

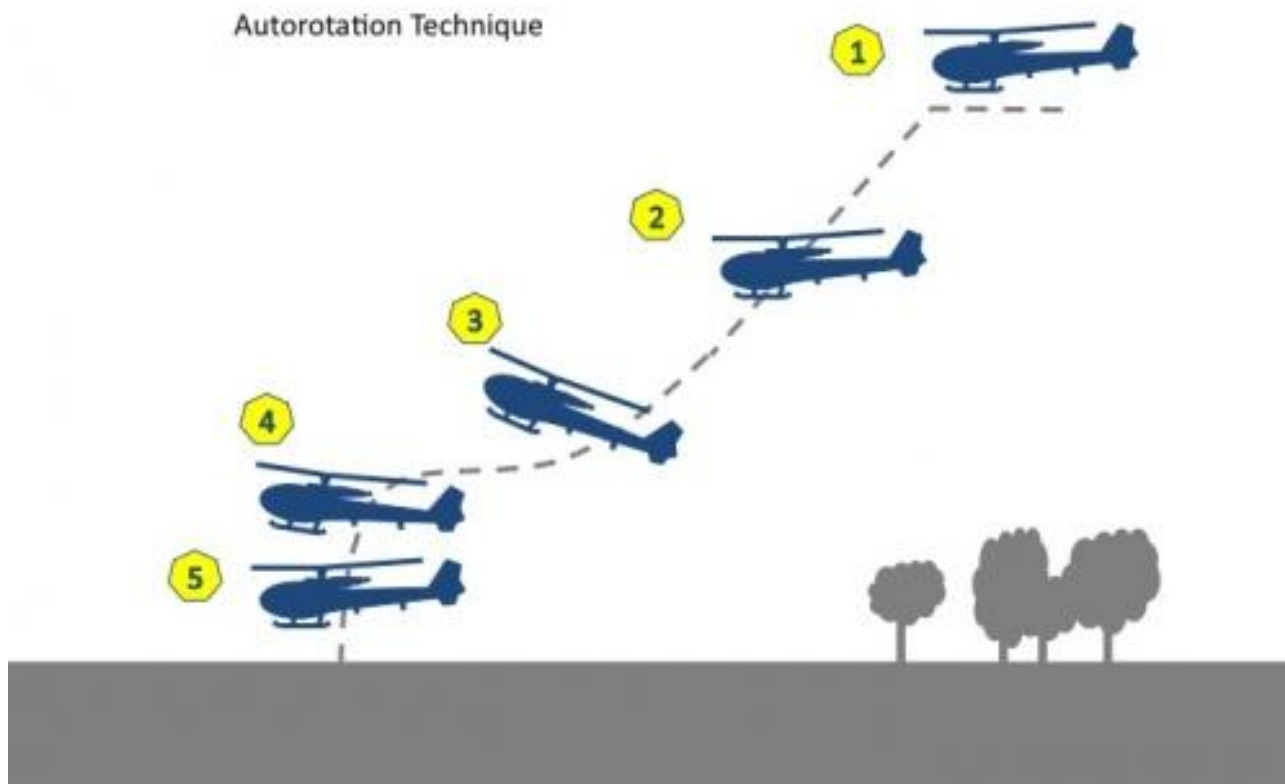
The StormTracker 5000

By Timothy Best

Vocabulary

- Autorotation: Unpowered controlled descent by a helicopter.
- Monocopter: A rotary winged aircraft with a single rotor. EX: helicopter
- SITL: Software in the Loop
- HITL: Hardware in the Loop
- Airfoil: shape of a wing/blade

What is Autorotation?



Why Autorotation?

Predictions:

1. Increase in Rotorcrafts
2. Autonomous Flight
 - a. Autonomous car already on the road
 - b. US military heavily funds drone programs
3. Reusability of Spacecraft
 - c. Privatization of low earth orbit travel
 - d. Many current plans/propositions to go to Mars

Parachutes



Pros:

- low cost
- low tech
- light

Cons:

- High speed impact
- No flight control
- Needs Atmosphere

Gilder



Pros:

- Soft directed landing
- Looks cool
- "Reusable"

Cons:

- Safety
- Aerodynamics
- Needs Atmosphere

Rockets



Pros:

- Soft directed landing
- Works without atmosphere

Cons:

- reduces payload size considerably

Autorotation



Pros:

- Soft directed landing
- Light

Cons:

