Brigham Young University

AUVSI Capstone Team (Team 45)

Unmanned Ground Vehicle Initial Concept Development

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GV-001	0.1	2018-10-23	Initial Draft	John Akagi	Jacob Willis
GV-001	1.0	2018-10-31	Added introduction	Jacob Willis	Andrew Torgesen
GV-001	1.1	2018-11-8	Added conclusion and reference key success measures	Jacob Willis	John Akagi

1 Introduction

This document describes the initial concept generation of the Unmanned Ground Vehicle system.

2 System Objective

In the 2019 AUVSI SUAS competion, points are awarded for successfully delivering an Unmanned Ground Vehicle (UGV) to a target location; additional points are awarded if the vehicle drives to another target location. The UGV must be capable of carrying an 8oz water bottle, and the impact must subjectively be "soft." During the delivery the airframe cannot drop below 100ft ASL, so a system or mechanism for landing the UGV without damage is required.

Because points can be received for just delivering the UGV without it driving, and because the payload drop problem is the most challenging part of the UGV design, the key success measure related to this subsystem is airdrop accuracy. With this in mind, determining how to accomplish the payload drop is the subject of this concept development. The UGV is assumed to be a 700 gram "black box" capable of driving to its target once it is on the ground.

3 UGV Delivery Initial Concepts

The UGV delivery concepts were generated individually by team members and then discussed as a team to combine similar ideas. After all ideas were discussed, a subset were selected as being most promising and advanced to the testing stage. The concepts generated and initial decisions are listed in Table 1. Additionally, the concepts are shown as a concept classification tree in Figure 1 to highlight the variety of ideas generated.

Table 1: Description of initial ideas and decisions made. "Discarded" indicates the idea was considered unfeasible, "Investigate" indicates the idea was studied further, "Modify" indicates the idea was considered usable in conjunction with another idea or ideas.

Idea	Description	Decision	Rationale
Skycrane	UGV is lowered on a rope from the UAV	Investigate	Would eliminate the need for most cushioning and control surfaces on the UGV
Fins	Fins are used to give minimal control to a fast falling UGV	Investigate	Would be smaller than full glider wings but still allow decent control

Glider	Unpowered aircraft is used to control the falling UGV	Investigate	Would likely provide the greatest amount to control
Parasail	A controllable parachute is used to steer the UGV	Discarded	Difficult and unknown controls
Control Grids	Similar to SpaceX, grids are used to steer the descent of the UGV	Discarded	Too complex for this application
Magnus Effect	Spin the wheels of the UGV in the air to generate lift and control UGV attitude	Modify	Could be used in conjunction with other methods but unlikely to have much effect by itself
Autogyro	Unpowered helicopter rotors are used to slow descent and blades can be tilted to control the drop	Discarded	Mechanism was considered too complex
Bounce	UGV uses some elastic material under it to decrease the time of impact	Discarded	Bouncing would likely not reduce the impact forces to survivable levels
Airbag	An airbag is inflated just before lading to cushion the drop	Discarded	Needs precise measurements to determine when to inflate airbag, Airbag inflation mechanism is likely to require dangerous materials
Springs	Springs are placed under the UGV to absorb the energy from the drop	Modify	Could be used to reduce impact energy but unlikely to be able to dissipate all by itself
Counterweight	A large mass is ejected downwards just before impact in order to slow UGV descent	Discarded	Requires ejecting a large mass at high acceleration which is likely to be dangerous and impractical
Crumple Zone	Use a deformable material to break and absorb energy when UGV impacts ground	Modify	Could be used to reduce impact energy but unlikely to be able to dissipate all by itself
Balloons	Use balloons to increase drag and provide some lift	Discarded	Would be large and impractical to carry on board the UAV
Parachute	Use a parachute to slow the descent of the UGV	Investigate	Simplest idea and almost guaranteed to work

