Requirements List - LaserTech Lawn Defense System

Feb 3rd, 2019

Dr. Craig Scratchley
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RE: ENSC 405W/440 Requirements Specification for LaserTech

Dear Dr. Scratchley,

This requirement specification document for LaserTech is prepared by Team 11 for ENSC 405W/440. Our goal for the capstone project is to use motion detector to identify crows and expel them using multiple laser beam as a solution for house landlords who have issues in expelling annoying crows that peck and ruin front garden and backyard lawns.

LaserTech uses a motion detector, mounted on the roof of the house, to synchronously identify crows and once the crow has been identified landing on the grass, the motion detector sends the signal to the laser module so that it flashes the laser light beam at the crows in order to prevent them in continuing pecking the grass roots.

The requirements specification includes a list of 100 requirements from the proof of concept to the system overview to the final product. This document will cover general requirements and other requirements such motion detector and laser beam module. Moreover, this document will also discuss safety and sustainability requirements, as well as the engineering standards that our product will commence.

Our team would like to take this opportunity to thank you for your time to review our requirements specification. Should you have any questions, please feel free to contact me via email at axi@sfu.ca.

Sincerely,

Hope Wang Xi, CEO
LaserTech Systems

Requirements Specification
LaserTech System

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Abstract

This document specifies the requirements for the project and its overview of the lawn defence system, LaserTech. To begin with, it will give a general overview of the common issue that every house landlord is facing, and what can lawn defence system help landlords resolve the problems. This document will then discuss System Overview, Engineering Standards, as well as Sustainability and Safety factor.

By experiment in using laser pointer to we have found that lasers are efficient to expel crows. The basic design includes two major part: motion detection part that should be able to capture the crows when they land on the crow immediately and laser beam system that should be able to efficient enough to expel the crows.

The requirements for LaserTech includes the following major components:

● General Systems Requirements
● Software Requirements
● Electrical Requirements
● Hardware Requirements
● Safety and Sustainability Requirements

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1. Introduction

The LaserTech lawn defence system will provide real-time lawn monitoring functionality to protect house landlords' beautiful lawns from being pecked and ruined by crows. The LaserTech system uses a motion detector to detect any moving objects and identifies target objects crows, and once the target objects are identified, the system sends signal to the laser beam module buried in the middle of the lawn, and the module triggers the embedded laser pointers to flash at the crows as a result of protecting the lawns from being pecked by crows to continue pecking the grass roots to find chafer grubs, also known as European chafer beetle.

1.1 Background

It has been a common issue for people, especially landlords who have experience with crows landing on their front lawn garden and backyards pecking and ruining the lawn surface. The reason that the crows tend to peck the lawn is because they look for their favourite tasty grub snack also known as European chafer beetle [1]. The following image illustrates crows' favourite snacks, the chafer grubs:

Figure 1: Chafer Grubs

Nevertheless, it is not enough to keep the lawn healthy even if there is no chafer grubs, since the crows or skunks would still try to peck and find if there is any "jewelry" under the grass as illustrated as follow:

Figure 2: Damaged Lawn

Evidence shows that laser beam can effectively frighten and expel crows, which is also proven by our kick-off experiment of using laser beam is able to expel crows. Hence, We are commencing our project idea to build a system using motion detection technology to identify crows, and shoot red/green laser light beam to expel them.

1.2 Scope
The scope of the document is to specify general and function requirements in order to build an effective lawn defence system, so that it can effortlessly expel the crows once the system identifies if there is any crows landing on the grass that is being monitored.

1.3 Intended Audience
The audience of the requirement specifications document is intended to be Engineering professors, teaching assistants, enterprise clients that are interested in investing in lawn protection technology, as well as landlords who are experiencing the issues with their lawns being destroyed by the crows.

1.4 Requirement Classification
The whole system is used to expel crows on the certain lawn areas. The requirements are classified as follow:
1.   General Requirements (GR)
2.   Software Requirements (SR)
3.   Electrical Requirements (ER)
4.   Hardware Requirement (HR)
5.   Safety and Sustainability Requirements (SSR)

The different stages of the requirements are described in the following table:

Reference Code	Project Phase
C	Proof of concept
P	Prototype
F	Final product

Table 1: Stages of requirements

The phase level of the requirements are described in the following table

Reference Code	Project Phase
A	These requirements must be met in the model, which will be demoed in the prototype
B	These requirements should be met in the final product, which will be demoed in the product publication
C	These requirements are certainly difficult and may be demoed in the product publication

