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Howard University

Lane Departure Warning System Implementation and Evaluation Plan

Senior Design II | Dr. Charles Kim

I. Introduction

This report focuses on the implementation and evaluation plan of our design project. The implementation plan will highlight the steps that will allow our team to take this project from paper design to reality. Additionally, the evaluation plan will set clear benchmarks to ensure that the implemented design meets the design requirements. These two plans will ensure that our team develops an efficient process to do the work. This will build on the in depth analysis of the engineering design requirements that we developed to help prevent the class of accidents popularly known as Run-Off-Road (ROR) accidents.

II. Implementation Plan

In order to move this project from paper design to reality, we focused on the following components - Detailed Task Layout, Personnel Management, and Risk Management. The following is explains each of the components in more detail:

(i) Detailed Task Layout

The following is a timeline with the detailed deliverables to guide our team to project completion:

Week	Beginning Date	Deliverables
Week 1	08-Feb-09	1) Order the following parts - Line Tracker Input Sensors - Miniature car - Basys System Board FPGA - Ultra-Bright LEDs - Connecting wires - Seat vibrators - Electric switch (for turn signal) 2) Use relevant block set to create simulation with Simulink®
Week 2	15-Feb-09	1) Develop LDWS system algorithm 2) Consult with faculty advisor (Dr. Gloster) to critique the algorithm
Week 3	22-Feb-09	1) Use VHDL to develop the input module (interpret data from line tracker module) 2) Use VDHL to develop the control unit module

		(process data received from line trackers module)
Week 4	01-Mar-09	1) Construct demonstration set 2) Critique and test VHDL software
Week 5	08-Mar-09	1) Test model on demonstration set 2) Update VHDL code in input module if needed
Week 6	15-Mar-09	1) Develop user tests: Power User Test and Normal User Test 2) Develop and critique plan for user documentation
Week 7	22-Mar-09	1) Create user documentation based on previous plan
Week 8	29-Mar-09	1) Beta testing with select power users 2) Update user documentation accordingly
Week 9	05-Apr-09	1) Beta testing with normal users to ensure that user documentation is comprehensive and easy to follow

(ii) Personnel Management

For each set of task layouts described, here is a brief description of the individual responsibilities of the members of the team in the coming weeks of this project:

A. Chukwuemeka Ekeocha (Team Scribe)
   a. Record and compile minutes for all meetings as well as progress reports from all demo/building sessions, and provide weekly status summary
   b. Keep track of all team's external correspondence with advisors
   c. Collect receipts of all parts ordered, as all as all financial disbursements made
   d. Create project summary document for Dr. Kim's proposed SD booklet
   e. Construct miniature road track for demonstration purposes
   f. Build template for user documentation

B. Uchechukwuka Monu (Team Researcher)
   a. Carry out preliminary research into various part options (sensor, control unit, vibrators and LEDs) to be considered on the decision matrix

b. Present pros and cons of all options in an evaluable form to drive conversation at team meeting for building of the decision matrix
c. Remain abreast of expert opinion and best practices for the sensor technology, Field Programmable Graphic Arrays, and alternative mechanisms being considered.
d. Research into available building blocks in software for simulation of project

C. Uzoma Nwagba (Technical Liaison)
   a. Schedule meeting with Dr. Gloster and debrief on overall project and milestones till date
   b. Source technology options (Simulink, PSpice, MATLAB, Xilinx, and ModelSIM) to be used for simulation
   c. Schedule soldering visits to the Electrical Engineering lab, and also search for a lab technician who would be able to assist with the building phase
   d. Place calls to vendor companies to clarify compatibility concerns between components.
   e. Work with Uchechukwuka on researching expert opinion and best practices for each component—input, processing and output.

