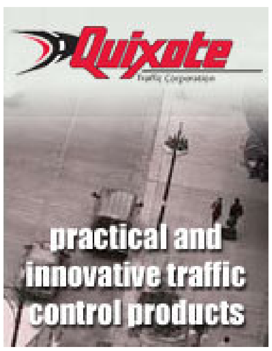

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Between the lines

Pete Goldin looks at how the use of radar detection systems can provide municipalities with a ready adaptive signal control solution

Every year there are more and more vehicles on US roads, and traffic congestion continues to grow accordingly. Meanwhile, the US Department of Transportation (USDOT) estimates that as many as 75 per cent of the 330,000 traffic signals in the US could be made to operate more efficiently by adjusting their timing plans, coordinating adjacent signals, or updating equipment.

While many traffic management agencies across the country have implemented or are experimenting with some form of signal control to reduce traffic congestion, the truth is that these systems are still in the embryonic stages. Some of the more progressive municipalities are deploying adaptive signal control, however, to optimise the flow of traffic through the road network.

Bad timing
The traditional method for optimising signal times is timing control, which simply involves counting traffic at certain times of the day, taking into account periodic increases in traffic such as during rush hours, and setting the signals to change at these times to meet traffic needs. Many cities are finding that this method does not handle changing and often unpredictable traffic patterns.

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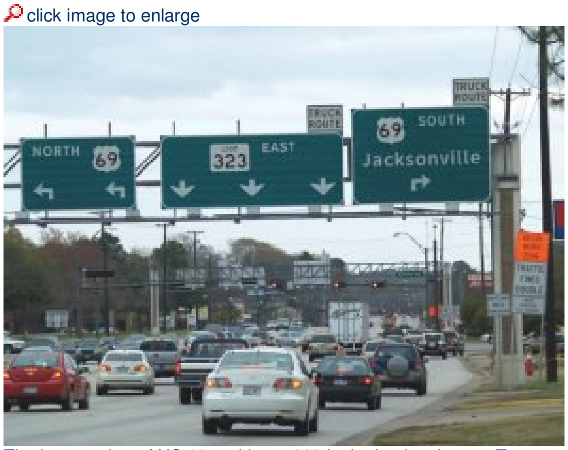
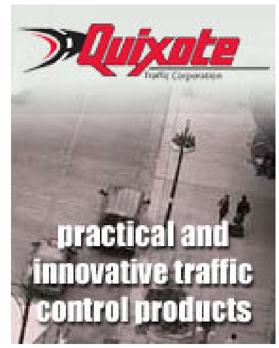


The intersection of US 69 and Loop 323 is the busiest in east Texas, with approximately 80,000 cars passing through each day

Although inductive loops in the road enable signal controls to respond to traffic in real time and extend green phases to reduce congestion, this approach still has limitations.

"Extending green lights off the data obtained from inductive loops can be inefficient because inductive loops only provide detection at a single point, and they can be fooled," explains Thomas Karlinsey, Senior Engineer at **Wavetronix**. "There might be a large gap between two cars, and a line of cars behind the second car. The sensor would only detect the gap, assume there is no traffic, and go to yellow."

Companies that provide above-ground sensors such as Wavetronix believe that inductive loops embedded in the roadway are outdated technology. Although this may be a bold assumption considering that most intersections



across the US still use loops, and radar sensors are only used by a small fraction of municipalities, the fact that some traffic control agencies in the US are migrating to above-ground sensors, which include video detection as well as radar, provides a window to the future of signal control.

