

February 9, 2015

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia, V5A 1S6



Re: ENSC 440 Functional Specification for ATVs (All-terrain vehicles) Anti-rolling System

Dear Dr. Rawicz:

The attached document, *Functional Specification for ATVs (All-terrain vehicles) Anti-rolling System* outlines functional specification of our project for ENSC 350W/440W. The team of ARS (Anti-rolling System) Innovations is designing and implementing an automatic protection system for ATVs to prevent the roll-over of the vehicle.

Our functional specification provides details to the ARS's functionality for its various stages of development. Our project manager and design engineers will use this document as a guide for research and development activities.

ARS Innovations is founded by five talented and innovative senior students from engineering science in SFU: Yuchen Tong, Eric Wang, Yigang Tao, Colman Wen, Xupeng He. If you have any questions or concerns about our proposal, please feel free to contact me by phone at (604) 369-3316 or by e-mail at shitongw@sfu.ca.

Sincerely,

A handwritten signature in black ink, appearing to be 'Yuchen Tong', written over a horizontal line.

Yuchen Tong
President and CEO
ARS Innovations

Enclosure: *Functional Specification for ATVs (All-terrain vehicles) Anti-rolling System*



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Functional Specification for

ATVs (All-terrain vehicles) Anti-rolling System

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Executive Summary

All-terrain vehicle (ATV) has been more and more popular nowadays. However, safety has been a major issue with ATVs due to the high number of deaths and injuries with them. For any off-road vehicle, rollover is the most seen accident and may cause serious accidents and injuries. The driver may feel the vehicle is tilted, but as the eye level is parallel to the ground, he or she cannot tell how steep the ground is and rollover may easily happen. At ARS, we feel that more proactive actions need to be taken to prevent danger from rollover for any off-road vehicle while keeping the fun and concentration of driving.

The objective of ARS is to design a system that can provide prevention and protection to the driver from rollover. The system will measure the angle of the vehicle. When a certain angle is reached, a buzzer and flash light will be triggered to alert the driver. This can allow the driver to react and drive more carefully to prevent the vehicle from rolling over. If the driver's reaction is not enough, when a steeper angle is reached, a protection bar will be ejected at the back of the seat. This can create a safe triangle around the driver to provide protection.

The development of this project will be done in three stages: two development stages to create the device, and a final production stage to make final adjustments. The stages are broken down as follows:

Development Stage 1:

- Design the main functionality of the prevention system (buzzers, lights)
- Construct a protection bar that is strong enough to support the weight of the vehicle and driver.
- Use level sensor as a switch to trigger both of the systems.

Development Stage 2:

- Research and test to find threshold of safety angle.
- Package and install the system to a ATV

At the end of stage 2 a working prototype should be delivered no later than April 15th, 2014. The APS system should comply with safety regulations and provide its main purpose of safety protection for ATV driver without interfering the current driving experience.

This following document will provide detailed functional specifications outlined for our system, along with the two sub systems. It is intended for use by designers, developers, testers for this product as guideline and updated when necessary.

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Glossary

ATV	All-terrain vehicles
ARS	Anti-rolling System
LED	Light-Emitting Diode
CAD	Canadian Dollar
ANSI	American National Standards Institute
DC	Direct Current
LCD	Liquid-crystal Display

1 Introduction

The ATVs Anti-rolling System (ARS) is a system that can provide prevention and protection to the driver from rollover. Automatic Protection System for ATV consists of two level sensors. One connects to a buzzer and LED light to notify the driver to mind the angle. Another one acts as a trigger to a protection bar that can be ejected when the vehicle is about to roll over. Using this system, the driver no longer needs to worry about the slope of the ground and injury caused by rolling over of ATV can be greatly minimized. This document layouts functional requirement of the ARS.

1.1 Scope

This document describes the functional requirements that must be met by a functioning Anti-rolling System. The listed requirements will be used as reference throughout the design and produce phase and will be traceable in future design documents.

1.2 Intended Audience

This functional specifications will be used by all members of ARS Innovations. The team leaders can use this document as a guide to measure the process throughout all development phase. Design engineers can refer this document to reflect on the requirements needed for ATVs Anti-rolling System. Test engineers should use this guide to verify the functionalities of the system.

1.3 Classification

The following conversions shall be used throughout this document to represent functional requirements:

[Rn-p] A functional requirement.

Where n is the functional requirement number, and p is the priority of the functional requirement as denoted by one of three values:

- A. The requirement applies to the proof-of-concept system only.
- B. The requirement applies to both the proof-of-concept system and the final production system.
- C. The requirement applies to the final production system only.

2 System Requirements

2.1 System Overview

ATVs Automatic Protection System is a portable protective device, which can be installed easily as an add-on by the user on various types of ATVs on the market. The system helps drivers have a safer experience by monitoring the vehicle's level constantly which assists drivers adjust their speed and direction with notification. In addition, if the vehicle is about to roll over, the protection system will be triggered automatically.

