by Ken Delahoussaye

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LaneAlert — A Driver's Best Friend

Stay "Alert" at the wheel with this effective lane detection device.

This Month's Projects

The Fuzzball Rating System

To find out the level of difficulty for each of these projects, turn to Fuzzball for the answers.

The scale is from 1-4, with four Fuzzballs being the more difficult or advanced projects. Just look for the Fuzzballs in the opening header.

You'll also find information included with each article on any special tools or skills you'll need to complete the project.

Let the soldering begin!

The technology age

It happens all too often: a driver falls asleep at the wheel, veers off the road, and narrowly escapes a fatal injury. You might think in this day and age of high-tech devices and fast-paced lifestyles, that kind of scenario would be a thing of the past. After all, it's the 21st century. Cars come equipped with all kinds of gizmos: seat belts, air bags, and anti-lock brakes. And, for those like myself who can be sometimes directionally impaired, GPS navigation systems help get us from A to B.

Why shouldn't vehicles also come equipped with road-sensing devices that detect when the car is drifting out of its lane on the highway? Technological advances make this idea a definite possibility. In fact, there are several patents on the books that describe such devices. Unfortunately, they are relatively complex and expensive to implement in the average vehicle, employing digital image sensors and complex frame processing algorithms. The expense puts this type of system out of reach of the average driver, at least for now.

In the meantime, you may be surprised to discover that there's a simpler solution to the problem. Employing some readily-available and relatively-inexpensive components, you can create your own lane-detection system. I named the device "LaneAlert" and developed a working prototype including sensors, microcontroller, and alarm, all for well under $100.00.

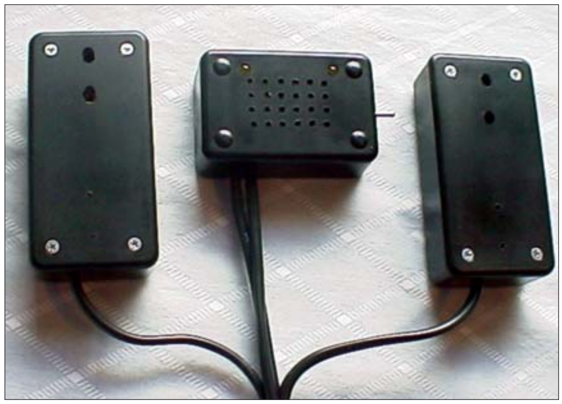


Figure 1: LaneAlert — lane detection system including computer module (center) and two sensor modules (left and right).

Figure 2: Sensor module — underside view showing cover and four aperture holes.

Let me say at the outset that LaneAlert is an experimental device meant to be a driver's aid. It is not intended to replace common-sense driving safety habits. The design was proven in daytime conditions. "But what about night driving?" you might be asking. Night testing presents some interesting challenges that we're not ready to tackle in this article. For now, we want to focus on the design and construction. We'll also do some testing, but in daytime conditions for convenience and simplicity.

Ready to operate

The unit offers two operational modes: alarm-enabled and mute. The three-position toggle switch selects the mode. This type of switch offers two "on" positions and a center "off" position. One position activates the device and enables the piezo buzzer (the alarm). Another position also activates the device, but disables the piezo (mute). When

Tools:
Parallax BASIC Stamp Development System
Soldering iron
Electric drill and bits
Multimeter

Skills:
Basic electronic assembly skills
Beginner level programming skills

testing, it's helpful to run mute and simply view the indicator LEDs. When the unit is activated, the LEDs turn on briefly and then extinguish within a second or so. After the brief initialization sequence, the unit begins scanning. When lane markings are found, the left and/or right LED illuminates to indicate the sensor that detected them. Actually, what the device is looking for are sharp changes in contrast. If either or both sensors "see" these changes, all is well and the device continues to scan. But if neither sensor detects a contrast within a three-second period, the alarm will sound. The unit then resets itself automatically, cancels the alarm, and begins scanning once again.

When testing in daylight, there are some variables to consider. One such variable is shadowing. When driving, shadows are detected as changes in contrast and could cause alarms. For the most part, this will not be a factor when driving at night. Another consideration is the situation that results when you're driving on a road that has dimly visible road markings such as back roads or alleys. In this instance, LaneAlert may not function properly. However, you must remember that the device's usefulness is best realized on long trips when driving state and interstate highways. In most cases, these roads should be well maintained and clearly marked.

