this baseline I made up a "target" consisting of a piece of sheet metal approximately 0.5 metres square with a simple L shaped bracket attached that could be bolted to the pillar. It was painted a high gloss red colour to increase its visibility and reflectivity and proved to work well within the limits of the instruments tested.

The accuracy figures on the tested instruments were derived using this baseline and the target I constructed.

UNIT TESTS

The following pages detail some of the basic characteristics of each of the five laser range finding instruments tested, with one page devoted to each unit and a photograph following. The Comments section contains my opinion on any notable negative or positive features.

Overall, I was impressed by the accuracy of all of the units tested. None of them, at any time, gave any reading which could be interpreted as being incorrect when tested on the Edmonton Baseline. The manufacturers claims regarding accuracy (typically plus or minus one (1) metre/yard) were always correct.

The previously mentioned beam dispersion manifested itself in one particular measurement on the Baseline when a stop sign that was much more reflective than my target and 85 metres beyond it and to the left caused the Bushnell instruments to range off of it rather than what I was aiming at. The Leica with its narrower dispersion was not affected by the stop sign. Neither of the Laser Technology products were able to get any reading. When I realized what was happening I aimed off the target to the right, catching my target on the edge of the Bushnell's footprint, missing the stop sign and obtaining a correct reading. This illustrates the need to be aware of the possibility of stray or erroneous readings and to be prepared to compensate for them.

At the Edmonton Baseline, I tested at fixed distances of 120, 454, 875 and 900 metres. On the day of testing there was moderate to heavy snow falling and I suspect this may have caused some disruption to the maximum range of the units as these were less than ideal conditions.

When this testing was concluded it became necessary to return the units to their suppliers and to purchase a unit for further field and operational testing. Based on the results observed to date and the budget limitations of this project ($700) the Bushnell Yardage Pro 800 was purchased for further evaluation as to the potential of these devices in Forensic Firearms work.

BUSHNELL - YARDAGE PRO 400

SIZE: 6.2" x 4.75" x 2.5"

WEIGHT: 1.0 lbs

MAGNIFICATION: 4X - monocular

POWER REQUIREMENTS: standard 9 volt battery

USEABLE IN DARKNESS: no

MINIMUM RANGE: Advertised - 25 yds
Actual - 21 yds

MAXIMUM RANGE: Advertised - 400 yds on an average target, 999 yds on a highly reflective target.
Actual - 876 yds (as tested on the Edmonton Baseline)

ACCURACY: Advertised - +/- 1 yard
Actual - +/- 1 yard

WARRANTY: 1 year

COST: Approx. $350.00

FEATURES: Will display distances in yards or metres. Has a Rain Mode which aids measurement in inclement weather, a Zip Thru Mode which ignores targets in the foreground such as brush or branches and a Reflector Mode which enhances distance measurement to highly reflective targets. Also has a Target Quality indicator which provides a visual reference of the reflective quality of a target, as well as a Low Battery indicator. Roll down eyecups to accommodate eyeglass wearers. Comes with carrying case and neck strap.

EASE OF OPERATION: Two button operation. Left button selects Mode and right button activates laser.

COMMENTS: Simple to use. Least expensive.

BUSHNELL
YARDAGE PRO 400

BUSHNELL - YARDAGE PRO 800

SIZE: 6.2" X 5.0" X 2.5"

WEIGHT: 1.1 lbs

MAGNIFICATION: 6X - monocular

POWER REQUIREMENTS: standard 9 volt battery

USEABLE IN DARKNESS: yes, LED display illuminated

MINIMUM RANGE: Advertised - 25 yards
Actual - 16 yards

MAXIMUM RANGE: Advertised - 800 yds on an average target, 999 yards on a highly reflective target.
Actual - 876 yards (as tested on the Edmonton Baseline)

ACCURACY: Advertised - +/- 1 yard
Actual - +/- 1 yard

WARRANTY: 1 year

COST: approx. $560.00

FEATURES: Will display distances in yards or metres. Has a Rain Mode which aids measurement in inclement weather, a Zip Thru Mode which ignores targets in the foreground such as brush or branches, a Reflector Mode which enhances distance measurement to highly reflective targets and a Scan Mode which provides continuous measurement as multiple targets are scanned or one moving target tracked (10 seconds only). Also has a Target Quality indicator which provides a visual reference of the reflective quality of a target, as well as a Low Battery indicator. Roll down eyecups to accommodate eyeglass wearers. Comes with carrying case and neck strap.

EASE OF OPERATION: Two button operation. Left button selects Mode and right button activates laser.

COMMENTS: Simple to use. Most features for the money.

BUSHNELL
YARDAGE PRO 800

LASER TECHNOLOGY INC. - IMPULSE

SIZE: 6.5" X 3.0" X 5.5"

WEIGHT: 2.1 lbs

MAGNIFICATION: 1X - no magnification, sighting device is red dot type pistol scope.

