Automatic bullet counting to automate the process of tracking shooting results.

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In May 2020 the Dutch Ministry of Defence (MoD) performed research on the process of training soldiers in their shooting abilities. This research showed that at the shooting range there is a need for a system that can automatically track the shooting results of soldiers. To track shooting results, the hits and the total shots must be known so that also the misses can be calculated. Since the MoD already has systems that can register hits, a device is needed that can count the shots that are fired by a weapon. Therefore, throughout this Bachelor's assignment, research has been performed on the research question; *'What device could make it possible to count the shots that are fired by a weapon and communicate this with a computer, in order to track the shooting results of a soldier?'.* To design this device several steps have been taken to come to a well substantiated final solution. This summary provides the main findings of this research.

To understand the context of the problem and to gain insights into technological possibilities with which gunshots could be detected, the research covers three central questions. The first question is about existing technologies that can detect gunshots. The second covers the understanding of firearm characteristics and the last is about how existing technologies are able to register hits in firing range settings. It was concluded that the most appropriate technologies to detect gunshots with, were either a thermal camera, a microphone, a remote voltage sensor, or an accelerometer. According to the central questions, a requirements list was set up to which to final solution had to comply.

Subsequently, it was decided to focus on two similar weapon types, one specific shooting range and one specific shooting exercise. Respectively, the Colt C7 and C8, the Noorderheide 1 and module 17 of the Colt. Ultimately, it was managed to design the device in such a way that it nearly sets limits regarding locations or shooting exercises. Most of all, the choice for the Colt C7 and C8 appears through the research, since the design of the final device is based on the dimensions and the usage of these weapons.

The next step that has been carried out is the development and assessment of ten different configurations, of which one was to be further developed as final product. The selection process was done by using, among others, the Analytic Hierarchy Process. The sixteen requirements were rated in importance and the different configurations were assessed accordingly. This approach displayed six configurations that scored above average, after which the remaining four were excluded.

After this process, a risk analysis was executed to identify the potential risks of the configurations. According to this analysis and the Analytic Hierarchy Process, a list was made with all the benefits and disadvantages of the remaining configurations. By means of this list it was chosen to further develop the configuration with the accelerometer attached to the weapon. This configuration also scored highest of all configurations in the Analytic Hierarchy Process.

It was decided to make the device with the accelerometer attachable to the picatinny rail, because such an attachment would provide a tight grip, while still being able to attach the device to different weapons. The device can be attached to the top rail on top of the barrel group, since this gives the least balance disturbance. Besides, in this way the weapon can still be equipped with a flashlight and a laser module. However, due to this choice the device can only have a maximum height of 12 mm so that it does not block vision from the sight. Therefore, the challenge became to stay within that boundary condition, while equipping the device with a microcontroller, an accelerometer, a battery and a mounting part.

Due to the limited space, it was concluded that the MoD needs to develop their own Printed Circuit Board. The device is equipped with a lithium polymer battery, which can be replaced and recharged when it is empty. This battery type allows being manufactured in specific dimensions whereby it can fit the device. For communicating the shot data, the device will be equipped with a LoRa transmitter. LoRa allows sending tiny amounts of data over long distances, while also being appropriate to be used regarding security. The device will be made out of black aluminium and is 57 (L) x 39.64 (W) x 18.42 (H) mm (including mounting part) in size and will weigh 42.57 grams. It is estimated that a single device will cost approximately 180 euros.

Although the device fulfills the requirements, the device still requires work to be finished. The device needs further research and development before it can be manufactured and used during shooting exercises. However, the development process and the prototypes have given great impressions on the possibilities the device offers. Hereby it is concluded that the device in this form has the potential of successfully fulfilling its purpose to track and communicate the amount of shots that are fired by a weapon.

The final device