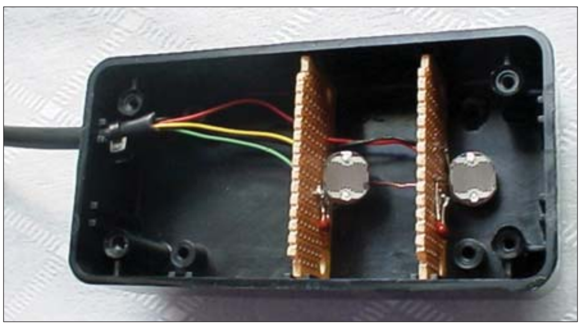


Figure 3: Sensor module with cover removed, exposing perf boards with photocells.

Figure 4: Computer module has two indicator LEDs. Small holes are drilled for the piezo alarm.

Construction

LaneAlert consists of three modules, each housed in a black plastic project box: a computer module and two sensor modules. Each sensor module is attached to the computer module by an eight foot length of four-conductor telephone cable. These sensors are located on either side of the vehicle, mounted under the sideview mirrors, and held in place with adhesive-backed Velcro.

The sensor modules view the road for lane markings. Figure 2 shows the under-side view of a sensor module. Four screws hold the cover in place. The cover is drilled with light-entry holes, known as apertures. The amount of light entering the sensor module is important. In much the same way the pupil of the eye regulates light, we must ensure the internal photocell sensors receive the right amount of light. The diameter of the apertures greatly depends on the outdoor lighting you'll be testing under. You'll want to test the device in sunlit conditions initially. I recommend holes no

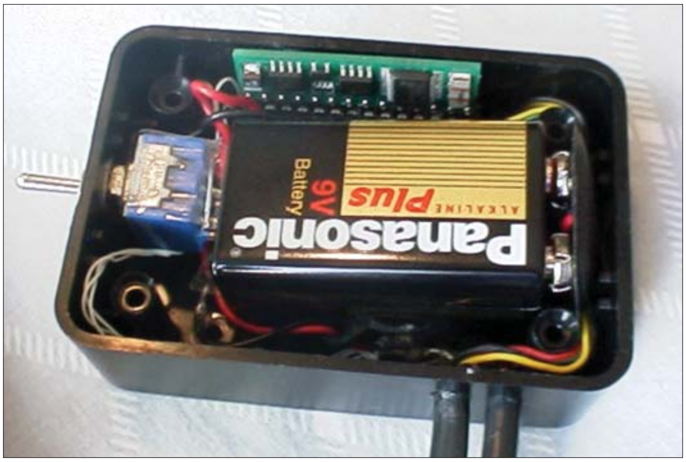


Figure 5: The internals of the computer module, including power switch (left), BASIC Stamp computer (top), and battery (center). Wiring is routed around the perimeter of the module.

greater than 1/16" diameter in bright light. When you're ready for low-light conditions, you will probably need to increase to about 3/16" or so. I recommend drilling two sets of holes as shown. When you want to test in low light, you can select the larger apertures. In bright light, use the smaller ones. To change the aperture configuration, simply remove the cover, rotate it 180 degrees, and re-attach.

Figure 3 shows a sensor module with the cover removed, exposing two photocells. Each photocell is mounted on a small piece of perf board, cut to fit into the slots of the project enclosure. Now is a good time to mention the importance of photocell selection. My initial experiments used a couple of different types. The type I finally decided on is made by a company called Clairex. You'll find the details including the part number and where to buy them listed at the end of the article. You

Figure 6: Top of sensor module containing adhesive-backed Velcro.

might be surprised to learn that all photocells are not created equal, even from the same manufacturer and model type. Use a multimeter to measure them in similar lighting conditions, noting the readings. You'll need to select a group of four photocells that are as closely matched as possible. Buy 10 or so to guarantee a good selection.

The remaining part of the system is the computer module. It is the brain of the system, obtaining sensor readings and evaluating the results. Intended for mounting on the dashboard or resting on the passenger seat, the computer module has two visible LED indicators as shown in Figure 4. Each indicator represents the left and right sensor modules. When a sensor detects a lane marking, the indicator illuminates. The computer module is operated by a Parallax BASIC Stamp BS1-IC and a nine-volt battery. Also contained in the module is a piezo buzzer for alarm annunciation. Figure 5 shows the inside of the computer module.