POWER REQUIREMENTS: 2 AA batteries for approx. 20 hrs of use. Two minute non-use auto shut off or manual shut off.

USEABLE IN DARKNESS: Yes, LED display illuminated.

MINIMUM RANGE: Advertised - less than 1 metre
Actual - less than 1 metre

MAXIMUM RANGE: Advertised - 500 metres
Actual - 120 metres (as tested on the Edmonton Baseline)

ACCURACY: Advertised - +/- .01 metre
Actual - +/- .01 metre

WARRANTY: 1 year

COST: Approx. $2500.00

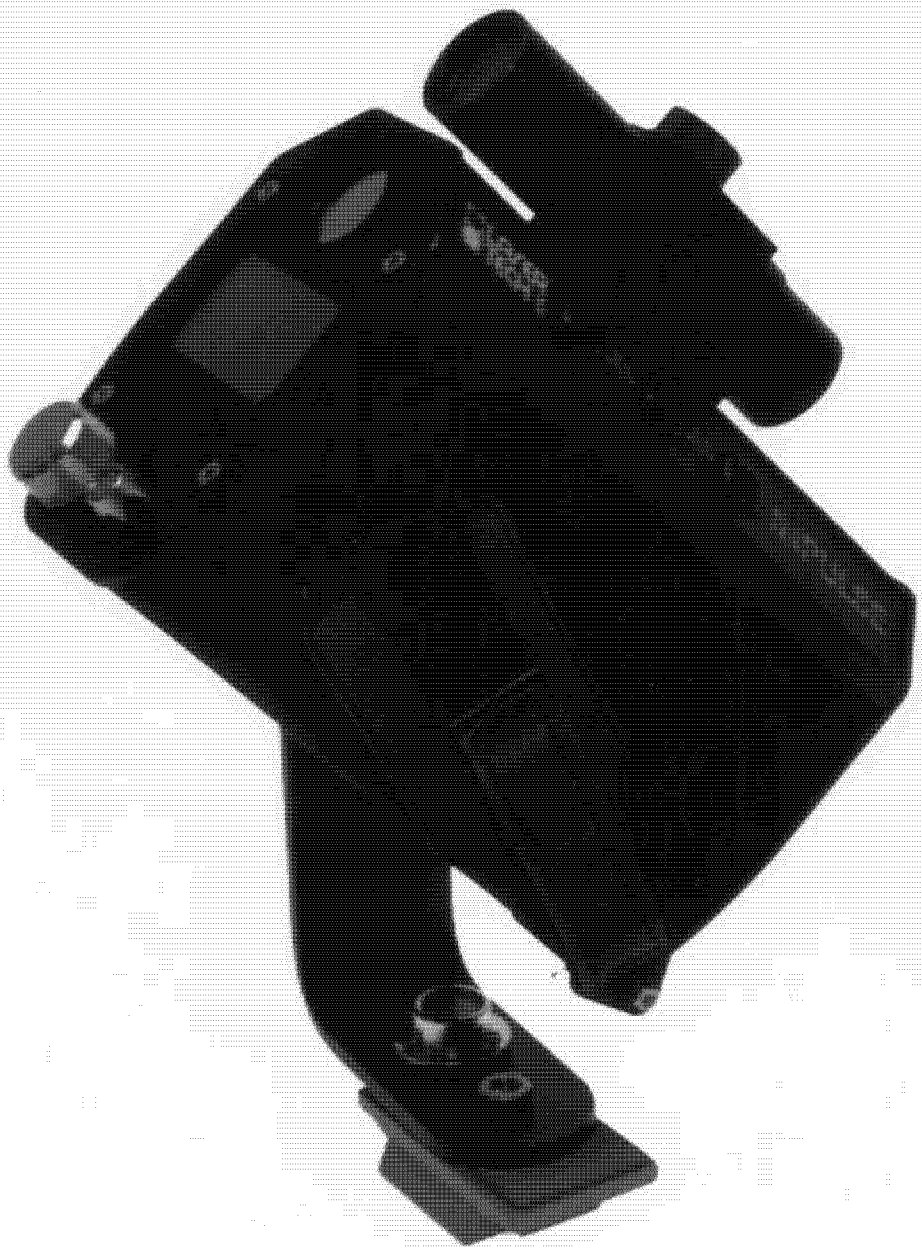
FEATURES: Capable of measuring distance and inclination to an object and performing calculations to determine height of an object, horizontal, vertical and slope distances. Capable of maintaining a cumulative distance measurement for a succession of targets or to calculate the differences between a base measurement and a series of targets. Measures in feet, metres, (not yards), degrees, grads and percent slope. Low battery indicator. Convertible to left and right hand use. Uses a 4 pin serial connector to download information to a data collector or a notebook computer. A compass add-on will give bearings. Has a built in filter to screen out brush and any objects but highly reflective targets.

