Bioinspired Active Electrosensing System for Microscopic Robots

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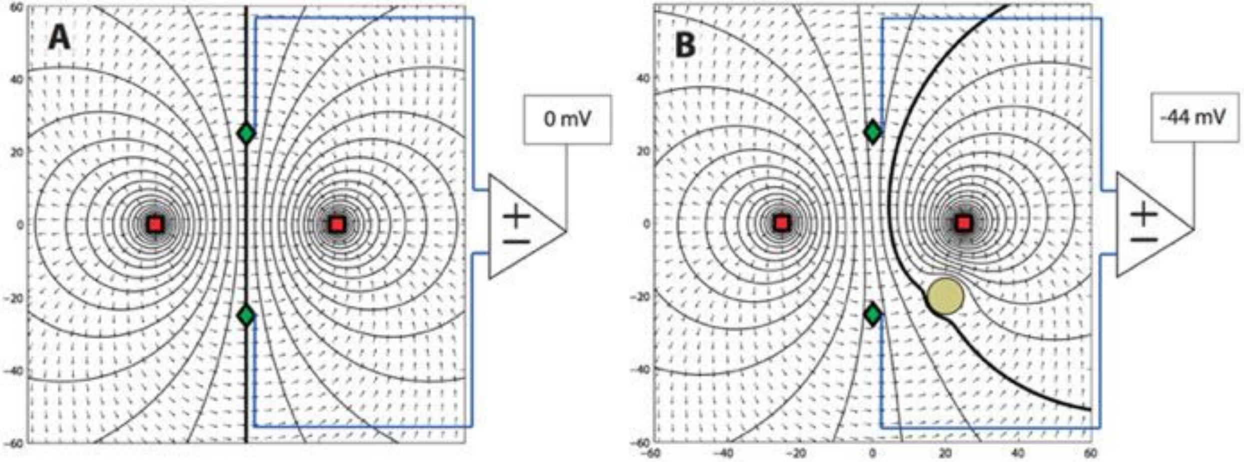
Miskin et al. 2020

How can microrobots sense their environment?
↳ A possible approach: **active electrosensing.**



Solberg et al. 2008

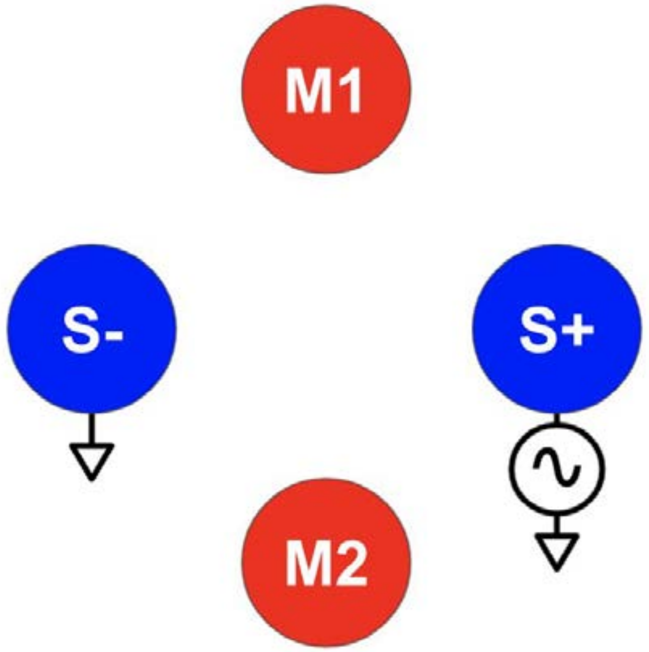
- Robot generates an electric field in solution by sourcing a voltage.
- An object perturbs the electric field.
- Robot measures changes in electric field to localize the object.

Active electrosensing has previously been demonstrated in macroscale underwater robots.

↳ Can we demonstrate the viability of active electrosensing for robots **at the microscale**?

Experimental design

- Probe microelectrode pads to source AC voltage signal on two source electrodes and measure differential signal between two measurement electrodes in solution
- Fabricate titanium-platinum microelectrode arrays for electrodes and build probing setup
- Electrodes and probes immersed in phosphate buffered solution or deionized water.