Table 2: Phase Level

The requirements are formatted as:
[{Sections}- {Project Stage}-{Phase Level}-{Sections #}.{Subsection #}.{Requirement#}]

2. Glossary

Name	Description
Chafer Grub	European Chafer Beetle
MPE	Maximum Permissible Exposure

Table 3: Glossary

3. System overview

Since we have determined that the red laser can work properly in our goal. In order to expel the crows successfully, there are two main parts: detecting and laser shooting. The acceptance test plan in our expectation is as following:
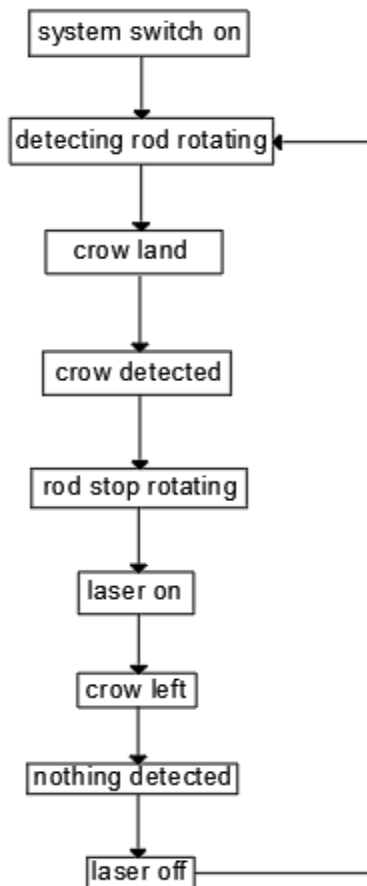
Figure 3: Acceptance Test Plan flow chart

Like the above chart-image shown, our design is opening manually. After we open it, the rod starts rotating (in 360 degrees). The laser is in the same rod and directs to the same way with detecting stuff, once the crow land on the lawn and the detecting stuff find the position, the system stops the rod rotating and turns on the laser, laser will expel the crow. The laser turns off and rod started rotating again after the crow left and there is nothing we detected.

The following image is a script drawing for our design:
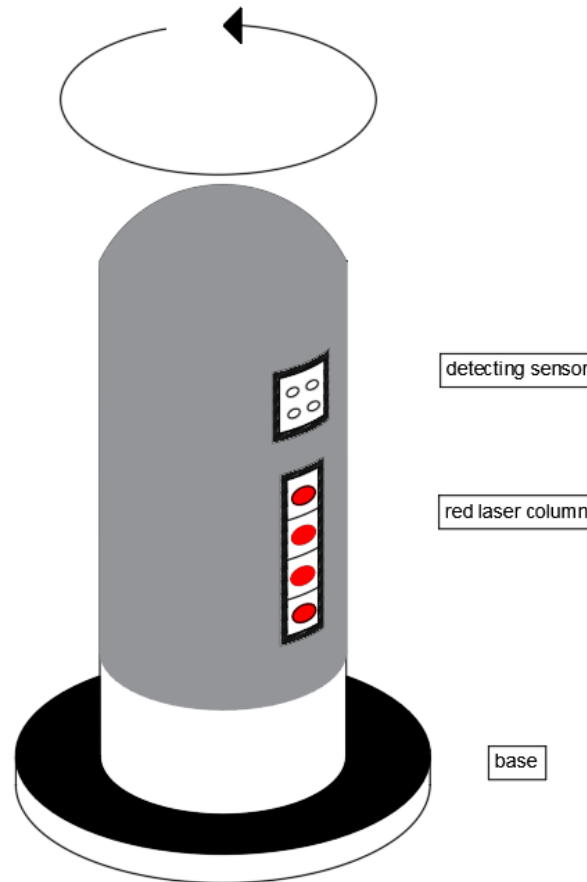
Figure 4: Laser Beam Module Design drawing

Features	Related descriptions and reasons
1: Black part is the base	Fixed in lawn
2: White part above base is fixed with base	Locate the motor (better water-proof then locating in base)
3: Gray part is the rotating rod	Rotating in 360 degree before detecting crow
4: Four red spots are the red laser in column	(a): use more laser to ensure the efficiency (b): height of the lowest one is higher than lawn

Table 4: Features and Descriptions

4. General Systems Requirements

This section describes the general requirements of the whole system, including the system requirements and functional requirements. In the system requirement, the system's working condition and basic function will be specified. The next section function requirement will specify the requirement of the system's procedure.

4.1 System Requirements

The detailed system requirements are listed in the following table.