EASE OF OPERATION: Operates utilizing six buttons on its control panel. None of the buttons are marked as to the function they perform and all perform multiple functions depending on the sequence in which they are manipulated. Fifty-five page operators manual.

COMMENTS: Very accurate over its useable distance, which was shorter than advertised. Performs a large variety of functions but is difficult to learn how to operate. Perhaps more suitable for "survey" type use.

LASER TECH. INC.

IMPULSE



LASER TECHNOLOGY INC. - SHARPSHOT 2000

SIZE: 6.5" X 3.5" X 5.5"

WEIGHT: 2.1 lbs

MAGNIFICATION: 1X - no magnification, sighting device is red dot type pistol scope.

POWER REQUIREMENTS: 2 AA batteries, up to 20 hrs operation.

USEABLE IN DARKNESS: Yes, LED display illuminated.

MINIMUM RANGE: Advertised - 1 metre
Actual - 1 metre

MAXIMUM RANGE: Advertised - 600 metres
Actual - 454 metres (as tested on the Edmonton Baseline)

ACCURACY: Advertised - +/- 1 metre
Actual - +/- 1 metre

WARRANTY: 1 year

COST: approx. $2000.00

FEATURES: Capable of measuring distance and inclination to an object and performing calculations to determine height of an object, horizontal, vertical and slope distances. Capable of maintaining a cumulative distance measurement for a succession of targets or to calculate the differences between a base measurement and a series of targets. Measures in feet, metres, (not yards), degrees, grads and percent slope. Low battery indicator. Convertible to left and right hand use. Uses a 4 pin serial connector to download information to a data collector or a notebook computer. A compass add-on will give bearings. Has a built in filter to screen out brush and any objects but highly reflective targets.

EASE OF OPERATION: Operates utilizing six buttons on its control panel. None of the buttons are marked as to the function they perform and all perform multiple functions depending on the sequence in which they are manipulated. Seventy-three page operators manual.

COMMENTS: Performs a large variety of functions but is difficult to learn how to operate. Perhaps more suited to "survey" type work.

LASER TECH.
SHARPSHOT 2000

LEICA - GEOVID

SIZE: 8.1" X 7.0" X 3.2"

WEIGHT: 3.3 lbs

MAGNIFICATION: 7X binocular

POWER REQUIREMENTS: 6 volt Lithium battery

USEABLE IN DARKNESS: yes - display illuminated

MINIMUM RANGE: Advertised - 25 metres
Actual - 23 metres

MAXIMUM RANGE: Advertised - 1000 metres
Actual - 876 metres (as tested on the Edmonton Baseline)

ACCURACY: Advertised - +/- 1 metre
Actual - +/- 1 metre

WARRANTY: Unknown

COST: approx. $4000.00

FEATURES: True binocular capability with individually adjustable diopters. Through the lens viewable LCD. Auto shut off. Available with internal compass to give bearing measurement.

EASE OF OPERATION: One button operation - simple to use.

COMMENTS: Very high quality optics. Relatively large and heavy. Comes with carrying case and strap. Readout is in metres only. Appears to have the narrowest beam divergence and greatest sensitivity of any unit tested. Expensive.

LEICA GEOVID

LASER RANGE FINDERS IN USE

Having a laser range finder available in the section on a fairly continuous basis now for several months enabled more field testing to be done as well as actual operational use.

While our Firearms Section infrequently goes to crime scenes, the Bushnell 800 has accompanied me to one such scene where a distance measurement was required. The important distance in this case proved to be less than the minimum 16 yards this instrument is capable of measuring. An old fashioned tape measure did the job. Other secondary and less important distances were quickly and easily measured with the laser.

On several occasions the Bushnell 800 has been utilized to measure odd shooting distances at the local rifle range when distances other than the usual 25, 50 or 100 yard/metre increments were required. It performed this function rapidly and accurately.

An interesting aside is that I have taken this device to several ranges and have measured their target frame distances from the firing line, finding them to be usually quite accurately placed. Usually - but not always. The most glaring examples were a 300 yard target frame that was located 343 yards away and a 25 yard target frame that was located 21 yards away. The latter being at the local range where we do our outdoor range testing and trust the target frames to be correctly distanced. Not any more. Additionally some ranges are spaced in metres and others in yards with no indication as to which they represent.

CONCLUSIONS

As a result of the work that has been done with these devices and the Bushnell 800 in particular, their potential in Forensic Firearms work is seen to be largely in the areas of determining distances at a crime scene and as a measuring device to aid target placement when doing shooting tests at extended ranges. Secondarily, they can confirm the distances such as target frame to firing line, that have in the past (perhaps mistakenly) always been taken as a given.

Laser rangefinding devices can save considerable time in making measurements and are likely more accurate than the old method of stretching out a long tape especially over multiple increments. They are eye-safe to use, accurate within required parameters, can be calibrated to insure accuracy and are available at reasonable prices. It is recommended that each Firearms Section have at least one laser ranging device available to assist in making distance measurements.

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