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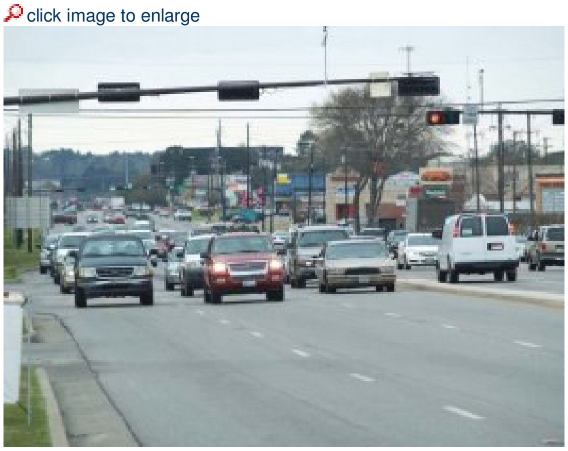

By measuring what goes on in a wider area, not just at a stop bar, above-ground sensors allow a more accurate overall picture of the traffic situation to be obtained

Adaptive alternative

The alternative, adaptive traffic control, links an entire grid of intersections which is controlled by a system which continuously optimises signal timing. The concept behind adaptive signaling is simple: aligning the timing of the lights along the entire roadway more closely with the timing of the traffic in real time produces a more efficient traffic flow.

According to a study conducted by USDOT in 2006, of 106 metropolitan areas surveyed only 30 were utilising some type of adaptive signal control technology. Out of approximately 150,000 total operated intersections within those 30 metro areas, less than 5,000 had implemented adaptive signal controls. Adaptive signaling is catching on, however, and some municipalities are using radar sensors to support this system.

Although traditional inductive loops could theoretically be used for an adaptive signal application, Don Leavitt, Communications Director for Wavetronix, suggests that this is not practical.

“For loops to be installed, an entire lane of traffic has to be kept closed. In order to repair a loop, you have to dig it out of the ground which will require you to close the lane of traffic again. That doesn’t happen with above-ground radar sensors. If the sensor goes bad it can be simply replaced, in most cases without disrupting the normal flow of traffic. In addition, one radar sensor can do the work at an intersection of several different loop stations.”

Radar love

“To implement a traffic adaptive system over a large area would require a non-intrusive technology like radar,” says Karlinsey. “Considering deployment time and expense, radar is the technology of choice moving forward for adaptive control.

“A percentage of cities are using cameras for signal control, but simply for detection right at the stop bar to trigger the green on a side street or for a left-hand turn. Cameras have not proven themselves to be adept at detection in advance of the stop bar. A small percentage of the market is using cameras but most are still using inductive loops.”

Karlinsey adds that radar has not been widely adopted at the intersection yet, although there has been some penetration.

“Inductive loops are a proven technology, and for a long time they were the only available technology,” Leavitt explains. “Many agencies which have invested in loops, and know that they are fairly accurate, will choose inductive loops because they are a known quantity.”

One of Wavetronix’s current challenges is informing agencies that its sensor technology is as accurate as inductive loops but does not have the inherent installation and maintenance problems, he adds.

"Some agencies have been slow to adopt radar over embedded technologies because of the perception that radar is not as accurate," Karlinsey says.

"While this may have been true for first-generation radar devices, second-generation devices have consistently performed as well as loops in third-party testing."

"The industry is very slow to accept new technology," Leavitt admits, "but we are pleased with how well we have been able to get the word out. We are starting to see some real movement in the market towards these above-ground non intrusive technologies."

Texas-size traffic

The fast-growing community of Tyler, Texas, is one of those municipalities that have deployed above-ground sensors, in both video and radar forms, in an integrated, adaptive signal control system. Isolated in east Texas, Tyler has become a regional shopping hub. The US 69 (Broadway) corridor, a six-lane arterial with raised medians, has a heavy concentration of retail stores combined with a significant amount of new development, and a large volume of traffic.

Tyler's Traffic Engineering Department has deployed an adaptive signalling system on 16 signals in the corridor, which also includes a collector that parallels US 69, and a section of state highway Loop 323 which is at grade and crosses US 69. The intersection of US 69 and Loop 323 is the busiest in east Texas, with approximately 80,000 cars passing through each day.

"US 69 is a corridor where the traffic situation rapidly changes," explains Kirk Houser, Traffic Engineer for the City of Tyler. "We felt we were not keeping pace with the changing traffic using traditional timing methods."