- Needs Atmosphere
- Parts of the descent will be without control
- Needs Atmosphere

Goal

To Return a small payload safely from 30,000 meters to where it was launch using autorotation

Modeling The Problem

Initial Conditions:

- Mass
- Airfoil
- Reference Area
- Altitude
- Time Interval
- Chord Length

Outputs:

- Altitude
- Time
- RPM
- Terminal Velocity
- True Velocity
- Vertical Velocity
- Pitch Attitude Angle

Design

- Electronics

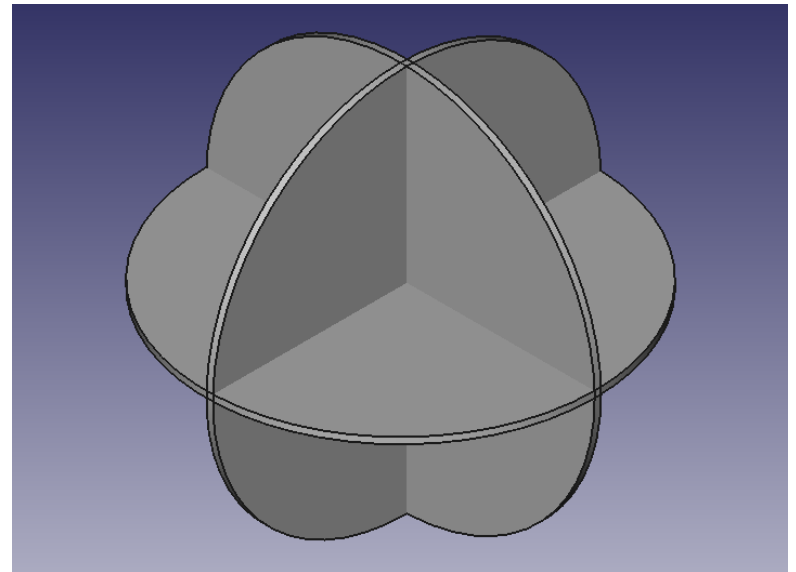
- Flight Computer: APM 2.5 ArduPilot Mega 2.5
- GPS: 3DR GPS uBlox LEA-6
 - 3 meter accuracy
- Altimeter: MS5611-01BA
 - 12.5 meter accuracy
- Gyroscope & Accelerometer: MPU-6000/6050
- Magnetometer: Honeywell HMC5883L
- RPM sensor: most likely a servo
- Batteries: lithium ion
- Telemetry: in debate

Design (cont.)

- Rotor Design
 - Modeled with poor airfoil statistics so that actual airfoil will be better
 - Rotors will need to be protected from balloon and landing
- Parachute Release
 - Damage to the rotor blades or decent vehicle
 - Failure in detaching from the balloon
 - Programming error or glitch
 - Unsafe or unexpected atmospheric conditions
 - For initial testing of flare

Design (cont.)

- Cut Down Device
 - Nichrome Wire
 - Cigar Cutter
 - Servo & Pin
 - Chinese Finger Trap
- Radar Reflector
 - projects payload from other air traffic



Programing

Building off Arducopter

- ✓ Setup quadcopter SITL
- Add Support to SITL for Monocopters
- Add Autorotation to ArduCopter
- Test in SITL
- Test in HITL

Cost

Parts	Mass (grams)	Cost (USD)
Electronics	200	270
Cut Down Device	100	70
Descent Vehicle	700	200
Ascent Vehicle	---	100
Radar Reflector	85	5
Totals	1085 ~ 2 lbs	595

Testing

- Parachute Deploy
- Cut down
- High altitude flare
- Minimum altitude for success
- Full flight

Future Work

- Test deployment from hobby sized rocket
- Increase payload size test for plane drop
- Power flight and electronics through rotor and or solar
- Adapt code for low altitude helicopter failure

Questions



Sources

<http://spaceflight.nasa.gov/gallery/images/apollo/apollo16/lores/s72-36293.jpg>

<http://upload.wikimedia.org/wikipedia/commons/d/d6/STS120LaunchHiRes-edit1.jpg>

http://space.skyrocket.de/img_lau/grasshopper__1.jpg

<http://www.damer.com/pictures/events/rotaryrocket99/rrtest.jpg>

<http://i.space.com/images/i/000/012/529/original/student-balloon-pop-earth-to-sky.jpg?1317920192>

<http://www.skybrary.aero/images/thumb/Autorotation2.jpg/500px-Autorotation2.jpg>