GROVER: An Autonomous Vehicle for Ice Sheet Research

April 17, 2014
Introduction
What is GROVER?

▷ Goddard Remotely Operated Vehicle for Exploration and Research
▷ Developed closely with Lora Koenig
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- Fully autonomous (GPS, Telemetry, Failure modes)
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- Solar-powered
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- Controlled via satellite or line-of-sight radio (WiFi)
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- Developed closely with Lora Koenig
- Fully autonomous (GPS, Telemetry, Failure modes)
- Solar-powered
- Controlled via satellite or line-of-sight radio (WiFi)
- Tested in the field in May/June 2013
Original Mission

- Demonstrate that it could:
  - Operate 24/7, in harsh environment
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  » Complete track within two weeks
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- Demonstrate that it could:
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  - Complete track within two weeks
  - Go over same point to maximize crossover
Original Mission

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▶ Successfully completed stage 2
Original Mission

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- Successfully completed stage 2

- Performed additional power failure tests
Hardware

Requirements

- Zero emissions vehicle
Hardware

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- Running 24/7
Hardware

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- Running 24/7
- Operational in the extreme cold

- High efficiency solar panels (300W, 20%)
Hardware

Requirements

- Zero emissions vehicle
- Running 24/7
- Operational in the extreme cold

- High efficiency solar panels (300W, 20%)
- Constant sensor monitoring
  - GPS
  - 2 × Temperature
  - 2 × Voltage
  - 1 × Current
- Two 20 Amp motors, travel over powder and sastrugi
Hardware
Instrument

- FMCW radar, low-power
- 4GHz - 10GHz

© Charly Whisky
Instrument

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- 4GHz - 10GHz
- Footprint between tracks
**Instrument**

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- 4GHz - 10GHz
- Footprint between tracks
- Ice layer present between 50cm-100cm
Power Consumption

- Autonomy of 6 hours (14Km) recharges in 6 hours.
- Total power consumption 570W
- Can power on-board or external instruments
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Sensor malfunction (disclaimer)

- Current sensor failed within 48 hours
- Had no replacement
- Took us days to figure it out
- Computer battery failed as well
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- Total power consumption 570W
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Hardware
Hardware

Data lost due to defective battery on PC

Batteries charging

Power (volts)

Heading (degrees)
Software

- Designed to be used in many applications

```python
from grover.core.configurationLoader import ConfigurationLoader
from grover.core.message import Message
from grover.core.messagepublishers.basemessagepublisher import BaseMessagePublisher
from grover.core.messagepublishers.messagepublisher import MessagePublisher
from socket import socket as Socket
from threading import Thread
from util.logger import Logger
import random
import select
import socket as SocketPkg
import time

class NetworkMessageManager(BaseMessageManager):
    def __init__(self, connect_to=None):
        super(NetworkMessageManager, self).__init__()

        self.name = "NetworkMessageManager"
        self.sender_name = self.name + str(random.randint(0, 999))
        self.domain = "Domain" + str(random.randint(0, 999))

        Logger.log_red(self.name, "Domain Name: {}".format(self.domain))

        self.connect_to = connect_to
        self.connection_threads = []

        self.connected = False

        Logger.log_gray(self.name, "Initializing...")
```
Software

- Designed to be used in many applications
- Publisher/Subscriber design pattern
Software

- Designed to be used in many applications
- Publisher/Subscriber design pattern
- Written in Python
  - gpscomponent.py
  - headingcomponent.py
  - iridiumcomponent.py
  - motorcomponent.py
  - navigationcomponent.py
  - radarcomputercomponent.py
  - telemetrycomponent.py
Software

Introduction

Mission

Hardware

Software

Results

Conclusion
GUI
GUI
GUI
Communications
Field Performance

- Collected 20GB of data
Field Performance

- Collected **20GB** of data
- Covered **30+ Km**
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- yet...
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- Mark Robertson, Cryogars working on data
Conclusion

- GROVER demonstrates that autonomous rovers can be a revolutionary tool in polar research
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- The technology and the software are available and ready to be implemented
Conclusion

▶ GROVER demonstrates that autonomous rovers can be a revolutionary tool in polar research
▶ The technology and the software are available and ready to be implemented
▶ Exciting new opportunities using this platform for scientific data collection.
Future/Current Work

- Working with **Alberto Behar**
- Bigger/better solar panels
- **Redundancy** in sensors
- Rewiring electrical systems
- Optimize travel path to maximize **exposure** to the Sun
- Add visual indicators to facilitate the localization of the robot in **poor visibility** conditions
Conclusion

References


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