The system consists of level sensors, microcontroller, protection bar, LED lights and buzzers. The level sensors are connected to the microcontroller, and provide a continuous level measurement. Based on the measurement, the microcontroller will determine which situation the user currently in and activate LED lights, buzzers, or protection bar accordingly.

The following drawing shows an overview of the system:

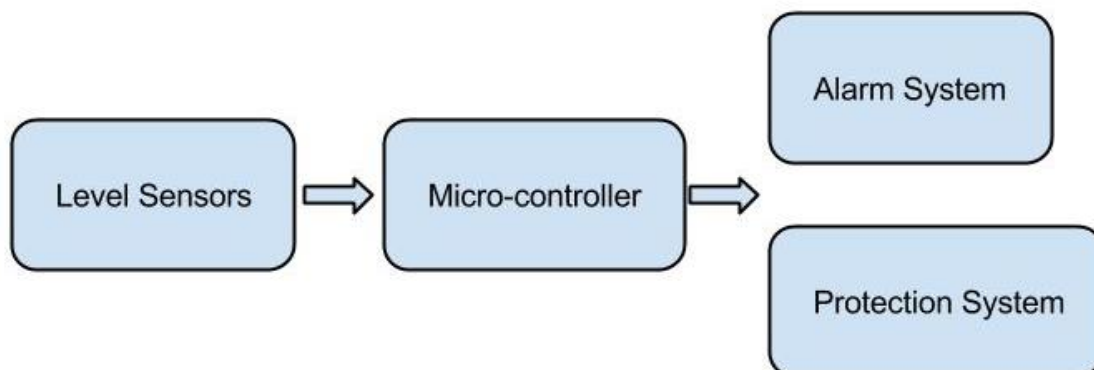


Figure 1 System Overview

2.2 General Requirements

[R1- A] The device should be able to use in various types of ATVs on the market.

[R2- B] The device shall be portable.

[R3- A] Developments costs of the device shall be less than \$1000 CAD.

[R4- B] The user shall be easy to install/ uninstall without professional help.

[R5- C] The device retail price should be under \$300 CAD.

[R6- C] The device shall be water and dust proof.

2.3 Physical Requirements

[R7- B] All electric components of the device shall be firmly installed in the box on the protection bar.

[R8- C] The protection bar shall be robust and able to support the ATV in the event of a rollover.

[R9- B] The device must be light and will not affect the balance of ATV.

[R10- C] The assembly of the device shall withstand a free fall from 2 meters.

[R11- C] The device shall not have any sharp edges.

2.4 Electrical Requirements

[R12-B] The device shall be powered by the vehicle internal battery with adaptors.

[R13-C] The system will operate properly when there is interference from other devices.

[R14-C] All the electrical components on the final product must be powered under 5V.

[R15-C] The device must include a power switch.

[R16-B] The device shall not cause any damage to the ATV's electrical system.

[R17-C] The device shall include a fuse and diode protection against any electrical damage.

2.5 Environmental Requirements

[R18-C] The device shall operate in within the temperature range:-20°C to 50°C.

[R19-C] The device shall perform the same under dry and wet conditions.

[R20-C] The device shall operate normally at sea level and up to an elevation of 2000 meters.

2.6 Standards

[R21-B] The system shall obey the ANSI standards [1].

[R22-B] The system shall obey BSI BS EN 15997 regarding of the safety requirement and test methods [2].

2.7 Reliability and Durability

[R23-B] The device shall be accessible to change the broken LEDs, buzzers and protection bar.

[R24-C] The lights and buzzers shall be bright and loud enough in the field.

[R25-B] The system shall not have hardware or software defects.

[R26-C] The main body of the device must have a lifetime of minimum 5 years.

2.8 Safety Requirements

[R27-C] The system shall be off when the ATVs is turned off.

[R28-C] The sensors and microcontroller shall remain dry any time.

[R29-B] The device shall not have any electric leakage.

[R30-C] The spring's elasticity from the protection bar shall not cause danger to the user.

[R31-C] The device shall not create excessive heat dissipation that might endanger the user.

2.9 Performance Requirements

[R32-B] The protection bar shall be launched before the vehicle flips over.

3 Hardware Requirement

3.1 Roll-bar

Roll-bar provides protection to driver by creating safety space during rolling over accident. It is important that the material used for roll-bar must have enough strength to support the vehicle. To ensure that the roll-bar does not interfere driving, the roll-bar need to be compressed in normal situation. The protection system can only reset by user manually, therefore the roll-bar cannot compressed after launching. The requirements reflect the standards in document “IEC 60730-1 ed5.0 Automatic electrical controls for household and similar use” [3]



Figure 2: Roll-bar 3D Graph

3.1.1 General Requirements

- [R33-B] The roll-bar cannot compress after launching.
- [R34-B] User can reset the roll-bar manually.
- [R35-B] Protection system should not interfere the normal driving.
- [R36-B] The shape of roll bar should look good.
- [R37-B] Roll-bar should not cause injury to driver in normal use its function.

