
PascoBot

Ant-inspired system for rapidly mapping
environmental contamination

Team 6

Bio-Inspired Design

Georgia Institute of Technology

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Biological Source of Inspiration

Desert Ants

- *Cataglyphis bicolor*

Location

- Sahara Desert

Function

- Polarized light navigation

[Desert ants in action](#)



Photo: Encyclopedia of Life.

Source of Inspiration Mechanism

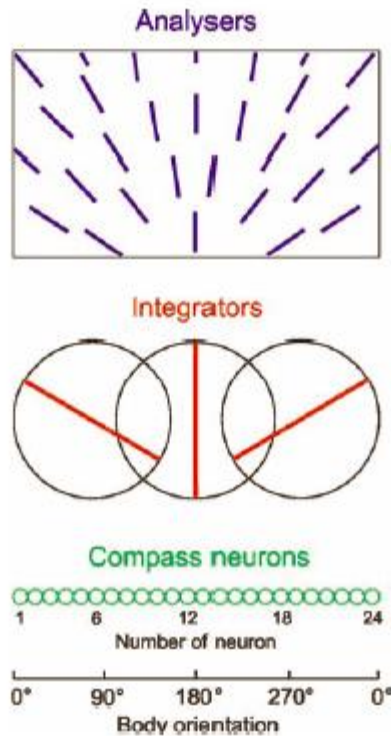


Fig. 5 Hypothesis about way stations of the insect's polarization compass: *analysers* (array of polarization-sensitive photoreceptors, see Fig. 3B), *integrators* (wide-field polarization-sensitive medullar interneurons, see Fig. 4), and hypothetical *compass neurons* each responding maximally when the animal is oriented in a particular compass direction. The number of compass neurons ($n=24$) is chosen arbitrarily

Wehner, 2003

Hard coded homing vector generation

- Simplified processing
- Minimal energy expenditure

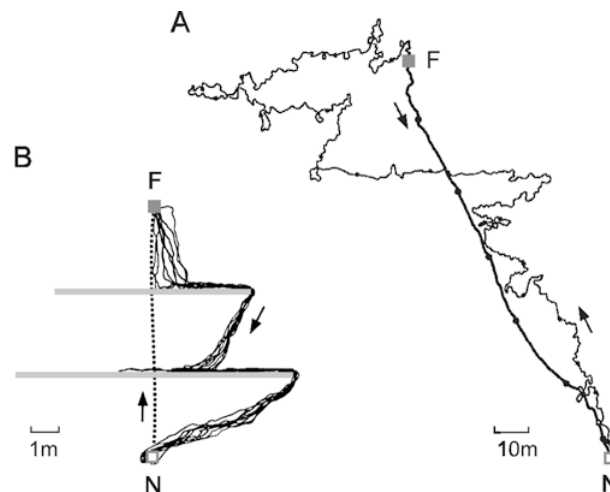


Fig. 2A, B Path integration (vector navigation) in *Cataglyphis fortis*. A An ant's tortuous outward (foraging) and straight homeward path recorded in a featureless salt pan. B Straight outward paths indicated by the dotted line and multi-leg homeward paths caused by experimental barriers (grey bars), which the ant could pass on its way out (from N to F) but not on its way in. Nine successive runs of one ant. F feeding site, N nest. A from Wehner and Wehner (1990), B from D. Andel and R. Wehner (unpublished observations)

Problem

Simple, cheap solar navigation

- Many uses

Example: small-robot navigation

- Solution fits problem

Specifically: radiological/chemical detection

- Scattered hazardous material
- Potential small-robot solution



Image Source:
www.edupics.com

Existing Solutions to Problem

Traditionally:

- Hand scanning, distance measurement

More modern:

- Pretty big, slow, expensive robots
- Remote-controlled



Image Source: www.irobot.com

Analogy

Function:

