

Vegetation Clipper

Jongmin Baek, Aaron Doody
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Introduction

Vegetation removal is an essential component of a complete demining process. A large portion of time is spent on removal of vegetation in order to prepare the field for metal detection and excavation. While mechanized vegetation clearance is available, many hand tools remain in wide use because of low cost and easy maintenance. These include shears, loppers, pruners, sickles and secateurs, but they encounter a significant shortcoming of forcing the deminer close to the blast in case of accidental detonations.

A previously developed prototype, pictured below, overcame this problem by providing a standoff tube and blastproof body, but several key features were further desired: a gripper to hold onto a cut vegetation in order to facilitate disposal and ensure that the vegetation does not fall into the danger area; a handshield to provide additional protection; and a method to prevent blast ducting. These key features were considered and appropriately implemented onto the original prototype, shown in Picture 1.



Picture 1: Previously developed prototype. This prototype was inherited from the previous year.

Design

The design of the vegetation clipper began with brainstorming and sketching of various concepts, and a thorough survey of commercially available vegetation clippers. The key functional components in our design are the cutting blade, the anvil, the vegetation gripper, and the handle.

The blade and anvil must work together to cut the vegetation. In order to prevent excessive dulling of the blade, the stainless steel anvil is faced with polycarbonate. The polycarbonate serves a second function, it keeps the blade and anvil parallel when fully closed. After the blade has been sharpened multiple times, the polycarbonate can be replaced with a slightly thicker piece, which will compensate for the removal of material from the blade. The sharpening of the blade is important as well; the blade has been sharpened with the bevel facing down. This



Picture 2: View of the final gripper design.

prevents vegetation from being forcefully ejected from the blade when it snaps closed. Finally, each internal corner on both the blade and anvil has a radius, to prevent stress concentrations which could cause failure resulting from a mine blast or normal operation.

The vegetation gripper, as shown above, was designed after testing three commercially available cutting tools, two which included compliance springs and one that used a rigid gripper fixed to the top of the blade. It was found that the spring-based gripper designs were highly reliable. It was decided that a cantilevered compliance spring would work well for our application. The spring is designed to follow the profile of the blade, in this way the spring is protected from distortion during transportation and lies in the shadow of the blade in the event of a mine blast.

The handle was designed with safety and ergonomics as the primary considerations. A 30-cm standoff tube moves the operators hand and body further from the explosion in the case of an accident. The standoff tube may pose the danger of channeling the blast towards the user. To alleviate this danger, the end of the tube near the the cutter is capped to prevent blast gases from entering. A forearm support helps to support the weight of the cutter to prevent fatigue and enable one-handed operation.

(Photograph)
Top view of the clipper

(Photograph)
Profile of the clipper with someone holding it

Picture 3: The newly developed vegetation clipper.

The handshield is another principle addition to the prototype, aimed to protect the deminer's hand. It is designed to afford the desired protection while not hindering the regular operation of the vegetation clipper. In order to provide adequate protection, the handshield uses kevlar, which is the material of choice for personal protection equipments. To afford the necessary flexibility without sacrificing thickness of the material, layers of kevlar is stored in a pouch in front of the hand, as shown in Picture 4, and the rest of the handshield is made with a fabric of choice. The top and bottom ends of the pouch thin out and respectively connect to the standoff tube and the trigger.



Picture 4: Handshield design for the clipper. From top left clockwise: the back view, with the pouch visible; the front view; the handshield incorporated into the clipper; the handshield in actual use.

Manufacture

The tools used to manufacture the parts of the prototype included a drill press, band saw, grinder, and sheet-metal sheer, as well as basic hand tools such as pliers, a ball-peen hammer, and hack saw. No mills or lathes were used, and CNC machining is not necessary. The design was constrained by the tools listed above, so that any machine shop would be suitably equipped to manufacture our clipper.

The material used was stainless steel. Other types of steel should not be substituted, because the stainless steel selected as passed blast-tests without fracture, due to its high toughness and ductility. It also has the favorable property of resisting corrosion when maintained and stored properly.

The parts, when possible, were welded together. Welds are typically stronger and less likely to fracture than other attachment methods such as rivets, bolts, and adhesives. The internal corners of all parts were drilled, prior to being cut with the band saw, to provide a radius at the corner. The radius of the corner helps to prevent stress concentrations that could become a sight of cracking and failure.

Testing

Several prototypes of the clippers were developed and tested along with commercially available products, seen in Picture 6. Thick and thin branches were defined as in Picture 7, and the gripper functionality was tested against a set number of branches of either type. The test revealed that any cantilever-spring design performs better than any other designs, and that the blade face should be on the bottom in order to avoid ejecting cut branches. The blade works well otherwise, though it does not cut as readily as commercial products. The clipper should perform satisfactorily on vegetation clipping.

The handshield interacts with the clipper prototype smoothly, but it remains to be seen how effective it will be in a blast test.

Future Work

Future work should proceed logically from the current design. Feedback from demining experts, and field tests may reveal potential design improvements. For example, the current design is an anvil style cutter, which effectively cuts wood and stems, but is unable to cut some fibrous or thin vegetations such as grass and weeds. To ease transportation, it may be necessary to make the forearm support collapsible. Further iterations of the design may also wish to explore refinement of the trigger, perhaps incorporating a prefabricated mechanism such as a bicycle brake handle.

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Appendices

A. Various Gripper Designs



Picture 5: Various gripper design proposed. From top left clockwise: a coil-spring actuated gripper, a vertical cantilever spring gripper, a horizontal cantilever spring gripper that wraps out backward, and a regular horizontal cantilever spring gripper.

B. Commercial Prototypes



Picture 6: Commercial products examined. From top left clockwise: Corona BP6210 bypass pruner, Corona CH7720 cut-n-hold pruner, Victorinox F65009 rose shear, Berger 4075 long-reach shear.

C. Testing



Picture 7: Pictures from field tests. From left to right: a depiction of branches classified as thin and thick, with a pen as a reference; a cantilever spring gripper is demonstrated with the Corona CH7720 pruner.