Requirement ID	Requirement Description
GR-P-A-4.1.1	The whole product contains a motion detector and a laser beam system.
GR-CP-A-4.1.2	The system should be able to determine the existence of crows on the lawn area.
GR-CP-B-4.1.3	The whole system must expel crows on the certain lawn area.
GR-P-B-4.1.4	The whole system should have an on/off button to turn on/off the whole system.
GR-P-C-4.1.5	The whole system should have another on/off button for manualing turning on/off the laser light when the system is under work.
GR-PF-B-4.1.6	The price of the final product should be under $550.
GR-P-B-4.1.7	The laser system should be waterproof and weatherproof

Table 5: General System Requirements

4.2 Functional Requirements

The detailed functional requirements are listed in the following table.

Requirement ID	Requirement Description
GR-P-A-4.2.1	The whole system should correctly identify the existence of the crow in the certain lawn area.
GR-P-B-4.2.2	The signal, which indicates the existence of the crows must be sent from motion detector to the laser beam module every three seconds.

Requirement ID	Requirement Description
GR-P-B-4.2.3	The laser beam module will be activated once signal, which indicated the existence of crows, received from sender.
GR-P-B-4.2.4	The laser beam module will be deactivated once signal, which indicated the non-existence of crows, received from sender.

Table 6: General Functional Requirements

5. Software Requirement

This section describes the software requirements of the whole system, the ability to detect the motion on the lawn using motion detection. Once objects are detected, the ability to distinguish our target crows, from other objects. Once it identified as a crow, the ability to activate or deactivate the laser pointer once motion does or does not detected.

5.1 General

Requirement ID	Requirement Description
SR-C-B-5.1.1	The software of the system must run automatically.

Table 7: Software General Requirements

5.2. Motion Detector

Requirement ID	Requirement Description
SR-C-A-5.2.1	The software of motion detector must identify the moving objects.
SR-C-C-5.2.2	The software of motion detector may distinguish crows from other objects.
SR-CP-B-5.2.3	The software of motion detector must send detection result to laser beam module every 3 seconds.

Table 8: Software motion detector Requirements

5.3 Laser Beam Module

Requirement ID	Requirement Description
SR-P-B-5.3.1	The software of laser beam module should identify the signal from motion detector every 3 seconds.
SR-P-B-5.3.2	The laser system should be able to activate once signal indicating small motion detected in the lawn.
SR-P-B-5.3.3	The laser system should be able to deactivate once signal

| | indicated no motion is detected in the lawn |

6. Electrical Requirements

This section describes the electrical requirements of the whole project. The whole system should be plugged in the house socket, such the users are able to turn-off the system if they decide they want to play with their pet on the lawn. The laser module should turn on uniformly when crow detected, and the electricity will provide source of motion for our module to rotate 360 degrees to eliminate blind spots. The entire electrical system should be safe, energy efficient, and environmentally friendly.

6.1. General

Requirement ID	Requirement Description
ER-F-B-6.1.1	Laser Beam module are supposed to work with a steady and safe power system.
ER-F-C-6.1.2	LaserTech System should be designed with an emergency crash module which auto5matically terminates the whole system when any risk occurs.
ER-F-B-6.1.3	The system must have circuit protection.

Table10: Electrical General Requirements

6.2. Power Supply

Requirement ID	Requirement Description
ER-F-B-6.2.1	The power of motion detector is from the house socket 110V.

Table11: Power Supply Requirements

6.3 Laser Beam Module Output

Requirement ID	Requirement Description
ER-F-B-6.3.1	The laser will shoot red laser light.
ER-F-B-6.3.2	The intensity of the light should be 3B.

Table12: Electrical Laser Beam Module Requirements

7. Hardware Requirements

This section is the hardware requirements of the whole system, the main goal of our hardware requirements is about eliminate blind spots on the lawn, it should cover the whole lawn with possible crows, then shoot crow with laser accurately and safely, meaning preventing the possibilities of the laser shooting at people.