Seedpod	Attach a single propeller blade to the UGV which would cause the UGV to spin and slow its descent similar to how maple seeds work	Discarded	The UGV is likely too heavy to implement this properly
Nothing	Make the UGV as rugged as possible and drop it from the UAV with no slowing mechanism	Discarded	Any UGV that is rugged enough to survive a 100 ft drop would be too heavy and bulky to carry on the UAV
Low Drop	Drop below the minimum allowable flight level and drop the UGV from a lower altitude for increased survivability	Discarded	Would violate rules that state we must remain above a certain altitude

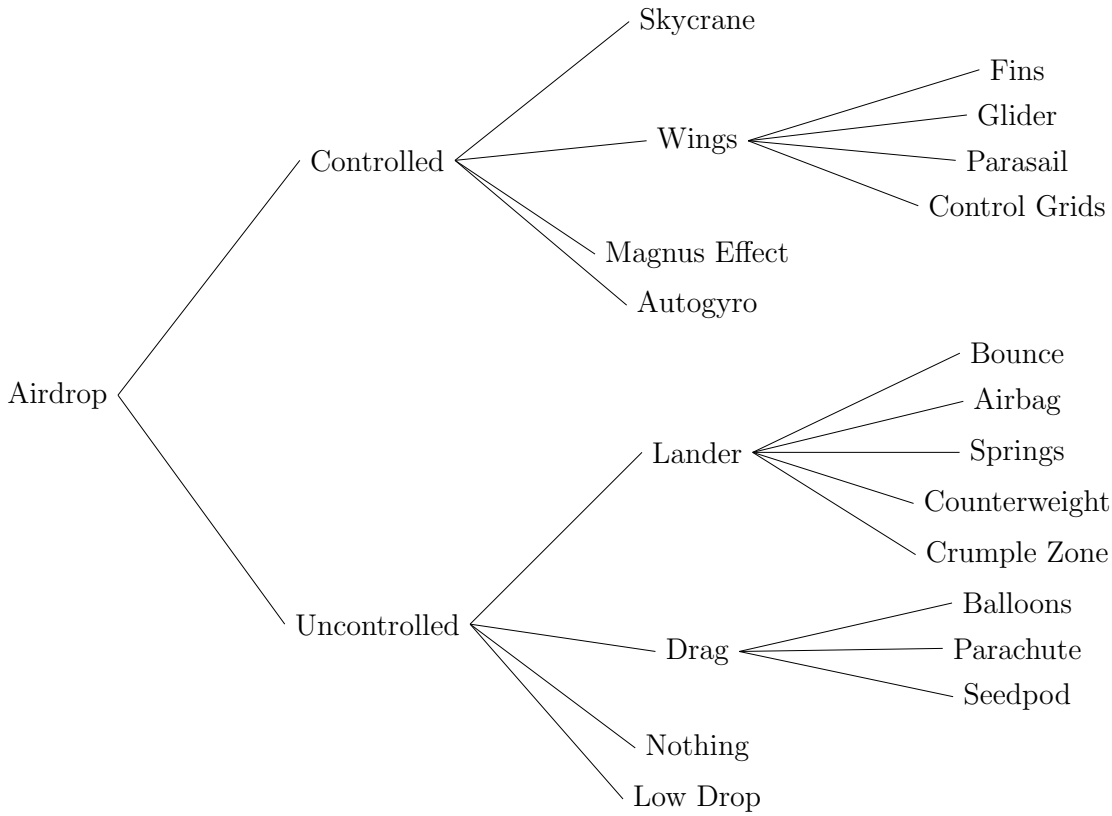

Figure 1: Concept development tree of the initial ideas generated for the payload delivery system.

4 Conclusion

Through our concept generation efforts, seventeen distinct concepts were created. After considering novelty and feasibility, four concepts were selected for additional investigation. These concepts are the skycrane, glider, and parachute, along with combining the parachute and fins concept to create a controlled parachute.