Auto-adjustable Spoiler Control System

Progress Report

Project Team:
Zhengdong Cao **CEO**
Yueying Li **COO**
Tianye Zhou **CFO**
Tianlin Yang **CTO**

Contact Person:
ZhengDong Cao
E-mail: zcao@sfu.ca
Phone: 778.317.4405

Submitted to:
Dr. Andrew Rawicz
Mr. Steve Whitemore
School of Engineering Science
Simon Fraser University

Issued Date:
November 29, 2015

Revision: 1.4

AOA	Angle of Attack
ASCS	Auto-adjustable Spoiler Control System

Introduction

The Auto-adjustable Spoiler Control System (ASCS) is a feedback control system in which drivers are capable of adjusting the elevation and angle of attack (AOA) of the car spoiler manually or automatically. The goal of Veroptimal Solution is to enable a single car spoiler to be multifunctional, providing better safety performance as well as reducing the fuel consumption. This design specification provides detailed technical descriptions for the design of each component of the ASCS. The design of ASCS can be divided into three major subsystems: Front Panel, Main Controller and Spoiler System based on their designated functionalities. This document describes the progress and current state of the project. The scheduling issues, financial status and the solutions to current problem are outlined.

Schedule

As shown in the table below, the initial proposed tasks schedule in under column “Expectation”. As colored on the column “Reality”, Research and Planning, System Design and Hardware Development are completed on time. However, the Mechanical Development was delay for 3 weeks. The major reason for the delay is due to the unexpected long time to fabricate materials for mechanical structures. Although, the Mechanical Development was behind schedule, the development team tried their best to catch up and finish all the tasks in week 10 and integration will then start immediately. After the Mechanical Development and System Integration is done, Testing and Optimization is about to start.

Table 1: Schedule of project development

Technical Aspects	**Expectation**	**Reality**
Research and Planning	Week 2	Week 2
System Design	Week 3	Week 2
Hardware Development	Week 6	Week 6
Mechanical Development	Week 7	Finished on Week 10
Firmware Development	Week 9	Week 9
Integration	Week 10	In progress
Testing and Optimization	Week 12	In progress

Finances

With careful consideration under limited funding from ESSEF, which is $400, a larger amount of tentative cost for the project development has been cut off or replaced. Table 2 below shows the current financial status in our project. Many electronic components were bought from China hence the price is much cheaper.

Table 2: Budget

List	Proposed	Actual
Electronic Components	370	200
Circuit board Prototyping	35	45
Motors	220	190
Structrual Elements	75	160
Total Expenditure	700	595

With limited budget, the development team found the following replacements.

1) Hand Supporter Links
   Proposed: Fabricate Hand Supporter Links using carbon fiber
   Actual: Hand-made Supporter Links with Aluminum Alloy

2) Motor Stabilizer
   Proposed: Fabricate Motor Stabilizer using carbon fiber
   Actual: Hand-made Motor Stabilizer with wood

3) Enclosure
   Proposed: Fabricate all enclosures using 3D printing
   Actual: Find replacement cases and covers

Progress

Most of the tasks listed in the table# are completed on time. The ASCS product is transitioning from proof-of-concept phase to prototype phase. With more funding and time, further modifications and improvements will be implemented in the final production stage.

- **Research and Planning**

Research and Planning have been done on time. The development team did adequate research on aero-dynamic before starting design the spoiler system. Beside, the engineers have done marketing research to found out the product potentials.

- **System design**

General system design has been done on time. The design of ASCS has been finalized. The product will have a user interface panel which allow user to have full control of the spoiler. The operation modes have been developed as follows. The first one is automatic mode. Second, it is manual mode. The third one is based on user preference. In preference mode, driver can mark down a certain condition as stored in pre-set mode. In addition, the ASCS is divided into three major subsystems: Front Panel, Main Controller and Spoiler System. These subsystem

functionalities involve with hardware, mechanical and firmware aspects. Detailed development process will be provided in the following sections.