Each sensor module attaches to the computer module with an eight-foot length of four-conductor telephone wire. Drill holes in each project case just large enough for cable entry. Apply a thin layer of Super Glue™ at each opening to secure the cables and to provide strain relief. Wire the system according to the schematic diagram.

To install the sensor modules, use some strips of adhesive-backed Velcro. Apply one part of the Velcro to the underside of the side-view mirror housing. Apply the other part to the top-side of the module as shown in Figure 6. Figure 7 shows the installed sensor module. Route the left sensor cable to the vehicle interior through the crevice where the door panel hinges to the body. Be careful to avoid possible pinch points. Repeat the process for the right side-view mirror. The computer module can be attached to a convenient space on the dashboard using Velcro strips or allowed to rest on the passenger seat.

How it works

Figure 8 shows the schematic diagram of the entire system. The design is based on the concept of light reflectivity. When light hits a surface, a certain amount of it reflects away, while the remaining amount is absorbed by the surface. Different colors have varying levels of reflectivity. Light-colored surfaces have high reflectivity. White, for instance, has high reflectivity. Dark surfaces have low reflectivity. The computer continually takes light readings from each sensor module, comparing each photocell's readings. A significant difference indicates a successful detection.

The diagram in Figure 9 shows the positioning of the photocells, aperture holes, and road markings. As shown, the photocells are slightly offset from the position of the holes. This gives the device two specific fields of view in each sensor module. The computer compares the light intensity from each field. The idea is that one of the fields should "see" lane markings while the other sees the road itself. Since lane markings typically contrast the road surface, the light intensities should differ significantly, resulting in detections.

The test drive

Now that you've constructed the prototype, it's time

Figure 7: Sensor modules attached to the bottom of the side-view mirror with aperture openings facing down.

for a test drive. First, you'll need to determine the time of day for the test. Generally, you have a couple of choices: low lighting and bright lighting. The selection is important since it determines which set of aperture holes you will use, as described earlier. For bright lighting (e.g., mid-day), use the smaller holes. Too much light will over-expose the sensors and you'll get improper detection. For low lighting (e.g., dawn, dusk), use the larger holes. To change the selection, simply remove the sensor module covers, rotate 180 degrees, and re-attach. Next, make sure the sensor modules have been securely affixed to each side-view mirror and that cabling does not bind or pinch in the door opening.

Now we're ready to roll. Turn the unit on at the toggle switch. Make the appropriate selection for alarm or mute.

Parts List

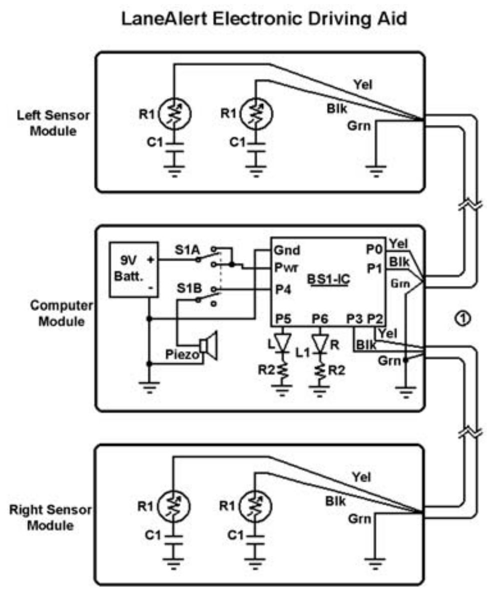
Resistors:
R1 - photocell (Clairex CL5P4L, 690NM)
R2 - 470 ohm (1/4W, 5%)

Capacitors:
C1 - 0.1 uF (ceramic)

Semiconductors:
BASIC Stamp BS1-IC
L1 - LED (yellow)

Misc.:
Telephone wire, four cond., solid, black jacket (20 feet min.)
1 project enclosure (3 x 2 x 1)
2 project enclosures (4 x 2 x 1)
Perf board
S1 - DPDT switch, center off
Piezo buzzer (3.0 - 20VDC, 2.7kHz)
14-pin SIP IC socket
Nine-volt battery
Velcro strips

Notes:
All parts except BS1-IC, 14-pin SIP socket, and photocells available from RadioShack
Photocells available from Mouser Electronics
BS1-IC available from Parallax
14-pin SIP socket (solder-tail) available from Digi-Key



①Telephone wire, 4 cond., solid, black jacket, RadioShack #278-385
R1 - Photocell (Mouser #621-CL5P4L); R2 - 470 ohm
S1 - DPDT toggle switch (center off); C1 - 0.1 uF
L1 - LED (yellow)

