Summary of Final Report, BD542
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VISUAL MONITORING OF RAILROAD GRADE CROSSING

PROBLEM STATEMENT

From 1993 to 1998, there were 25,001 highway-rail crossing incidents (worldwide?) involving motor vehicles, an average of 4,167 incidents a year. In the United States alone, a train collides with a vehicle or person once every 115 minutes, and, in an average year, more people die at highway-rail crossings than in commercial airline crashes. According to the Federal Railroad Administration's (FRA) Railroad Safety Statistics Annual Report '98, there were 75 highway-rail grade crossing incidents in Florida in 1998, resulting in 7 fatalities. Therefore, it is important to explore the use of innovative technologies to solve railroad grade crossing safety problem.

OBJECTIVES

The aim of this research is (1) to use computer vision technology to automatically monitor the motion of pedestrians, bikers, animals, and vehicles at highway-rail crossings, and (2) to develop algorithms to automatically analyze video sequences obtained from video cameras installed near the rail grade crossing and detect any dangerous situation. The system should be able to detect, classify, and track different moving objects in the video and analyze their activity. This situation awareness capability of the system can raise local alarm to warn the detected party, and it can transmit the warning message to appropriate monitoring staff (e.g., FDOT, Highway Patrol) at a remote location. This mechanism should help to avert accidents on the railroad crossing and reduce the likelihood of an accident. Portability should be incorporated in the final system so that it can be deployed on a remote railroad grade crossing location with minimal setup time and work without external power supply and communication connection.

FINDINGS AND CONCLUSIONS

Work on this project started with the acquisition of visual data from two railroad sites located in New Smyrna Beach and Mount Dora, both in Central Florida. Computer vision techniques were used to build a visual surveillance system that can detect, classify, track, and interpret the interaction of different objects in the scene being monitored by the system. There were various problems that were faced during the course of the development of the algorithms. For example, abruptly changing scene illumination resulting from fast cloud movement causes a problem in the stage during which moving objects are distinguished from the stationary backgrounds. This problem was solved using a novel approach for background subtraction.

The classification and tracking modules of the system provide a reliable framework for understanding object interaction. The tracking module benefits from the superior model that handles the shadows of the objects, which ensures that the true features of each object are used so that reliable tracking can be achieved. The surveillance software system benefits from the trip-wire feature, which can be used to mark off dangerous zones; hence, a warning can be raised if someone is detected in the danger zone. The software has the feature of train detection as well. It utilizes the train-zone area marked by the user upon system initialization. Thus, the software can keep a complete log of the trains detected along with the objects in the danger zone. The log maintains both object parameters (e.g., time-stamp, duration in danger-zone) and the image snapshot of the object.

The system has been tested under a variety of conditions of lighting, weather, camera position, and so forth. The performance of the system was evaluated for the detection, classification, tracking, and violation detection. The results were compared against the manually annotated ground truth and were found to be over 80% accurate.

The deliverables include a portable system that uses solar power with backup battery. The final system also includes a wireless communication module to transmit the log data and warning message to a remote location. This log information can be viewed in near real-time on a website that is accessible from any part of the world with internet access.

BENEFITS

The developed system performed satisfactorily and can be used by the FDOT for improved security and surveillance at any railroad grade crossing. The developed system has a useful online data logging feature that can be used for various operational purposes, e.g., traffic monitoring at a remote railroad grade crossing including pedestrian and vehicle statistics during a specific part of day, month, or year.

The portable system can be deployed at a remote location without power and communication link availability. The system can run off solar power and use cellular internet data service for communication. The setup time of the system is less than 20 minutes.

Overall, this system has produced encouraging results and can be very effective for improving security, surveillance, and operations, as well as for performing engineering studies.

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