I. PROBLEM NUMBER

II. PROBLEM TITLE

ADVANCED DETECTION FOR CRITICAL INTERSECTION CONTROL

III. RESEARCH PROBLEM STATEMENT

Over the past several years, advanced vehicle detection has been introduced throughout the US, making use of sensing by visual, radar and other means. These new detectors can potentially provide a wide range of traffic data that could not be considered with current sensors such as loops and magnetometers. With advanced detection, many more measures such as queue length, speed and possibly even vehicle delay could be acquired and used in traffic signal timing.

At the same time, however, traffic signal controllers have not been kept pace to take advantage of these new measures. Although recent work with "Advanced Transportation Controllers" (ATCs) has greatly increased the processing power of controllers in step with advances in computer technology in general, there has been very little work to take advantage of the new detection capabilities. This is most clearly seen in the fact that despite controller advances, standard designs of both NEMA and Type 170 controllers accept simple contact closures only, limiting input to vehicle presence or passage.

In view of developments in both detection and signal controllers, it is appropriate to consider ways to combine them to improve traffic flow. Improvement is most important at heavy volume critical intersections that typically dictate overall network performance. At these locations, even slightly better allocation of green time and queue management can result in large delay reductions and faster travel, thus they should be the focus of research.

IV. RESEARCH OBJECTIVE

The goal of this research is to investigate and develop methods to apply advanced vehicle detection to critical intersection control. Creative ways to first collect performance data in a real-time environment, process it and use it to better time signals will need to be conceived, developed and implemented on an experimental or prototype basis. This will require traffic engineering analysis, software and processing review, plus consideration of hardware interfaces, capabilities and their improvement. A multi-disciplinary approach is necessary, because success will hinge on integrating diverse aspects into a unified package for improved traffic management.

This work will need to consider on-going FHWA efforts with real-time control in the RT-TRACS (Real-Time TRaffic Adaptive Control System) program, since some of the basic concepts will overlap. For example, one RT-TRACS research area is how and when to switch from performance optimization of fairly smooth flow to flow metering and queue management for oversaturated conditions. Better detection ought to be able to discriminate more quickly between the two and support more proactive control.

The initial focus should be on single intersections or pairs of closely spaced intersections, as at interchanges. Queue length measurement and management through the often high volume/high turning interchange area should be particularly amenable to performance improvement through advanced detection, where downstream queues often affect upstream queue discharge rate. The research should investigate collection, real-time compilation and use of stops, queue length, throughput, speed and delay on a per lane basis. Another potential measure is platoon progression behavior (volume patterns) in real time. The time duration effect of oversaturated volumes on delay needs to be considered. Since this work will be complex, a combination of field studies and so-called "hardware-in-the-loop" simulation (detailed traffic simulation model directly connected to a functional controller in a lab setting) should be used to consider alternatives and investigate effects.

Another aspect should address where the intelligence for detection data processing should reside: in the detection unit or in the controller. In either case, a major issue will be development of control strategies to
make use of comprehensive detection data. First an appropriate interface between the detector and the
controller must be defined. Then proactive control strategies must be developed to run on the controller.
Tests of concepts should be developed as prototype devices, perhaps in cooperation with controller
supplier(s), but with an overall emphasis on implementation in software.

One related issue is whether similar benefits can be realized by simply adding loop detectors that provide
equivalent detection information. An overall goal should be to maximize control at minimum cost, thus
comparison to traditional detection should be basic to the research. Another comparison reference should
be volume-density controllers that attempt to achieve a similar goal with minimum detection. A second
related issue is the use of advanced detection for improved network control by identifying changes in
volume level and patterns; this could trigger development of new timing plans either automatically or with
operator intervention, or allow intersections to run free instead of in coordination. The idea is to expand
single intersection benefits over a wider control area. A third related issue is how advanced detection
might help provide improved dilemma zone protection on high-speed approaches.

V. ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

It is estimated that this research can be completed over a thirty-month period, at a cost of about $350,000.
Prototype products for further development by others should be a deliverable.

VI. URGENCY, PAYOFF POTENTIAL, AND IMPLEMENTATION

This work is needed to maximize the potential of advanced detection. Many states and communities across
the US have installed, typically, a small number of video detection intersections at locations where
traditional detection is difficult to maintain or operate. Users are at a point where they could use knowledge
of a full range of possibilities, particularly since advanced detection comes with a high price tag. The effort
should lay the groundwork for wider use of advanced detection, ultimately leading to better management of
traffic and reduced travel time on surface streets.

VII. PERSON DEVELOPING THE PROBLEM

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