- **Hardware Development**

Hardware design for ASCS has been developed on schedule. The overall hardware design follows the microcontroller based circuit design scheme. All the circuit designs have been finalized and constructed on perf-board as well as being tested. The product is developed to be controlled by Arduino microcontroller as the central processing unit. Detailed pins and connections between Arduino microcontroller and hardware components have been decided. Besides, tests have been done to secure the Arduino microcontroller controls of single hardware components.

a) The Front Panel is done to be done with two parts, circuit design and board prototyping.
b) Main Controller circuit design of the is developed. The sub-tasks are as follows. RF Module, GPS Module, Brake Detection Circuit, Force Measuring Circuit, Angle Measuring Circuit and Motor Driving Circuit.
c) The Spoiler System cable design, is done to addressed to serves as a bridge between the Main Controller and Spoiler System for both power delivery and signal transmission.

- **Mechanical Development**

The two-week delay mechanical development is done in week 9 and most of the tasks are related to Spoiler System mechanisms. The Spoiler System Mechanism is concluded to be in two parts, Arm mechanism and Arm Mechanism.

a) Arm Mechanism is done. The movement of Arm Mechanism is driven by the Linear Actuator which is able to adjust the spoiler height using power source in this stage.
b) Hand Mechanism is finalized. The AOA of the spoiler can be controlled with Hand Mechanism using motor, which will be compatible with any type of car spoilers with different width and thickness.

- **Firmware Development**

The on time schedule of firmware development has been mostly done. Most of the approaches in firmware developments are greatly laid on Main Controller.

a) Firmware implementation is done on Arduino Nano microcontroller. The program is developed for the system control. These functions are involved with the movement control of linear actuator and motor. Besides, system has been developed to collect data from downforce sensor and angle sensor as well as data storage.

b) Firmware programming is also developed on the radio transmitter chip RF2.4MHz. for data exchange process. Besides, data from Main controller is implemented to be displayed on the LCD Screen.

- **Integration**

The integration is in progress based on Hardware Development and Mechanical Development. Integration has been started. The engineers are working on the wiring between hardware part and mechanical part. The development team is preparing to integrate the firmware part to the above two after tests passed.

- **Testing and Optimization**

As soon as the Integration is in completed stage, the Testing and Optimization is about to start.

Remediation

A major change in the mechanical design was implemented as shown in the two figures below.

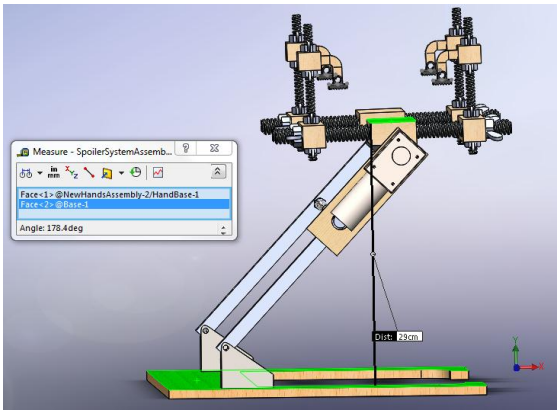

Figure 1: Proposed Spoiler Hand Mechanism CAD

Figure 2: Spoiler System Mechanism

The design Hand Mechanism in mechanical development has been modified. With limited time and budget for the project, the development team came up an enhanced design as shown in the Figure 1. With the new Hand Mechanism design, engineers replaced clampers with mega clips, which will serve the functionality as the proposed design. Besides, the new Hand Mechanism design have a smaller AOA surface compared with the proposed one, which will suffer a decrease amount of air flow that enhance the product adjustment. Last but not least, new Hand Mechanism will have a lower cost and better time efficient.

Conclusion

In summary, we have made considerable progress during the term based on the planning. However, the development team will spend more time and efforts before the demo. The overall development progress is slightly behind our predicted schedule. But the engineers will try their best to catch up any delays. With limited budget and intense development schedule, Veroptimal Solution will present the final product in the demo day.