Tracking vehicle speed

What's new in the world of radar technology

By Geoffrey Gluckman

In the secretive world of speed assessment technology, competition is fierce — each company battling to get the ears and eyes of law enforcement departments on the prowl for the latest and greatest advancements. In the midst of all this posturing, one question remains.

What is the truth about innovations in radar and lidar technology?

Radio frequency interference

As with most areas of the modern world, computers are continually making their presence known, both as improvements and hindrances. The world of speed measurement and enforcement is not immune.

In recent years, the biggest problem for radar equipment has been radio frequency interference (RFI). All electronic products emit an electromagnetic force field (EMFF) and those that send and receive signals produce radio frequencies, thus there exists a strong potential for interference with police radar equipment.

"Many patrol cars are now fitted with GPS, which sends a location transmission back to headquarters every eight to 10 seconds," states Steve Hocker TITLE of Kustom Signals Inc. of Lenexa, Kansas. "These automated transmissions and receptions, such as silent dispatch, to the mobile data computer (MDC or MCT) within the patrol car create the likelihood for increased RFI." In the past, according to Hocker and others in the industry, if the interference level became too high when a radar unit operated, it would shut down, showing RFI in the display window.

One company, Stalker Radar reports it has solved this issue and other problems related to RFI. In its full line of radar units, this Plano, Texas-based company has digitized the antennas receiving the Doppler signal. Furthermore, Stalker's units employ third-generation computer technology with two sets of microwave circuits and amplification circuitry to create a "high-speed, bi-directional communications link" to transmit the information between antenna and the counting unit. The same is true for most of other radar manufacturers. In fact, Decatur Electronics Inc. of Decatur, Illinois, calls its system "RFI hardened", employing twin signal filters in the Genesis II Select radar unit. Most manufacturers also use shielded cables for further RFI protection, such as Owensboro, Kentucky-based MPH Industries' Enforcer.

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A related interference issue occurs during radar use in motion — the accurate measurement of patrol car speed. Known as shadowing or ghosting, the phenomenon occurs when the radar unit measures the enforcement vehicle's speed as the difference between the actual and target vehicle's speed. Typically, this happens when the target vehicle and the patrol car rates of travel are very different. In essence, the radar unit needs help in determining the ground speed of the cruiser.

Again, computers come to the rescue. The use of digital signal processing (DSP), usually 32 bit, is industry standard and has significantly increased signal clarity. MPH Industries connects the radar unit to the unit's On Board Diagnostics (OBD) center through the data port that monitors vehicle speed. Kustom Signal's TruTrak monitors the patrol speed by DSP connected to the speedometer, whereas Stalker uses an optional cable attached to the vehicle speed sensor (VSS), common on most modern cars. The VSS is attached to the transmission or an axle that generates the speed signal, thus feeding the radar unit for accurate cruiser rate of motion.

There are two advantages to the cable method. First, it features an auto-calibration function that activates each time the unit turns on, which then takes tire wear into account. Second, the cable allows departments to switch the radar unit between patrol vehicles.

Finally, in relation to RFI, is the issue of audio tone variance that can occur as the patrol car alters speed. The industry addresses this through a purification of the Doppler audio signal, where the tone of the patrol car is fixed, so any changes in audio pitch are due to the target speed. Thus, the officer can know the rate of travel without looking at the display.

Certainly, with the increase of radio transceiving, both inside and outside the enforcement vehicle, there is always room for improvement in the area of RFI immunity. However, John Broxon TITLE of MPH states that the complaints of RFI problems from officers are few.

Pinpointing the target

An equally disruptive challenge to effective speed enforcement has been the detection of a faster target in the presence of a stronger (larger vehicle) signal. In the past, a radar unit would display an LED readout to an officer monitoring traffic on a four-lane highway (two lanes each direction). However, due to the wide beam emitted by radar, determining which target was traveling at that rate was left to the officer to decide, especially since radar units had only two windows — target and patrol speed. This often led to incorrect target identification. The frequent case would be that a stronger signal from a truck would override an approaching faster target, even though the officer could visually estimate the speed of the latter. Moreover, in many states, if the faster target's speed cannot be locked and tracked, then the chances for successful court resolution, if required, would be slim.