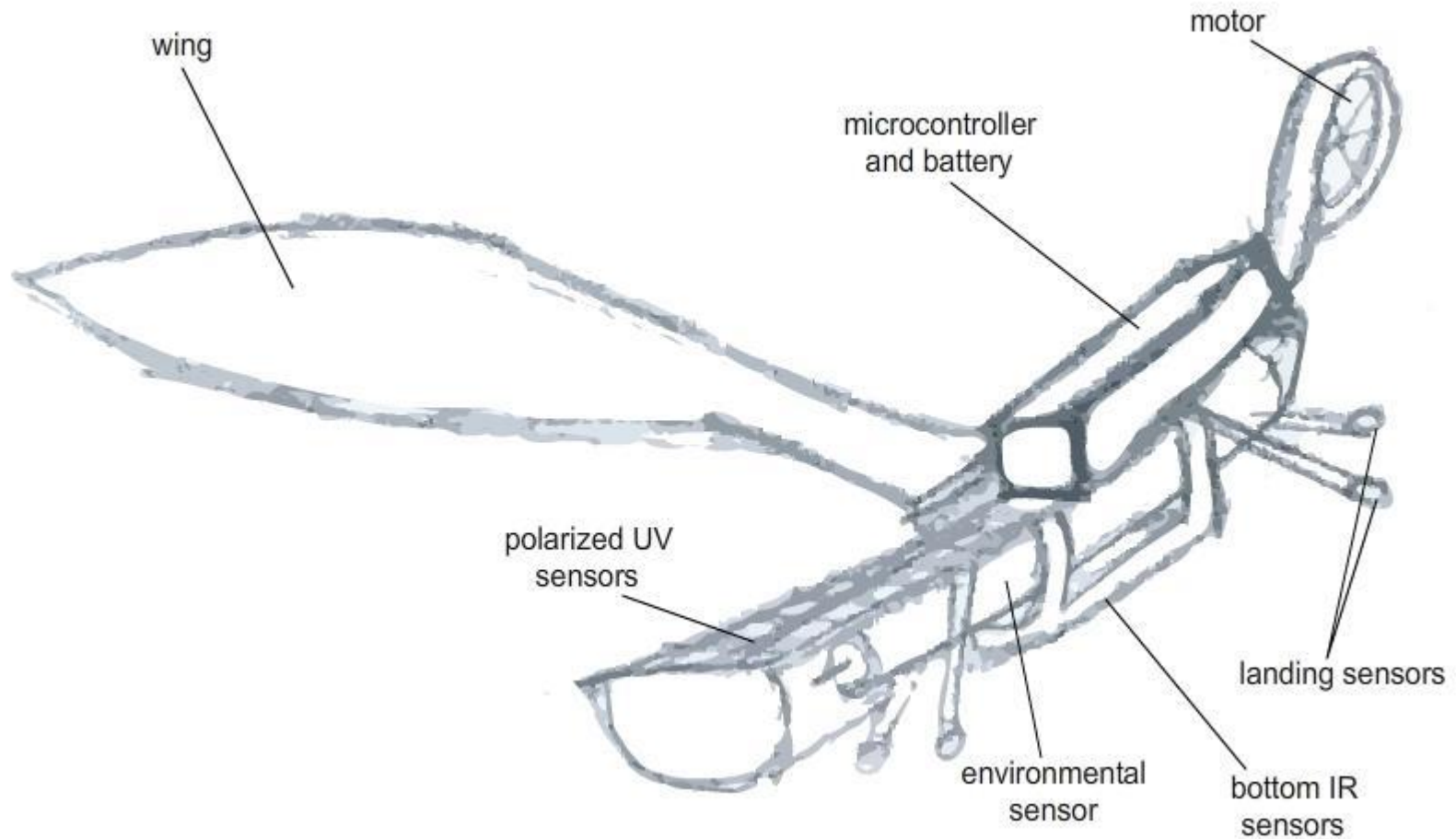
Quick, safe, and efficient survey to understand radiation or chemical activity in a given area

Ant Methods:

