CHAPTER 3. RESEARCH METHODOLOGY AND ORGANIZATION

3.1 Research Methodology

The research methodology adopted in this research consists of the following steps:

1- Investigate through literature the safety and accident problems and the kind of ITS applications and technologies currently deployed or still under research, with a special emphasis on the different warning and collision avoidance systems. Anticipated results of those applications and research outcomes are documented in the literature review chapter.
2- Better understand the specific problem under study by collecting data and information about the various elements contributing to accident occurrence namely about roadway characteristics, traffic conditions and driver performance.
3- Develop a conceptual design of the proposed system in terms of functions and sub-functions, then followed by a detailed design of the various system components.
4- Evaluate the system in terms of predefined measures of effectiveness MOEs, especially the measure of reducing the number accidents and eventually the number of human and property losses.

The proposed methodology presented above implicates accomplishing the following tasks:

3.1.1. Task 1: Literature Review

Conduct detailed and comprehensive literature review about the following:

1- Accidents in general, and accidents in rural roads specifically, including statistics, causes and countermeasures.

2- The Intelligent Transportation System (ITS) and in particular the Advanced Rural transportation systems (ARTS) and their contribution to safety improvement.
3- Collision avoidance systems concepts and applications.
4- Warning systems technology and applications in ITS world.
5- Enforcement systems technologies and their applications.

3.1.2. Task 2: Data Collection

Data collection efforts will be conducted for the project for aspects that may affect system design, namely:

1- Roadway inventory: road alignment (vertical and horizontal curves), cross section, abutting land use and roadway signs and marking.
2- Traffic conditions: traffic volumes, vehicle classification and average speed.
3- Accidents history: investigate from official records the accident attributes at that roadway section (frequency, time of day, type, damages, ..)

3.1.3. Task 3: Identify Geometric Characteristics of The Site and Coverage Area

This step would clarify some aspects related to site deficiencies that contributed to accident occurrences such as insufficient stopping and passing sight distances. It will also help in the determination of the area boundary of the project.

3.1.4. Task 4: System Architecture

The focus of this task is to identify system requirements, to describe functional subsystems and to develop comprehensive concepts of these subsystems. The following subsystems will be covered:

1. A detection and surveillance subsystem,

2. A central control processor,
3. A warning subsystem, and
4. A communication system.

Data flow among the various system components will be depicted on a representative flowchart.

3.1.5. Task 5: System Design

After system architecture has been developed for each functional entity, each subsystem will be designed and equipment will be selected based on detailed specifications.

The following components of the system architecture are to be developed in this task:

1. *Hardware Design:* Many hardware elements are expected to be used in the following subsystems:

    a. *Detection system:* Video camera detection that may be supported also by other types of sensors
    b. *Warning panel:* Variable message sign design (dimension, letter tile size, face display)
    c. *Central processor:* Processor specification able to conduct analysis and control system operations.
    d. *Communication:* Type and topology of the network, including the transmitters and the receivers devices, and the transmission channels.
    e. *Enforcement:* The type and Characteristics of the camera needed to capture the image of the license plate and processing it.

2. *Software Design:* Software plays a key integrative role in this warning and collision avoidance system. An algorithm will be developed to identify violating vehicles and activate both warning systems and vehicle license identification system.

3.1.6. Task 6: System Simulation

In order to test the system functions and assess the application implications, a system simulation will be conducted using a simulation tool.

The simulation will show the impact of many parameters contributing vehicle crashes and reflecting - in the same time- the complexity of the problem we are dealing with. Actually, we may classify these parameters into three groups related to the three transportation system components:

1- Roadway-related parameters: horizontal layout, vertical profile, and lane configuration…etc.
2- Vehicle-related parameters: location, speed, acceleration, and deceleration, of the different vehicles involved in the incident.
3- Driver-related parameters: reflecting driver behavior and psychological conditions such as probability of violation, perception time, reaction time and degree of being risk-taker of risk averse.

Eventually, a huge number of outcomes could be resulted from the combination of those parameters. However, different scenarios based on certain assumptions could be made in order to distinguish the impact of the system on certain parameters and how that will minimize the severity of the problem.

3.1.7. Task 7: System Evaluation

The performance of the project can be evaluated by conducting a comparative analysis between violation rate crash rate (or casualty rate) in the period before and the period following the implementation of the warning system. However, due to randomness of accidents occurrence and to overcome the difficulty of evaluating the **observed** "before" and "after" number of

collisions, we may rely on the simulation output when comparing the impact of deploying a warning system.

A sensitivity analysis could then be done where the system performance could be examined in the light of varying the value of some input parameters such as violation rate, traffic volume and speed.

Eventually, the simulation outcome in addition to the evaluation results of deploying other comparable systems will be the main sources to identify the benefits the proposed system in terms of reducing casualty and property losses.

Those benefits will be quantified and monetized, and preliminary economic evaluation will be conducted in order to determine some of its economic indicators such as B/C relying on the prevailing unit costs of incurring benefits frequently adopted and used in evaluation studies.

3.2 Organization of the research

Based on the above, the research will go in parallel with the sequence of tasks. Figure 3-1 depicts the structure of the research that actually gets along with the conventional steps of planning, designing, implementing and evaluating any project.

Figure 3-1. The Research Structure