FLASH LiDAR KEY BENEFITS

In 2013, 1.2 million people died in vehicle accidents. That is one death every 25 seconds. Some of these lives could have been saved with vehicles that have a better understanding of the world around them by detecting possible hazards and obstacles—and taking critical decisions when lives are at stake.

PHANTOM INTELLIGENCE is committed to enhancing vehicle perception and helping to create safety solutions we can all fully trust. Our vision is that a day will come when we can claim zero casualties caused by vehicles. We will be a key player in this revolution to save lives thanks to our collision warning sensor technology that ensures reliable and consistent pedestrian and vehicle detection—even in harsh weather conditions.

Compared to other technologies, such as cameras, PHANTOM INTELLIGENCE's LiDAR processing technology detects vehicles, pedestrians and other obstacles even under harsh environmental conditions. Our LiDAR technology is not sensitive to visual blooming, darkness, weather conditions (rain and snow) or poor contrasts with backgrounds. It also detects non-metallic obstacles (pedestrians) better than radar-based systems. The resulting sensors are compact and low-cost units that can be placed behind the windshield, resulting in a system with fewer compromises in body design.

The overall result is detection technology that can be fully trusted to save lives.

THE CHALLENGE

What is it that makes PHANTOM INTELLIGENCE's LiDAR sensing solutions superior to other existing solutions on the market? After all, solutions have been developed in the past to provide some detection capabilities for vehicles. However, these existing solutions, based on traditional technologies, all fail under some critical situations. The net result is safety solutions that you cannot trust will operate in the moments you may need them the most. PHANTOM INTELLIGENCE is convinced that its unique technology works reliably where others fail.

Before we go into what we do, here is a quick glance of what others have tried, so far:

CAMERAS

Everybody understands cameras. Image processing can do interesting things. It may seem the obvious choice for detecting obstacles. However, cameras do have their weak points:

- Cameras do not detect distance. Cameras see color and light intensity. And from that, they "figure out" the distance of obstacles based on the contrast with the background and other visual cues.
- What happens when the light is poor or rapidly changes? Cameras fail.
- What happens when the contrast is poor, such as when a pedestrian dressed in green stands in front of a bush? Cameras fail.
- Do cameras operate well under the rain? No.
- And, even in the best conditions, the precision of cameras decrease dramatically as distances increase.

While cameras are essential for tasks that require that objects be identified or classified based on their colors, such as sign recognition or lane detection, they are a risky choice for applications that need to understand volume in a safety context.

RADAR

Radars have been used to find planes in the sky for years now. They also seem to be an obvious choice for a solution that detects obstacles. Again, things are not so simple.

- Radars use microwaves to locate obstacles. The problem is that the frequencies automotive radar uses are more easily "absorbed" by water. Human bodies and soft tissues are over 80% water. Consequently, they reflect less of that energy than solid structures. This explains why radar is great at detecting cars and other solid objects, but has more difficulties with pedestrians.
- Because of the long wavelength of radar and some of the processes used in radar detection, most radars get confused by multiple objects standing separated, side-by-side, and at a similar distance from the sensor[1]. This makes radar impractical in dense urban situations.
- Radars use radio frequencies that are susceptible to interference. Since they reflect a lot on metallic surfaces, they are susceptible to "ghosting." Radars can be completely blocked by some obstacles, like a thin layer of ice on a car in wintertime.
- The range resolution of radars can be quite large—sometimes in the order of meters[2].

All these shortcomings make radars a relatively unreliable solution for the analysis of complex, urban driving situations.

[1] Tutusaus, Mark Mir, "EVALUATION OF AUTOMOTIVE COMMERCIAL RADAR FOR HUMAN DETECTION," University of Helsinki, 2008
[2] Tutusaus, Mark Mir, "EVALUATION OF AUTOMOTIVE COMMERCIAL RADAR FOR HUMAN DETECTION," University of Helsinki, 2008

WHY LiDAR?

One word: reliability.

LiDAR uses a principle that is very close to radar. By bouncing a short pulse of light of an object, LiDARs can calculate the "time-of-flight" and, therefore, the distance of obstacles.

- Contrary to cameras, LiDARs do not "guess" distances: LiDARs "see" distances. There is no interpretation: just facts. This results in fewer errors.
- Also, contrary to cameras, LiDARs rely on their own illumination sources. They will see obstacles at all times of day and are not dependent on lighting, contrast or shadows.
- Using shorter wavelengths than radars, LiDARs are much less sensitive to interference and "separate" close objects better. Lidars can distinguish pedestrians in complex situations much better than radars do.
- LiDARs can be set up at various places on the vehicle. They can be placed behind the windshield, where they will work optimally regardless of any weather conditions. PHANTOM INTELLIGENCE's LiDARs are even less sensitive to adverse weather. This will be addressed later on.