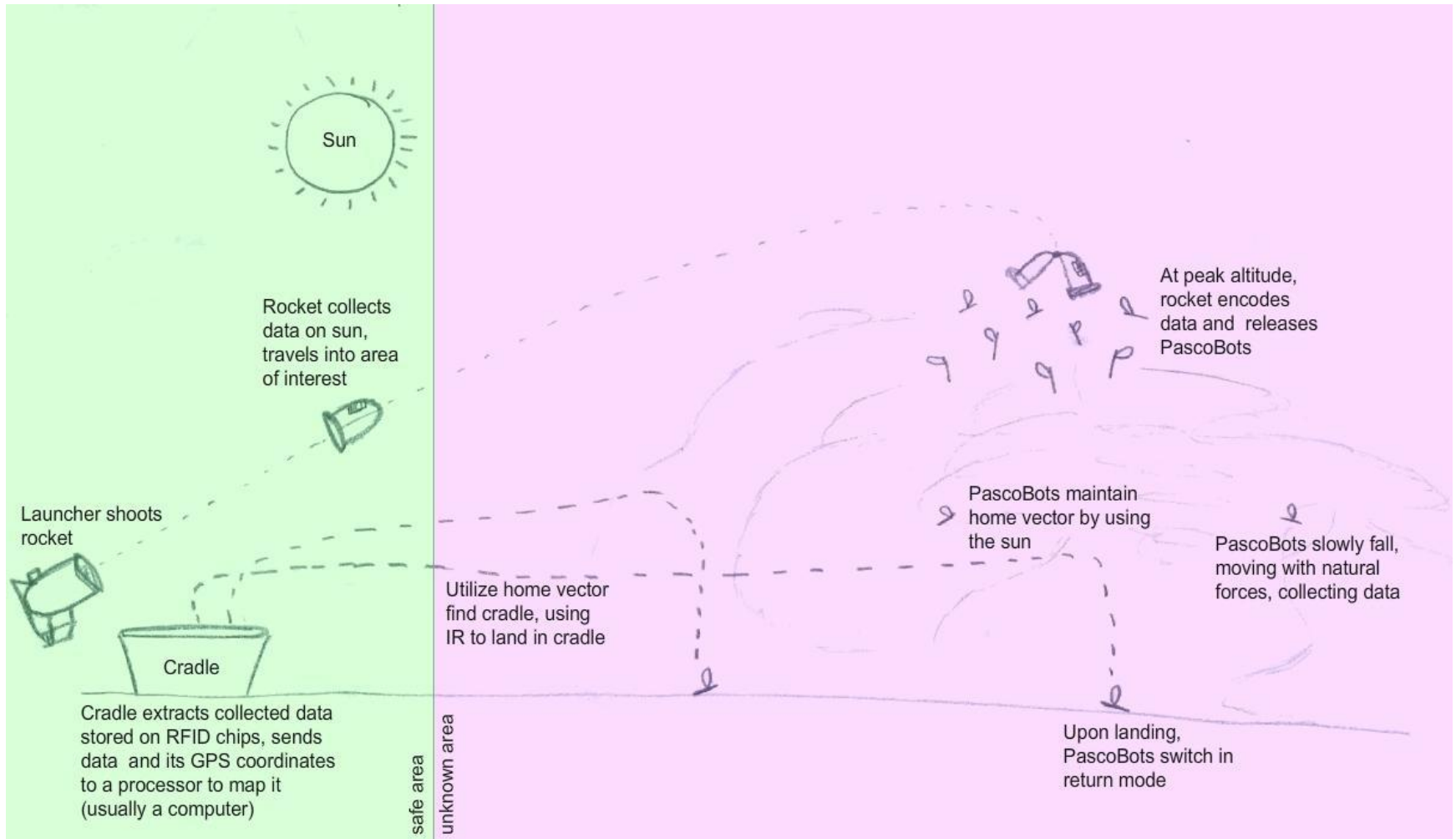
Random foraging, followed by a quick, almost straight run home with findings

- Very Cheap (each ant is almost disposable)
 - Autonomous
 - Fast coverage, given sheer numbers (> 100)
-

