INVESTIGATION OF A COMBINED PHOTOGRAPHIC AND COMPUTER-SIMULATION TECHNIQUE FOR USE IN THE STUDY OF ISOLATED INTERSECTIONS

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ABRIDGMENT

•THE objective of this study was to develop a new intersection study technique. The specific aims were the following:

1. To develop a photographic data-collection system that is capable of recording continuous intersection traffic data, including information on stopped time delay of left-turn vehicles and on left-turn gap-acceptance characteristics;
2. To develop an intersection simulation model so that, with information provided by the data-collection system, the intersection of two- and four-lane roadways, with or without left-turn channels, can be simulated; and
3. To carry out tests necessary to determine the validity of the simulation model.

THE PHOTOGRAPHIC TECHNIQUE

The use of photography for traffic engineering studies is desirable for a number of reasons: (a) Photographic data collection provides a continuous and permanent record of all the events taking place within the view of the camera; (b) photography helps to minimize error that can result from manual data collection; and (c) furthermore, a properly developed photographic data-collection procedure enables the researcher to collect data with a minimum of support personnel.

In past studies that made use of photographic data collection and that were concerned with intersection operation, the importance of camera placement was readily recognized, and the difficulty of obtaining satisfactory data on more than two approaches simultaneously was not overcome. As a result of this study, a unique camera and mirror system was developed that, with the use of two robot motor-recorder cameras, can photograph four intersection approaches simultaneously. This camera, manufactured in West Germany, is a compact 35-mm camera and is available with a 200-ft film magazine. Utilizing an estar-based Kodak linagraph film, the camera has a maximum capacity of recording more than 30 min of continuous data at the rate of one frame/sec. Each robot camera and mirror unit is housed within an aluminum frame that is attached to a tripod head. The tripod head is inserted into a pipe pole mount, which is then secured to a pole by two U-bolts, and a firm grip is ensured by rubber sheeting positioned between the U-bolts and the pole and also between the steel plate and the pole. The entire camera mount system for one camera (Fig. 1) provides a maximum of adjustment movements as well as portability and ease of use. Figure 2 shows a typical photograph.

Other components of the data-collection system include an intervalometer that provides the pulsing mechanism necessary for the actuation of the camera shutters every second; a 24-V power supply for the film-advance motors; a frame counter that provides a means for recording signal indication and frame count; and a specially designed control box for the camera and power actuation.

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Figure 1. Camera mount system.

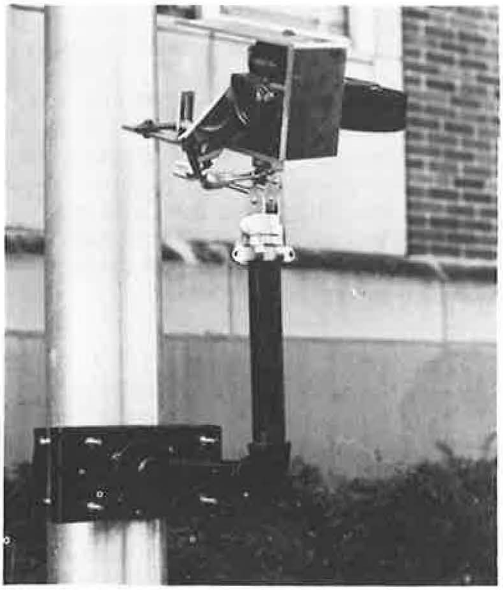

Figure 2. Sample photograph.

Data were collected at four types of intersections: single-lane approaches with and without left-turn channels and two-lane approaches with and without left-turn channels. The specific locations were chosen so as to provide information on approaches of each particular type.

The data collected included information regarding volume and turning movements, vehicular delay, vehicle arrival distributions, starting delays, and left-turn gap acceptance.

INTERSECTION SIMULATION MODEL

The simulation model developed for this study simulates two opposing approaches to an intersection and is capable of modeling any one of the following four geometric configurations: single-lane approaches with no left-turn channels, single-lane approaches with left-turn channels, two-lane approaches with no left-turn channels, and two-lane approaches with left-turn channels. The model, developed for use by the Transportation Engineering Center, Ohio State University, is referred to as the TEC model. The model is written in the specialized simulation language, GPSS/360 (General Purpose Systems Simulator).

The TEC model simulates an intersection subject to the following basic assumptions: (a) Traffic consists solely of passenger cars of similar dimensions and operating characteristics, (b) no passing or lane changing (except into left-turn channels) is permitted in the approach lanes, and (c) all vehicles enter the system with some preselected speed, such as the observed running speed.

MODEL VALIDATION

We performed a number of tests to determine the validity of the complete TEC model. Because comparison data for four different intersections were available from the data-collection phase of study, the effectiveness of the TEC model for modeling each of these intersection types was tested. The basis for the validity tests is the Kolmogorov-Smirnov one-sample test for goodness of fit. The Kolmogorov-Smirnov test is concerned with the degree of agreement between the distribution of a set of sample values and some theoretical or generated distribution. Briefly, the test is concerned with the agreement between two cumulative distributions. The point of maximum divergence D between the two distributions is determined from

$$D = \text{maximum } |F_o(X) - S_n(X)|$$

where $F_o(X)$ is a completely specified cumulative distribution function, the theoretical cumulative distribution under H_o, and $S_n(X)$ is the observed cumulative frequency distribution of a random sample of N observations. The values that have been compared between the collected data and the simulation output are the delays for vehicles passing through the intersection.

These results indicated that in all but two cases the hypothesis that the sample distribution can be reasonably thought to have come from the population distribution is accepted at the 0.05 level of significance for the 5-sec increment chosen. Both cases in which the hypothesis was rejected represent examples of low approach volumes. The two cases, however, differed considerably, and it was difficult to attribute the failure of fit to any one specific characteristic. Nevertheless, these tests do indicate that the TEC model provides adequate simulation of the types of intersections under study.

SUMMARY

The specific results of this research are related to the stated objectives of the study. The accomplishments of this research can best be discussed relative to these objectives.

The first objective was to develop a photographic data-collection system capable of recording continuous intersection traffic data, including information regarding stopped time delay of left-turn vehicles and left-turn gap-acceptance characteristics. This objective was accomplished by the development of a new camera and mirror system that uses a 35-mm robot camera with a magazine capable of recording data for 30 min at a rate of one frame/sec.

The unique data-collection system was tested in the field and was shown to be an adequate means for collecting various traffic data. Coupled with previously developed data reduction equipment, this system provided the data necessary for this study.

The second objective of the study was to develop a computer-simulation model capable of simulating the intersection of two- and four-lane roadways with and without left-turn channels. The TEC model, which can simulate these four types of intersections, was written in the simulation language GPSS/360.

The final objective of the study was to validate the simulation model, and this was accomplished by using various data collected in the field, particularly delay data.

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