With all these advantages, it would seem that LiDAR is an obvious choice for automotive safety applications. However, LiDARs were a late entry in the automotive market, it used to be that making robust LiDARs was quite an expensive undertaking. Not anymore. Now, the technology is competing with more traditional solutions from both a performance and cost perspective.

WHY FLASH LiDAR?

There are two different approaches to building a LiDAR. The traditional approach, "scanned LiDAR," uses a thin, concentrated laser beam to "paint" a situation with the help of a rotating mirror or another mechanical element to steer the beam. A single receiver element, which acts as the LiDAR's eye, calculates the time of flight and reconstitutes the 3D image.

The problems with this approach are:

- Scanned LiDARs use mechanical parts for the scanning processes. The mechanical assemblies require a lot of adjustment and calibration. That makes high-volume manufacturing a costly proposition. In addition, the mechanical assemblies may be more fragile in the long term.
- Scanned LiDARs take time to "paint" a complete situation with the thin beam. This makes the refresh rate relatively low. In emergency situations, you want updated information in almost real time. If you try to compensate by moving the thin beam faster, you create "holes" in your 3D vision. These holes can be large enough to miss obstacles, which is far from ideal.

"Flash" LiDAR uses an alternate approach: it "floods" the entire scene with a wide light beam and uses many simultaneous receivers (eyes) to capture sections of the image. Pretty much like a digital camera's pixels capture sections of the image. The Flash LiDAR solves many of the traditional scanned LiDAR's problems:

- There are no moving parts. Everything (except lenses) is made up of electronic or mechanical components. The assembly of a Flash LiDAR can easily be automated for high-volume production. Furthermore, the calibration is simpler. No moving parts also ensure the robustness of the final assembly. This results in lower assembly and maintenance costs.
- Images are captured in a single flash (or sometimes multiple flashes, but almost instantaneously). Very high refresh rates are possible: scenes can be analyzed faster for safer decision-making.

Obviously, the use of "multiple eyes" means that there is more processing to perform in a shorter time span. In the past, no technology manufacturer was able to perform that much processing performance in an economical manner. PHANTOM INTELLIGENCE's LiDAR processors provide this tangible benefit. Today, the best detection technology can be implemented at an affordable cost.

FULL-WAVEFORM FLASH LiDAR: THE PHANTOM INTELLIGENCE DIFFERENCE

There is one last aspect of PHANTOM INTELLIGENCE's LiDAR technology that truly makes our LiDAR processing technology stand out.

Traditional LiDARs use a very simple scheme to detect the returning light beam and calculate the "time of flight." Usually, a piece of finely tuned analog electronics is used to process the returned beam and acts a threshold gate with a simple timer, which calculates the "time of flight."

This works well when you have a very high level of light coming back. Light levels that stand well above the noise we find in all electronics systems. But we are dealing with invisible lasers. And in order to protect your eyes, we use low levels of laser light. With analog electronics, setting the trigger levels at very low levels generates false triggers. We do not want that. Also, reflections from raindrops or dust can generate false triggers. We do not want that, either.

PHANTOM INTELLIGENCE's solution is to digitally acquire the entire return light signal for the maximum "flight duration" of the light (microseconds) and to analyze the resulting waveform using exclusive digital signal processing techniques. This is what is called "full-waveform processing" and it is there that PHANTOM INTELLIGENCE's expertise and magic really shine.

On the contrary to an analog LiDAR, PHANTOM INTELLIGENCE's full waveform processing LiDAR engines are able to detect very faint returns through electronic noise. They can also filter out returns that would otherwise lead to false detections on traditional systems. PHANTOM INTELLIGENCE provides more reliable systems that generate less false triggers than traditional systems. In addition, they can see further than traditional systems and withstand harsh conditions.

Our processing engines carry out these functions at very high and process the multiple detectors required by Flash LiDAR systems.

SUMMARY OF THE ADVANTAGES OF PHANTOM INTELLIGENCE'S FULL WAVEFORM FLASH LiDAR

PHANTOM INTELLIGENCE provides an exclusive architecture for full waveform processing flash LiDAR, so that you can build safety solutions that:

- Are more sensitive to their environment
- Help in taking faster decisions
- Are reliable in almost all conditions
- Are economical and can be manufactured in high volumes

Our LiDAR technology can inevitably save lives and prevent tragedies. Isn't that what we all want?