Research Problem Statement Title:
Development of Inexpensive Portable Vehicle Sensor Node System for Volume, Turn Movement, & Collision Avoidance Studies

Problem Statement:
A debate on designing proper roadway intersections is currently underway among those in the transportation community. Optimally, intersections should facilitate traffic flow, maintain driver safety—as well as that of pedestrians crossing the intersection, and minimize vehicle wait time at intersections to reduce fuel consumption. Many communities and transportation departments regularly conduct intersection Turn Movement (TM) studies to evaluate traffic flow as it approaches and leaves an intersection under investigation by counting the number of vehicles traveling through or turning right or left as they leave the intersection.

TM studies use either manual or automatic counters. Manual counters require an experienced operator, which makes them prone to errors resulting from operator fatigue. Automatic counters use nonintrusive technologies such as video imaging systems and radar, or intrusive technologies like pneumatic road tubes and inductive loops, among others. Nonintrusive technologies are expensive and require calibration. On the other hand, while pneumatic road tubes are inexpensive, they require road installation, and are accompanied by potential endangerment of on-site data collectors. A technology that is inexpensive, flexible, portable, and easy-to-install is needed.

Proposed Research:
This research will develop a nonintrusive, inexpensive, and portable wireless sensor for vehicle detection. The system will be programmable and will support various studies and applications, e.g., TM studies, intersection traffic flow studies, intersection capacity studies, intersection safety studies, traffic flow monitoring, and collision avoidance analysis.

In addition, the sensor will be designed to determine the unique magnetic fields detected as a result of over-passing vehicles. Hence, multiple sensors could be placed along the same highway to determine travel time. It is shown in the literature that the thirteen different FHWA classes of vehicles have unique magnetic disturbance that could be detected by the magnetic sensor.
**Suggested Tasks (to include but not limited to):**

- Perform Literature Search
- Investigate the accuracy of the data collected by various existing ODOT systems including TM imaging system (Miovision system), and pneumatic road tube systems.
- Develop nonintrusive, inexpensive, vehicle sensor detectors to facilitate the deployment of sensors on roadways and automate the configuration of the hardware to support various intersection designs.
- Fabricate deployable vehicle detectors, including an enclosure for housing the developed hardware circuit boards. The enclosure should be designed to withstand impact from all types of over-passing vehicles.
- Investigate methods of sensor-roadway deployment to minimize the duration of time ODOT personnel spends on the road; thus reducing the safety risk of ODOT personnel.
- Develop software to support backend server operations; including data visualization, analysis, and storage.
- Deploy the inexpensive portable system for TM and temporary traffic flow studies.

**Implementation:**
The Overall system components have been previously developed with funds furnished Dr. Refai by OCAST and ODOT during previous project periods between 2008 and 2011. The proposed system could be used for a variety of studies, including traffic volume and speed measurements, and surface temperature and conditions, among others.

Some advanced features supporting the successful implementation of the proposed system include:
- Battery-powered sensor nodes
- Wireless unit/base station communication via powerful Zigbee transceivers
- Magnetic sensors for non-intrusive vehicle detection and classification
- Automatic magnetic sensors calibration
- Network-wide auto-synchronization
- Power management and battery-life estimation
- Flash memories for detailed event logging and system diagnosis
- Temperature sensors for surface condition monitoring
- Worldwide real-time data monitoring and system control via the Internet
- Temporary adhesives to ensure easy-to-install/removal of sensor nodes
- Quick and easy system configuration using a laptop connected to the base station
- Competitive, exceptionally priced system when compared with alternate systems

High redundancy, i.e., the system automatically adjusts itself to account for malfunctioning nodes.

The Principal Investigator (PI) will provide an assessment of the results of the study which should include expected benefits and action needed for successful implementation. The PI should include draft specifications, if applicable, with final recommended implementation activities, methods or schedules to meet ODOT goals.
**Benefits:**
The following are identified as potential benefits to the development of a wireless sensor for vehicle detectors.

- Implementation of a non-intrusive vehicle detector to support the FHWA Section 1201- real-time traffic Management system.
- Flexible design to use the wireless sensor vehicle detector to conduct traffic volume, intersection turn-movements, and other studies.

**Deliverables:**
All projects require the submission of the following reports:

- Monthly Progress Reports
- Multi-Year Projects require a Year-end Annual Report
- Copies of the project Draft Final Report in Microsoft Word and ADA accessible Adobe Acrobat PDF electronic formats
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The Year-end Annual Report, Draft Final Report, Final Report and Color Article should be submitted to satisfy all federal and state requirements pertaining to the accessibility of documents including but not limited to:

- Oklahoma State Statute 62 § 41.5e and the Americans with Disability Act (ADA) of 1990, 42 USC 12.01 et seq.

The PI must also participate in the following project meetings:

- New project initiation meeting
- Semi-annual project meeting
- Close-out project meeting
- Continuing project meeting

**Existing Research:**
The following information has been provided as a convenience only and does not constitute a thorough literature review.

Alternative Vehicle Detection Technologies for Traffic Signal Systems


Field Test of Monitoring of Urban Vehicle Operations Using Non-Intrusive Technologies
Final Report, May 1997
Publication Number: FHWA-PL-97-018