Figure 8: Schematic

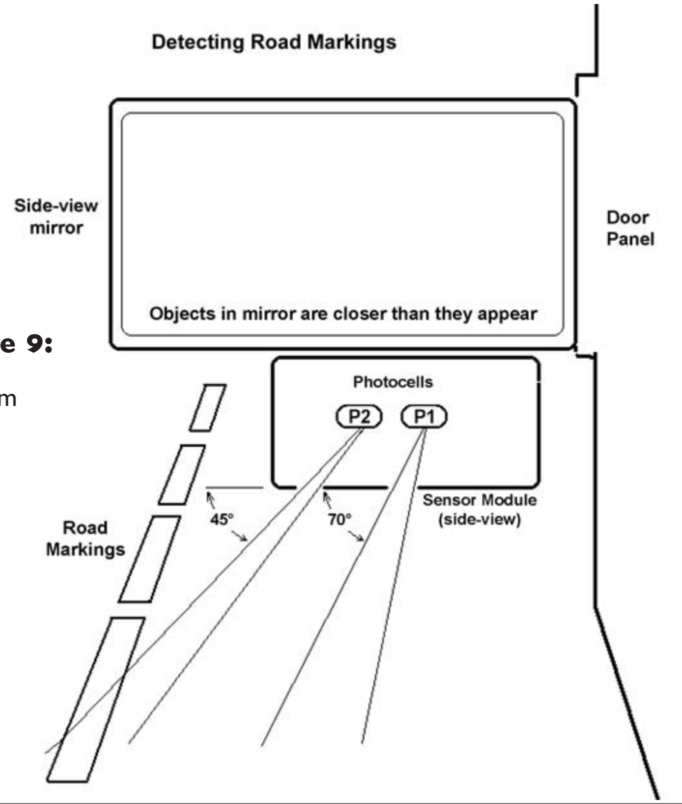


Figure 9: Sensor Diagram

You might want to start out with the alarm enabled. After a while, you should probably mute it to minimize distraction. Instead, just glance at the LEDs from time to time. As each sensor makes a detection, its associated indicator will activate. Remember to keep safety at the forefront of the experiment. Do not take your eyes off the road in a potentially dangerous situation. You don't want to become another statistic. For initial tests, I recommend less-travelled boulevards where speeds are not too great. Try to choose roads with good contrast between the road surface and markings.

A couple of things will trigger sensor detections besides road markings. One of these is shadows, as caused by buildings, power poles, trees, and other vehicles. The other source of detections is road discolorations. During daytime driving, these false triggers are to be expected. If you get good activity from both LEDs, the experiment is a success. If one or both indicators fail to activate, you'll need to return home and do some troubleshooting. The first thing to examine is the sensor module apertures. Make sure they're unobstructed and properly aligned. Next, remove the sensor cover and examine the photocells. They should be slightly tilted in the direction of the aperture. Finally, use a multimeter to ensure you have continuity between sensor and computer modules and that the cables are not damaged.

Code listing

Listing 1 (which is available for download at **www.nutsvolts.com**) shows the BASIC Stamp source code. The code is structured in a continuous loop that runs indefinitely (or until the unit is powered off). Each pass through the loop "reads" each of the two photocells in each sensor module. The values correspond to the amount of light detected by each photocell. The greater the amount of light, the higher the value. The values are compared to determine if a detection has occurred. If the difference is greater than CONTRAST, a detection has occurred. An alarm condition results when no detection has occurred in 50 loop passes (tracked by TCOUNTER). This translates to about three seconds. When this occurs, the piezo buzzer sounds a series of beeps and then silences.

Taking the next step

Remember that LaneAlert is a prototype, a work in progress. It effectively proves the concept of lane detection in sunlit conditions. The obvious next step is to make the appropriate modifications for night driving. Since there is not sufficient lighting, it will need to be improvised somehow, possibly with an onboard illuminator contained in each sensor module.

If you'd like updates on my progress, drop me a note at: **kdelahou@worldnet.att.net**. **NV**

Ken Delahoussaye is a software engineer/consultant with 18-years experience in real-time and embedded applications. He enjoys working with electronic and mechanical devices, prompting him to spend countless hours building all sorts of gadgets. He runs Kadtronix, a small robotics and programming services company in Melbourne, FL.