3.1.2 Physical Requirements

- [R38-B] The material for producing roll-bar must be able to support over 900lbs weight.
- [R39-B] The height for roll-bar in compressed mode should not greater than 70cm.
- [R40-B] The width of roll-bar should less than 150 due to the width of the vehicle.
- [R41-B] The height of roll-bar in extension mode must greater than 120cm.

3.2 Sensors and Controller

Two level sensors in the system to measure the angles between vehicle and horizontal/vertical level. The controller could control the protection part and alarm part by analyzing the analog signal from sensor. The requirements reflect the standards in document "IEC 60730-1 ed5.0 Automatic electrical controls for household and similar use" [3].

3.2.1 General Requirements

- [R42-C] The detecting and control system should able to work in shaking and rolling environment.
- [R43-C] The sensors should be placed in stable position.
- [R44-C] The user should able to change the sensor's setting easily.

3.2.2 Electrical Requirements

- [R45-A] The supply voltage for sensors should in range 3.5V - 5V.
- [R46-A] The devices in system should be able to operate by 12V DC voltage.
- [R47-A] The total power rating of all device should not greater than 200W.
- [R48-A] The current flow in circuit must less than 4A.
- [R49-C] The wiring space between load and wire should greater than 9mm.

3.3 LCD Display and Speaker

The function of LCD display is to show the numerical measurement of the current situation. The function of speaker is to produce a sound to call for the help. The requirements reflect the standards in document “IEC 60730-1 ed5.0 Automatic electrical controls for household and similar use” [3].

3.3.1 General Requirements

- [R50-B] The screen should place in proper position which make the observation easily.
- [R51-C] Speaker and screen should install on vehicle correctly to prevent split.
- [R52-A] The size of screen should consider the distance between driver’s eyes and screen.
- [R53-A] Speaker and screen should able to work in shaking and rolling environment.
- [R54-A] The speaker and screen should choose from recycling material to meet the goal of environment protection.
- [R55-C] The screen and speaker should work normally during complex weather conditions such as fog, dust and rain.
- [R56-C] The screen and speaker should not harm the beauty of vehicle.

3.3.2 Electrical Requirements

- [R57-B] These two devices should able to operate under 12V DC supply.
- [R58-B] The combine power rating of these two device must be less than 10W.
- [R59-B] The connection ports of devices must prevent dust and water.

3.4 Microcontroller Requirements

3.4.1 General Requirements

- [R60-B] Serve as a connection bridge between level sensors and hardware
- [R61-C] Be able to process angle and perform signal trigger
- [R62-A] The size of control part should in range 20cm ×20cm.
- [R63-B] All the circuits and devices must insulate with user.

3.4.2 Physical Requirements

- [R64-B] Supply voltage that is suitable to power the level sensors
- [R65-C] Should have low power capabilities
- [R66-A] Have programmable Input/output pins
- [R67-B] Should be installed firmly in the vehicle
- [R68-B] Should fit in small waterproof case
- [R69-A] Will be able to function after reasonably strength of impact

3.4.3 Electrical Requirements

- [R70-B] Should be operating at 12V from battery of vehicle
- [R71-C] Receive analog signal from the output voltage of level sensor as input
- [R72-C] Controllable output pin to trigger other electronic parts

4 Safety and Sustainability

At ARS Innovation, we designed our product is both safety and sustainability for users and environment. With Cradle to Cradle design, as in nature, there is no such thing as waste, no having to do without, no limitations. [4] In this design, we keep the Cradle to Cradle design concept in mind and try to make our product to have the least negative impact to our environment.

Roll-bar is to be made primarily of stainless steel which can be easily recycled and at same time stainless steel gives us enough strength to make sure it is safety to users. After the life cycle of our product, the roll-bar can be easily melted and reuse. For the electronic components, we chose RoHS compliant materials which is tested for the presence of Lead (Pb), Cadmium (Cd), Mercury (Hg), Hexavalent chromium (Hex-Cr), Polybrominated biphenyls (PBB), and Polybrominated diphenyl ethers (PBDE). For Cadmium and Hexavalent chromium [5]. By using the RoHS compliant materials in our design, there is no heavy metal in our product, also in future design and production phase, we will use RoHS compliant materials as the standard.

In order to get maximum length life cycle of all the material and component, we will give all the used component to ESSS to future project use except the roll-bar. Because the roll-bar is customer made, we will dispose it in Burnaby Eco-Centre. [6]

5 Conclusion

This document states the function specification for ATVs (All-terrain vehicles) Automatic Protection System. The requirements described in function specification provided necessary design elements to build our system. We have two fundamental design philosophies. First, the system must not cause any kinds of injuries by using its functionality normally. Second, the system must not interfere the operation of other systems. We will keep safety and reliability in mind during the development of system. Each individual component will has its own test plan which cover all possible conditions. The whole system will also take the assembling test after the individual test.

6 References

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