D. Peter Ramsumair (Team Coordinator)
   a. Drive the implementation phase of the project, setting deliverables for each member
   b. Map out preliminary calendar of meetings and manage timeline for project completion
   c. Submit part list for placement of order, and receive parts from the department
   d. Source props (chairs, disguises, etc) for finishing touches on the car
   e. Draw up implementation/test plan documentation

(iii) Risk Management

In this project, it was essential that we identify, monitor and mitigate the risks associated with developing a LDWS system. The following lists the main risks that we identified:

Risks	Risk monitoring and management
The appropriate sensors specific to our design, in terms of size and functionality, are unavailable in the market	An alternative sensor system has already been found from our extensive research and we would resort to it if the current sensor system in place is unavailable

The range of detection of the sensors is too low with a maximum range of just fractions of an inch	The height of the sensor system above the ground will be adjusted such that the lane markings on the road would be within the detection range of the sensors
The speed and motion of the car makes it difficult for the receivers in the sensor system to accurately receive the reflected rays thereby leading to long response times or inaccurate data	The RC vehicle selected has the functionality to alter speed levels, thus the speed of the car will be reduced to allow the sensors have more accurate data collections
IR reflections from the sensors could be affected by ambient light and shades cast by objects in the testing environment	The testing and experiments will be carried out in an environment that are not too bright or dark
The actual project cost exceeds the estimated project budget	The team members will contribute extra funds to finance any additional and unforeseeable costs
Logic errors and coding issues are encountered with the FPGA board	The team will extensively debug the program until the errors are pinpointed and rectified
There are compatibility issues with the input, output and control unit components	Alternative parts will be ordered to replace the incompatible parts
The wheels of the RC vehicle cannot roll smoothly on the black road surface	The road surface will be constructed using a different material that will allow for the smooth rolling of the wheels of the car
The speed of the RC vehicle is too fast and cannot be adjusted to a speed that will be convenient for the effective testing of the lane departure warning system	The RC vehicle that we ordered comes with a speed-varying feature which would enable us to adjust the speed of the RC vehicle to suit our design
The lane departure warning system does not respond to the positions of the switch on the FPGA board which serves as the turn signal, therefore causing the LDWS to send alerts during intentional lane departures	The programming code of the controller unit will be rechecked to trace the cause of the turn signal problem

III. Evaluation Plan

In this design project, we intend to use three main evaluation schemes to analyze our solutions alternatives – Expert Opinion Evaluation, Simulation Evaluation, and Prototype Evaluation. These three schemes will consider a number of factors. Each factor will be analyzed and scored (1 – 10). This score would depend on various measurable quantities, for example response time, light intensity, color recognition, power ratings, durability.

A. Expert Opinion Evaluation

1. The LDWS should issue a warning 95% of the time per left or right side drifts
2. The compilation of data must correspond with the SAE J1587, “Electronic Data Interchange between Microcomputer Systems in Heavy-Duty Vehicle Applications” (message definition for the J1708 data bus)
3. Warning should be visual and tactile
4. The LDWS should meet the environmental requirements specified by SAE Standard J1455, “Joint SAE/ Technology and Maintenance Council (TMC) Recommended Environmental Practices for Electronic Equipment Design
5. The system should meet the electrical requirements as specified by the SAE Standard J1455, “Joint SAE/ TMC Recommended Environmental Practices for Electronic Equipment Design”
6. The system should be small enough not to hinder the user
7. There should be no electrical or mechanical shock from the systems warning devices
8. The system should be isolated and easy to install
9. The connectors should be rated for automotive duty
10. The LED should be clearly discernable from the outside light or darkness and the vibrational threshold should be high enough to warrant a response
11. User documentation should be provided

B. Simulation Evaluation

1. Testing the input for different colors of the lane markings
2. Testing the input for different types of lane markings
3. Testing the input for different combinations of the sensors
4. Testing for the intensity of the lane drift
5. Testing the functionality of the system with or without the turn signal

6. Testing the response time of the user to the vibrational seat and the LED
7. Testing the operational speed of the FPGA to the different input connections
8. Testing the power supply of the FPGA to the sensors, LED and vibrational seat
9. Testing for false inputs/ false positives
10. Testing for the smooth transition between the directional drift and the seat warning(i.e. testing for the correct connections between the left and right sensors and the left and right seat vibrators)

C. Prototype Evaluation

1. Testing the prototype with different lane marking, and lane marking colors
2. Testing the prototype under normal driving conditions
3. Testing under poor visibility or bad weather conditions such as snow, rain, ice or fog
4. Testing the warning intensity as the extent of the lane drift varies
5. Testing the durability of the connections and the ease of use of the system