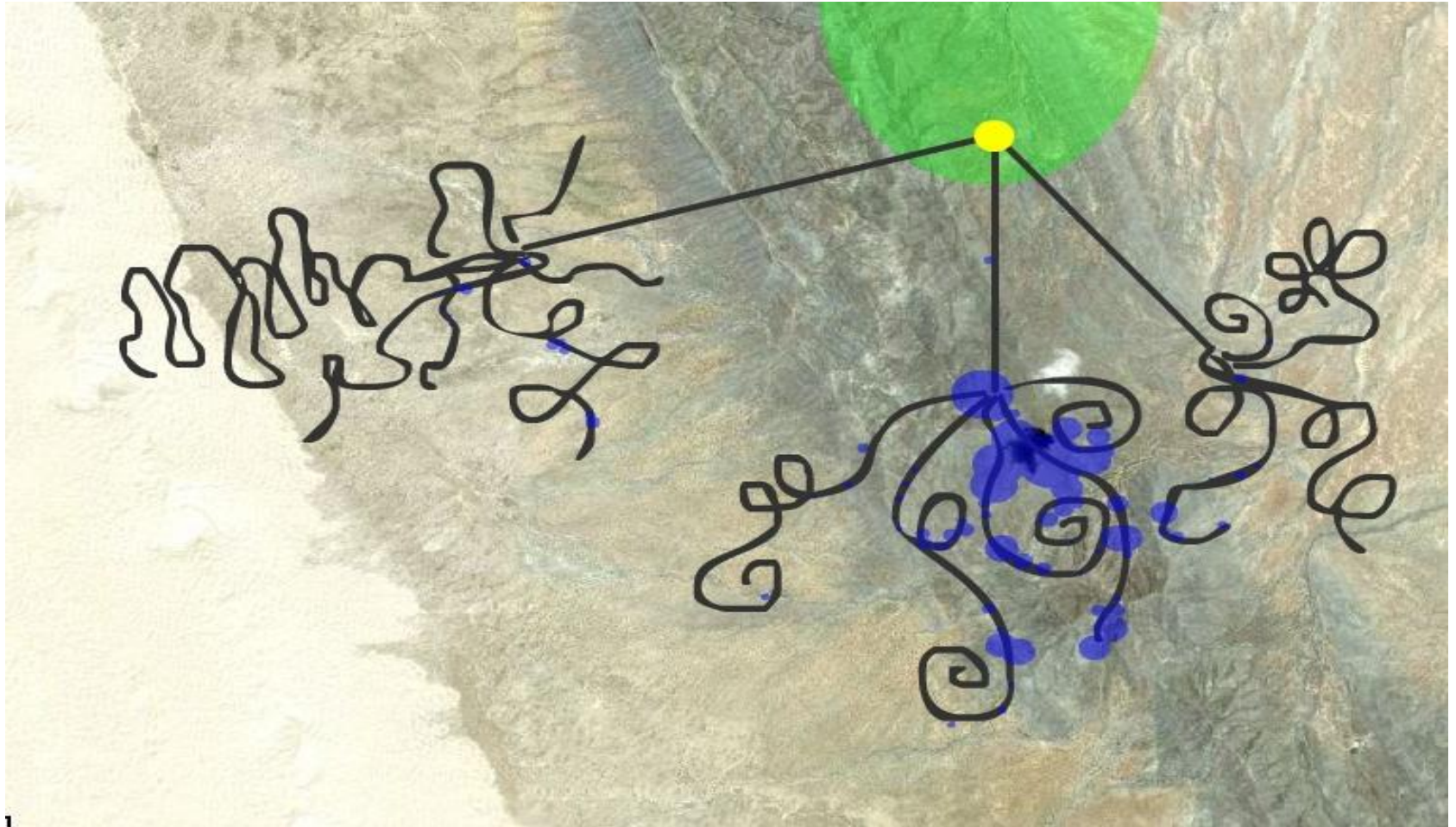
Design (PascoBot)



Design (System)



Design (Data)