Enter technology to save the day. Alteration to the radar unit design offered a solution to this problem as well as related differentiation issues. First, what is known through the industry as "Fastest" technology produced the ability to discriminate between the strongest target and the fastest target. Key in this advancement was the addition of a third window that specifically shows the "Fastest" target, while the other two windows display the strongest target and the patrol speed, if in motion. Some companies even use different colored LED readouts to further distinguish between the three. Also, in the case of Decatur Electronics, they have added easy-to-read settings in the display windows, instead of often confusing numeric messages. Added to this is an automatic tracking feature employed after locking on a target, which is critical for establishing history required for radar case law. Kustom Signal's units automatically track the target for five seconds after trigger release, then it discontinues signal transmission.

Direction sensing

Along with this improvement came the solution to another common problem — direction sensing. Again, due to the wide beam of radar (as much as 250 feet at 1,000 feet), the unit would not discriminate between approaching targets and those going away, especially on a two-lane road (one lane each way). This became an issue in the radar unit's ability to ignore vehicles traveling away, especially if they were closer.

The solution, such as MPH's trademarked Automatic Same Direction (ASD) technology, allows the officer to select from four modes of operation rather than from just two in older technology. The options are moving, stationary closing, stationary away, and stationary bi-directional. By the flick of a switch, radar units can now ignore targets that are moving away or vice versa, even if they are closer. This is most helpful on a divided highway where it would be impossible to pursue a violator on the opposite side of the enforcement vehicle. Furthermore, most radar units offer front and rear antennas and indication as to which one received the signal. As an added bonus, most units offer an automatic change between stationary and moving modes dependent on the state of the patrol vehicle, such as when stopped at a traffic light. Also, the Doppler audio tone heard in the patrol car is only linked to the target.

With MPH's equipment and most others', the ability to monitor same-lane traffic and determine without a doubt whether it is moving faster or slower than the patrol car is available as well. Most often this is beneficial when the patrol speed and the target speed are similar, but the distance is larger. Both of the aforementioned automated advancements have eliminated operator error by choosing the wrong mode, direction, antenna or target lock failure. In fact, most units on the market offer all of this information through audible notification.

Defeating radar detectors

A curious radar advancement in recent years relates to defeating radar detectors. MPH Industries employs its patented POP mode in most of its products. By activating this feature the radar computer emits a very short burst of microwave frequency that allows for speed assessment without setting off detectors. MPH claims 95 percent of all detectors cannot identify radar guns in POP mode, which field tests confirm. Kustom Signal's QuikTrak functions similarly. Using one button, the unit ceases "RF hold mode" and monitors targets. Then, target speed lock is achieved by releasing the button and the unit returns to hold status. Units from both companies offer the ability to get a target tracking history as well. In fact, in the field one method of tracking with MPH's technology has been dubbed "popping", where repeated POPs of the target create a valid history. While every moving radar unit on the market can be used in instant on mode, the two aforementioned innovations appear to be improvements.

Rugged units

Overall, manufacturers have improved the radar units to better suit law enforcement's needs, such as lessening weight through the use of aluminum and carbon casing, and hardening shells for impact resistance. One of the engineering feats has been to completely waterproof the units, particularly the cable-to-antenna connections. Also, unit placement has been a challenge, especially in smaller patrol cars, such as the Chevy Impala, where the airbag deployment would be inhibited. However, many of the designs have miniaturized the units and allow for multiple mounting options. Most handheld units, such as MPH's Z-35, come cordless.

Perhaps future radar technology will focus on Broxon's (MPH) view of "making the officer's job easier."

Advances in lidar

The biggest advancement in speed assessment technology is lidar (light detecting and ranging). Though radar units outnumber lidar units by seven to one, laser popularity is advancing, especially for use in dense traffic areas.

Lidar hit the market in the early 1990s, originally developed from work pioneered by Laser Technology Inc. (LTI), based in Centennial, Colorado, for military applications. Lidar is young in comparison to radar, but brings different strengths (and weaknesses) to the field of speed enforcement.

Lidar has three distinct advantages over radar. First, since it uses light for speed determination, RFI problems are not as significant. Second, it offers precise target identification through a narrow beam — three feet at 1,000 feet. The latter can be recorded onto a mini-PC unit and captured by digital camera, as in the case of LTI's 20-20 Ultra Lyte laser with Micro Digi-Cam. This data can then be transferred to a more permanent storage and retrieval system through USB capabilities, or printed at the enforcement site. Last, since the burst of light is narrow and short, it defies detection, unlike radar's advance warning. However, it is susceptible to jamming.

