Intelligent Robotics Group (IRG)

Overview

• 31 researchers (14 Ph.D.’s)
• 20+ summer interns yearly
• 75% NASA work (HEOMD, STMD, SMD)
• 25% reimbursable (Google, etc.)
• SBIR / STTR (10 current proj.)

Research themes

• Automated planetary mapping
  ▪ Base maps & terrain models
  ▪ Geospatial data systems

• Robots for human explorers
  ▪ Improve efficiency & productivity
  ▪ Pre-cursor & “follow-up” work

• Public service
  ▪ Disaster response & outreach

irg.arc.nasa.gov
IRG Collaborations (2010-2013)

Academic
- MIT
- Arizona State University
- University of Idaho
- EPFL
- ETH

Commercial
- Google
- Microsoft
- Aurora
- Stottler Henke
- Energid
- Honeybee Robotics
- Optech
- TRAC Labs
- PI
- ProtoInnovations
- PRCI

Government
- SPAWAR
- Cal Fire
- California Task Force 3
- USGS

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Robotics for Human Exploration

Purpose

• Increase human productivity
• Improve mission planning & execution
• Transfer some tasks to robots (tedious, repetitive, long-duration)

Before Crew

• Recon (scouting) & prospecting
• Site prep, deploy equipment, etc.

Supporting Crew

• Inspection, mobile camera, etc.
• Heavy transport & mobility

After Crew

• Follow-up & close-out work
• Site survey, supplementary tasks, etc.
Robots

- K10 mini
- TenseBot
- Smart SPHERES
- Lake Lander
- K10
- Modular Arm
- GigaPan
- KREX

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Perception

- High Dynamic Range inspection (2006)
- Robotic Site Survey (2008)
- GigaPan Voyage (2009 - 2011)
User Interfaces

VERVE (2007 - 2011)

K10 Data Browser (2010 - 2011)

Google Earth Ops (2008 - 2011)

Interactive Ground Control (2008 - 2010)
Architecture

RoverSW (2006 - 2011)

Strategic Data Producers
- Traverse Plans
- Geologic Maps
- Comm Coverage
- Gigapan Voyage
- MMSEV Data
- EVA IS Data

Tactical Data Producers
- Geologic Maps
- Comm Coverage
- Gigapan Voyage
- MMSEV Data
- EVA IS Data

importer
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importer
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custom python
Python/Django
MySQL

static HTML
comm layers
data catalog
maps

apache

xGDS

Mission Management Team
Tactical Science Ops
Strategic Science Ops

xGDS: Exploration Ground Data System
(2009 - 2011)

RAPID (2009 - 2011)

Rover SW (2006 - 2011)

Intelligent Robotics Group

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xGDS

Mission Management Team
Tactical Science Ops
Strategic Science Ops

xGDS: Exploration Ground Data System
(2009 - 2011)

RAPID (2009 - 2011)
K10 Robot at Haughton Crater, Canada
SmartSPHERES on ISS
K10 Remotely Operated from ISS
Mars in Google Earth

Explore Mars in 3D

- Released Feb. 2, 2009
- Co-developed with Google
- NASA Ames created content & processing scripts

Content

- Global maps: topography, infrared, historical, etc.
- Imager footprints & overlays (HiRISE, CTX, MOC, …)
- Mars rover tracks & color panoramas
- Tours (Bill Nye & Ira Flatow)
- Live from Mars: THEMIS
- And much more …
Moon in Google Earth

Explore the Moon in 3D

• Released July 20, 2009
• Co-developed with Google
• NASA Ames created content & processing scripts

Content

• Global maps: topography, geologic, historical, etc.
• Spacecraft imagery: Apollo, Lunar Orbiter, etc.
• 3D models of spacecraft, landers, and crew rovers.
• Tours (Andy Chaikin, Buzz Aldrin & Jack Schmidt)
• And much more …
Complete HiRISE Mosaic

- Mars Reconnaissance Orbiter HiRISE imager
- 74,000 images
- Each image: 20K x 50K pixels (> 1 GB / image)

Mosaic stats

<table>
<thead>
<tr>
<th>Tile Dimensions</th>
<th>256 x 256 pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root Tiles / Image</td>
<td>15,000</td>
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<tr>
<td>Tile Space</td>
<td>25 KB</td>
</tr>
<tr>
<td>Tiles Total</td>
<td>229 million</td>
</tr>
<tr>
<td>Total Mosaic Size</td>
<td>5.7 TB</td>
</tr>
</tbody>
</table>
xGDS is …

• Map content management
• Planning tool
• Real-time plots, maps, notes
• Post-processing data archive
• Browse and search tools

Users

• Field scientists
• Planetary scientists
• Mission planners
• Flight controllers
• Local & distributed teams
xGDS Architecture

- Path Planner
- Crew tracking
- Vehicle tracking
- Robot tracking
- Payload data

- Django
- MySQL
- Data store

- Map server
- Web planner
- Console log
- Data maps
- Data search

- apache

- Google Earth
- Web Browser

Plots
Raster maps
IRG Open Source Software

Vision Workbench

RoverSW

Neo Geography Toolkit
(with Ames Stereo Pipeline)

Exploration Ground Data Systems (xGDS)

Visual Environment for Remote Virtual Exploration (VERVE)

RAPID (NASA robot middleware)
Questions?

Intelligent Robotics Group
Intelligent Systems Division
NASA Ames Research Center

irg.arc.nasa.gov