New developments in the area constantly cause temporary spikes in the traffic, and Tyler Traffic Engineering was not able to cope with those changes using traditional timing methods which required counting of the traffic on site. Houser points out that surges would often subside in just a few weeks, before the new timing changes could even be implemented.

Another problem is that the average speed in the corridor shifts throughout the day. This means that prior to the deployment of the adaptive control system, Tyler's traffic engineers would have to make travel runs to help them pick a speed for each time of day. Now, with adaptive signaling, the system constantly measures the speed of the traffic in real time, predicting when that traffic will reach the signal and tweaking the offset for better traffic flow.

Smart choice

Tyler Traffic Engineering selected above-ground detection in the form of radar and video over inductive loops at most of the intersections. The Tyler adaptive control system employs Wavetronix SmartSensor HD side-fire radars for setback or 'mid-block' detection. The radar sensors are installed on poles 300-500 feet (100-160m) from the intersection, facing across the corridor and they count, classify and measure the speed of the vehicles in every lane as they pass by in both directions.

"For setback detection, we did not go with inductive loops because of the potential utility issues and other problems related to running the loop wire several hundred feet back from the intersection," says Houser.

Instead, Tyler chose Wavetronix SmartSensor HD radar sensors with wireless communication and power. Data is relayed back to the traffic controller cabinet through a 900MHz radio and power is provided by solar panels.

The SmartSensor HD offers a high RF bandwidth that translates directly into increased detection resolution. Side-fire radar sensors like SmartSensor HD transmit Frequency-Modulated Continuous-Wave (FMCW) signals, and the processing of the FMCW radar returns results in distance measurements to target vehicles on the roadway.

The bandwidth of the FMCW transmission determines the accuracy of that distance measurement. If the bandwidth of the FMCW signal is too low, then the radar processing may confuse the response of a single large vehicle with the responses of two smaller vehicles traveling side by side, resulting in what is termed spillover.

By increasing the bandwidth of the transmit signal, the detection accuracy of the radar sensor improves. The SmartSensor HD, which transmits at 250MHz, has five times the bandwidth of other radar sensors on the market, and its detection accuracy has been proven in testing, according to Wavetronix: a 2007 study by the Florida A&M University-Florida State University College of Engineering found SmartSensor HD had 98.8 per cent detection accuracies; and in Texas, SmartSensor HD had 98.9 per cent accuracies compared to inductive loops, according to data collected from a Texas Transportation Institute test bed.

"We chose radar because it was easy to implement and during our testing the radar was very reliable," Houser adds. "The downside of our installation, however, is that the radar is mounted on poles which are not very attractive and we have received a little bit of public reaction."

Integrated system

Data is also collected from Tyler's stop bar detection system, a mixture of inductive loops and video, to determine occupancy and intersection saturation. At the stop bar of most intersections, the system utilises video detection with **Iteris** cameras supplied by TxDOT, which the state provides to avoid the destruction of inductive loops because the asphalt on the state highway is milled and overlayed every couple of years.

On a few of the city street intersections, however, inductive loops are still used. For Houser, the choice between video and inductive loops is still a toss-up.

"Loops do have some issues but video detection has other issues," Houser continues. "We have discovered in general that video detection requires constant attention to little maintenance issues which are easy to fix. Loops will go for a long time without a problem, but when they do have a problem you might have to cut a new loop into the roadway."

The data is sent back to Tyler's ACS-Lite system, an adaptive software package on which the entire corridor is modelled. ACS-Lite was developed by the Federal Highway Administration (FHWA) and **Siemens** ITS as a low-cost version of the FHWA's Adaptive Control Software (ACS) designed specifically for closed-loop arterial traffic signal systems. ACS-Lite uses all available data to makes adjustments to the signal times to deal with oversaturation.

Tyler is the first entity to purchase ACS-Lite, making the city the first actual customer. Siemens ITS engineers log into the system remotely to analyse the performance and fine-tune the software, and frequent updates are sent.

Houser sees that the adaptive system is reducing traffic congestion, although he does not yet have any official data. Currently, Tyler is evaluating the implementation of a second system to cover the city's west loop corridor. ·

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