Design Mechanism

---Foraging Pseudo Code---

```
setup(){
  isDormant = true;
  isExploring = true;
  distanceToHome = 0;
  gotoCollector = false;
}
loop(){
  getSensorReadings();
  if(gotoCollector){
    movetoCollector();
  }
  else{
    if(accel>landingThreshold){
      isExploring = false;
    }
    if(isExploring){
      calculateHomingVector();
      moveExploratoryStep();
    }
    else{
      followVectorHome();
    }
  }
}
```

calculateHomingVector()

$$\text{Homing Vector} = 180^\circ - \frac{\int_0^{\text{Exploration Time}} \text{Orientation away from Sun}}{\text{Exploration Time}}$$

followVectorHome()

```
  moveinDirection(AngleHome);
  distanceToHome --;
  if(distanceToHome <0 ){
    gotoCollector = true;
  }
}
```

movetoCollector()

```
  calculateIRDirection();
  moveinDirection(IRDirection);
  if(IRSensor>collectorThreshold){
    stop();
  }
}
```

Design Quantitative Analysis

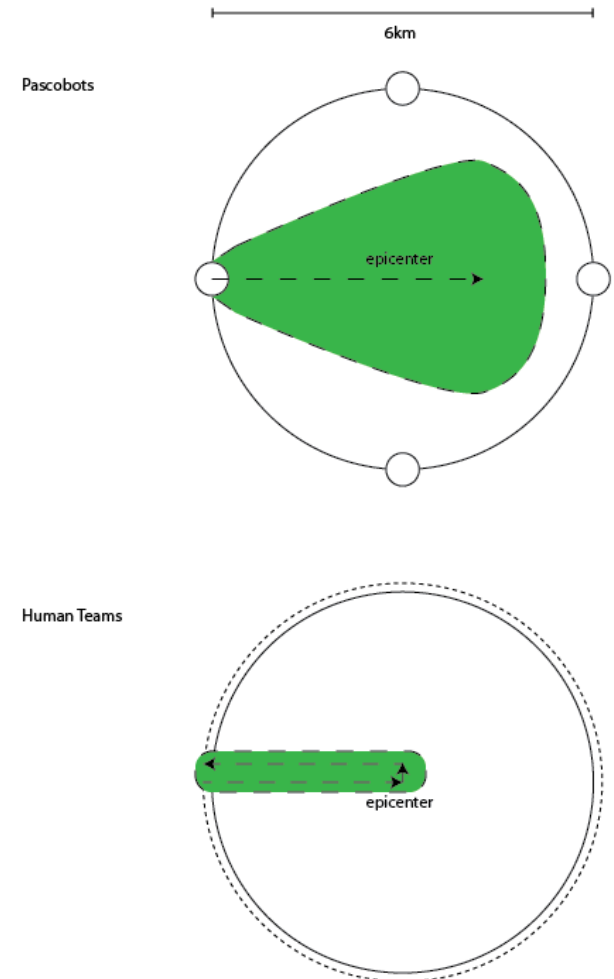
3 km disaster zone hypothetical analysis

PascoBots

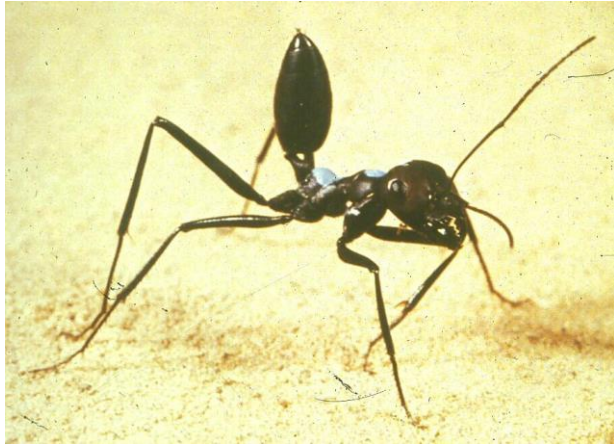
16 man-hours
1000 sensor bots
5.6 percent / hour (with 10% estimated loss)
0 Human contamination

Human Teams

80 man-hours
100 individuals
2.5 percent / hour
Human contamination



Transfer Challenges



Scaling only applies to behavior mechanisms
Neural --> electronic pathways

Design Value

- Disaster Response effectiveness
 - limits risk to human health
 - more accurate evacuation zones
- Efficiency
 - Processing
 - Materials
 - Energy
- Speed
 - Deployment
 - Completion of process



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