Not without limitations

One of lidar's biggest challenges — invalid readings, also known as sweep error — has troubled the industry. In this scenario, when the unit emits its stimulated light emission, part of that is returned to the internal microcomputer, which then calculates the distance traveled by the signal. Through further automatic computation this gives the speed of the target in question. At times, in panning a target, a lidar unit would issue false readings. According to Hocker, part of that sweep error relates to the operator's lack of steadiness, which often elicits the comment that lidar is harder to use.

According to Paul Adkins TITLE of LTI, this headache has been completely resolved by the company's "accuracy validation messaging" software, which prevents the machine from issuing a reading unless it is accurate. This has been rigorously tested in the field, even by independents (www.radartest.com). Adkins further indicates that this software was first perfected by LTI, though other competitors boast similar effectiveness.

Similar to radar, early lidar units suffered in inclement weather or with line-of-sight obstructions. Like radar, the top manufacturers equip their units with a bad-weather button, which has tested with much success, even in snow. Adkins says obstructions, such as shubbery, will be taken care of through the aforementioned software, standard in all LTI units.

Lidar units present two unresolved limitations. First, the angle required for effective target acquisition can be no greater than 20 degrees from center, though variance tends to lean in favor of the target, ie, lower speed reading. Second, lidar cannot be used in motion, since the operator needs to look down the site (heads-up display). However, in the future, this latter limitation may be solved in much the same manner that military fighter planes have missile lock.

Previously, slow target assessment was a common gripe from some users. However, LTI's original 20-20 assessed in 0.33 seconds, which other competitors now match. In general, all manufacturers claim their units have simply labeled buttons with backlighting, clear function indication, and the popular heads-up display (HUD). It is advised to test several models as precise configurations do vary.

Kustom Signal's Pro Laser III offers a forward swept handle, which lessens operator fatigue and eliminates the need for a shoulder stock. Also, this company and LTI produce units (radar or laser) for speed enforcement on waterways.

Finally, the issue most harmful to the increase of lidar unit presence within law enforcement departments pertains to cost. At present, the price of a high-quality laser is three times that of a comparable radar unit. For instance LTI's 20-20 Ultra Lyte ranges from $2,500-4,000. Agencies can purchase cheaper lidar , but at what reduction in quality?

Like the improvements of radar employed during World War II, future advancements in speed enforcement technology, whether radar or lidar, will be directly linked to augmentations in detection and jamming technology. But that's another topic all together. ■

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TIMELINE:

1860 James C. Maxwell, British mathematician and physicist, proposed existence of yet to be discovered electromagnetic waves.

1880s Heinrich Hertz, German physicist, proved Maxwell's theory — first radio wave creation and ability to bounce off solid objects.

1900s Equipment developed that allowed radio signals to be sent and received over long distance.

1917 Albert Einstein first envisioned the stimulated light emission process (laser).

1925 Gregory Breit and Merle A. Tuve, American physicists, reflected short radio waves off the ionosphere — its height determined by time it took signal to return.

1935 Robert Watson-Watt, Scottish engineer and physicist, used radio signal echoes to detect airplanes and ships — up to 17 miles. Machines lacked sensitivity and reliability.

1939 War brought a fervor of experimentation — British created a chain of radar stations along east and south coasts.

1940 US and Germany both produced pulse radar for tracking planes and sea vessels.

1947 Transistor invented — allowed for lighter, more reliable radar units.

1950's Klystron invented —generated microwaves at very high power — improved radar accuracy.

1954 Charles C. Townes, American physicist, created a maser (microwave amplification by stimulated emission of radiation).

1960 Theodore H. Maiman built the first laser.

1962 Semiconductor lasers built in US.

1960s Computers vastly improved the effectiveness of radar through signal processors, analyzation, and information presentation. Phased array invented--moved signal electronically, rather than by rotation of antennas. With the perfection of laser came optical radar--operated at high frequency, which miniaturized the antenna and lessened the beam (believe it or not).

1970s Laser technology blossomed into many areas of modern life, especially information communication.