7.1 General

Requirement ID	Requirement Description
HR-CPF-B-7.1.1	The laser system should project towards the ground at a descending angle, prevented from shooting others' properties (e.g. pets, pedestrians, neighbourhoods' houses, etc.).
HR-CPF-B-7.1.2	The laser system is expected to be cylindrical or rectangular to install four faces of laser lights, each face has multiple laser lights in order to cover different sizes of crows.
HR-P-B-7.1.3	The whole system should rotate.
HR-PF-B-7.1.4	The height of the Laser System is approximately 30 cm from ground level (height of a crow?)
HR-PF-B-7.1.5	The Laser System locates at the middle in the "testing lawn" to maximize the coverage
HR-PF-C-7.1.6	The laser system is retractable into the lawn for aesthetics purposes

Table 13: Hardware General Requirements

7.2 Motion Detector

Requirement ID	Requirement Description
HR-C-A-7.2.1	The motion detector is able to identify small moving objects.
HR-CPF-B-7.2.2	The motion detector should be mounted at a taller object to project to the lawn area, such as rooftop.
HR-P-B-7.2.3	The motion detector should cover the whole lawn area.
HR-P-C-7.2.4	The motion detector should identify the crow as the target of laser system.
HR-F-B-7.2.5	The motion detector should work sciently

Table 14: Hardware Motion Detector Requirements

7.3 Laser beam Module

Requirement ID	Requirement Description
HR-P-A-7.3.1	Laser beam should be effective to expel crows
HR-F-C-7.3.2	The laser beam must work to expel crows in daytime
HR-P-B-7.3.3	Both green and red laser should be identically effective
HR-F-B-7.3.4	The lasers should not be angled to point at the sky or ground

Table 15: Hardware Laser Beam Module Requirements

8. Safety and Sustainability Requirements

The safety issues are mainly focused on the harm of laser and electrical failures, the system should be environmentally friendly, it should do any harm to crows, pets or humans. The details of requirements are listed in the table below.

Requirement ID	Requirement Description
SSR-F-C-8.1.1	System set up and troubleshooting user manual should be provided
SSR-F-B-8.1.2	The laser system should not shoot in people's eyes
SSR-F-B-8.1.3	LaserTech System should not be capable of producing light above the applicable MPE.
SSR-F-C-8.1.4	The crash switches should hold the safe state and should require another separate action to reset the switch.
SSR-F-C-8.1.5	The system should not return to an armed state when a crash switch is reset. Re-arming must be performed by manually activation by users.
SSR-F-A-8.1.6	The laser should be kept the protective cover on the laser head at all times.
SSR-F-C-8.1.7	All beam paths should be identified, use warning signs and/or non-reflective barrier tape if needed.

SSR-F-B-8.1.8	All beam paths are only allowed maximum 30cm above the ground to avoid directing the laser or its reflections toward windows or area openings.

Table 16: Safety and Sustainable Requirement

9. Conclusion

The LaserTech is a local company that eliminates a very real problem that exist in beautiful greater vancouver. Crows are a large group of residence that lives among us, although people generally can co-exist with them, however, the fact that they would destroy people's lawn is still a huge issue that bothers many house owners. With the crows growing smarter and no longer afraid of scarecrows, we are providing a long-term solution to get rid of them on your lawn without harming their safety.

The main solution includes shooting laser pointer at crow such that the crow feels discomfort, thus it flies away, it would not harm the crow, and also our device is low enough so that it would not shoot at people's eyes. Our device is secure and environmentally friendly, low cost and efficient. Users will never worry about spending money on fixing their lawns.

Crows prefers a good living environment just like us, our city can definitely accommodate them since Vancouver is big on nature and its wildlife, after eliminating the fact they like to dig our lawns, we believe the co-existence of human and its nature is worth protecting.

10. References

[1] S. Blogs, "How to defeat the destroyer of lawns", *Vancouver Sun*, 2019. [Online]. Available: https://vancouversun.com/news/staff-blogs/how-to-defeat-the-destroyer-of-lawns. [Accessed: 06- Feb- 2019].

[2]"Why Are Crows Ruining My Lawn! (a.k.a. Living with European Chafer Beetle in Vancouver) | UBC Botanical Garden", *Botanicalgarden.ubc.ca*, 2019. [Online]. Available: https://botanicalgarden.ubc.ca/why-are-crows-ruining-my-lawn-a-k-a-living-with-european-chafer-beetle-in-vancouver/. [Accessed: 06- Feb- 2019].

11. Appendix

On the last stage, we are planning to demonstrate functionalities for proof-of-concept product.

Whole system:
[1] The whole system should be easily switched on and off

Detector:
[1] The detector should gather data accurately
[2] The detector should gather data sensitively
[3] The detector should gather data accurately

Laser beam:
[1] The laser beam should strong enough to expel crows
[2] The laser beam should not shoot out the yard and influence the passenger outside
[3] The height of laser beam should higher than lawn
[4] The height of laser beam should lower than dogs