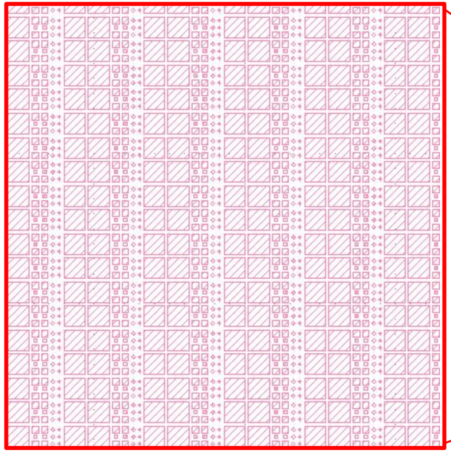
Fabrication of microelectrode arrays

Procedure:

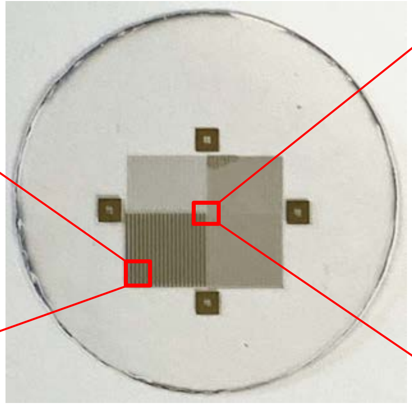
1. Spin photoresist
2. UV expose with photomask
3. Develop
4. Deposit ~20nm Ti, ~60nm Pt
5. Lift-off with PG remover

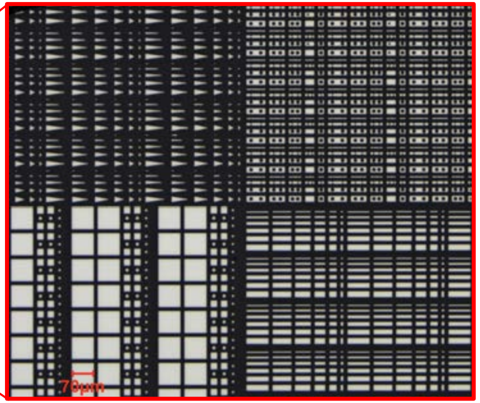
Photolithography

Pattern:

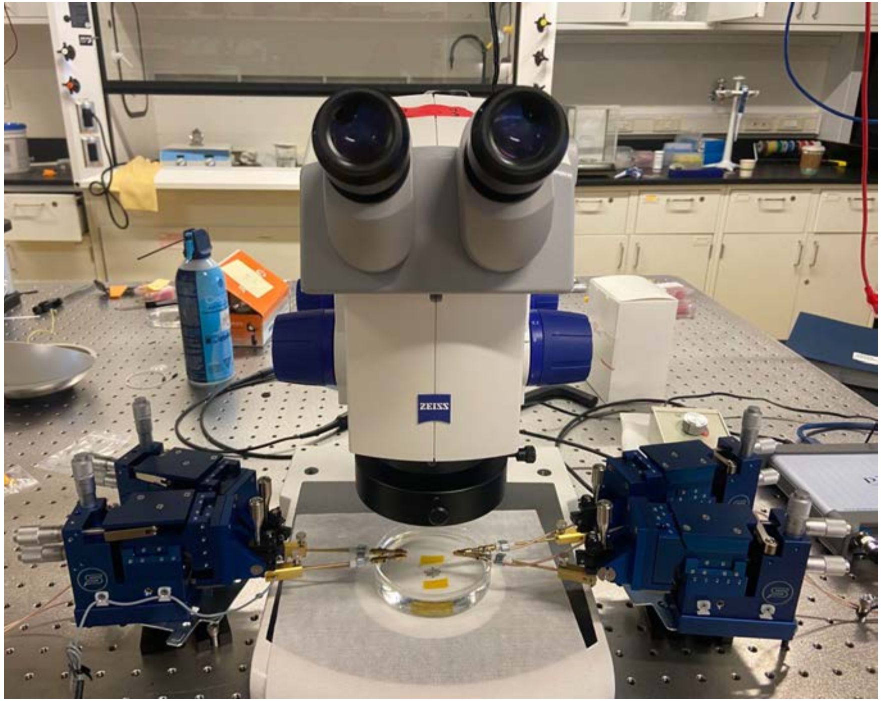


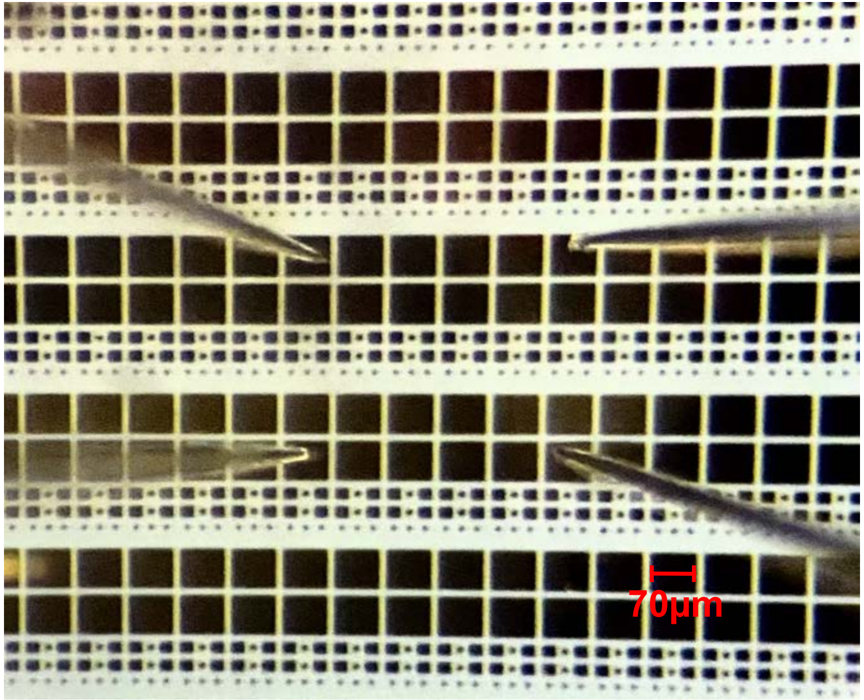
Result:





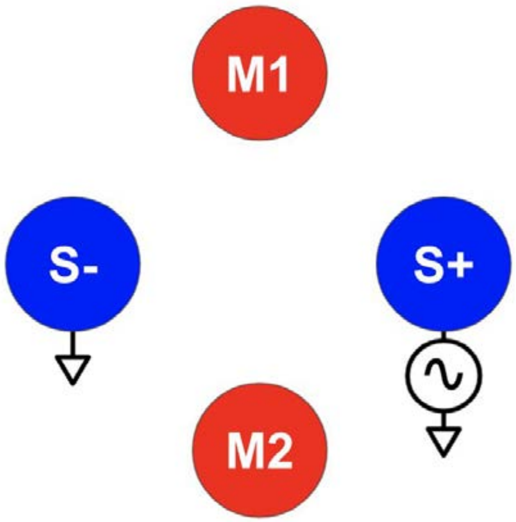
Building a probing station to source and measure voltage signals on microelectrodes





+ function generator + oscilloscope

Sourcing and measuring AC signals on microelectrodes



- Identified dependence of measured voltage signal on solution conductivity, source frequency, source voltage amplitude, probe submersion depth, measurement probe distance from source probe
- Our setup is sensitive to properties of the probes, not the measured signal.
- Most of the measured voltage signal is likely due to the probe tip impedance rather than the microelectrode.

Next steps

- Revise probing setup and electrode design to reduce voltage dependence on probe properties
- Introduce an occlusion
    - Vary and quantify effects of occlusion and electrode size/location on measured electrical signals

Block of photomask design for fabricating microelectrode arrays defining experiments with occlusions.

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