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Hydrophone Sensor Integrated with APL Snake Robot

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April 30, 2013

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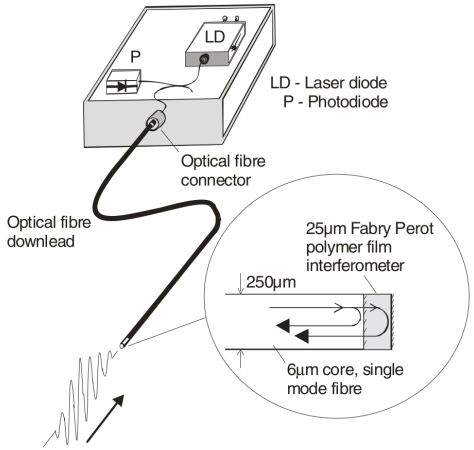
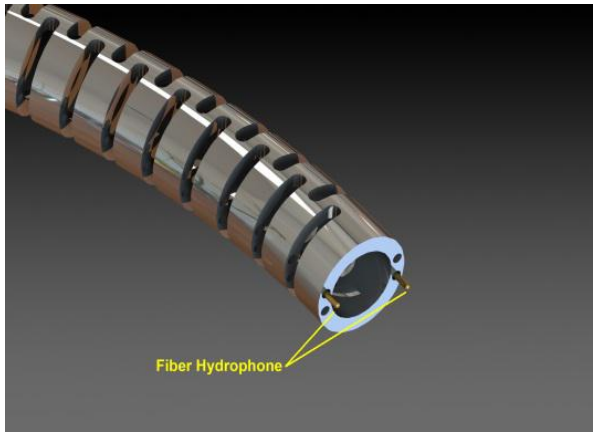
My project

1. Use optical hydrophone attached to the snake robot to measure external ultrasound signals
2. EM tracker on ultrasound probe to get position
3. Move probe to get out of plane measurement
4. Find snake robot tip position from ultrasound time of flight

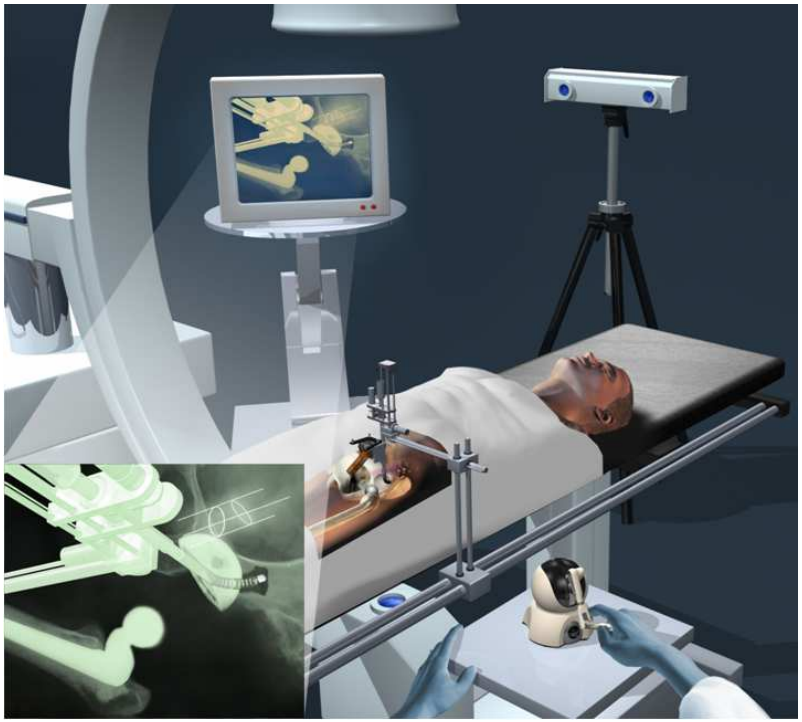


B T Cox et al.



Courtesy of Xiaoyu Guo

Motivation



Kutzer et al.

Current method

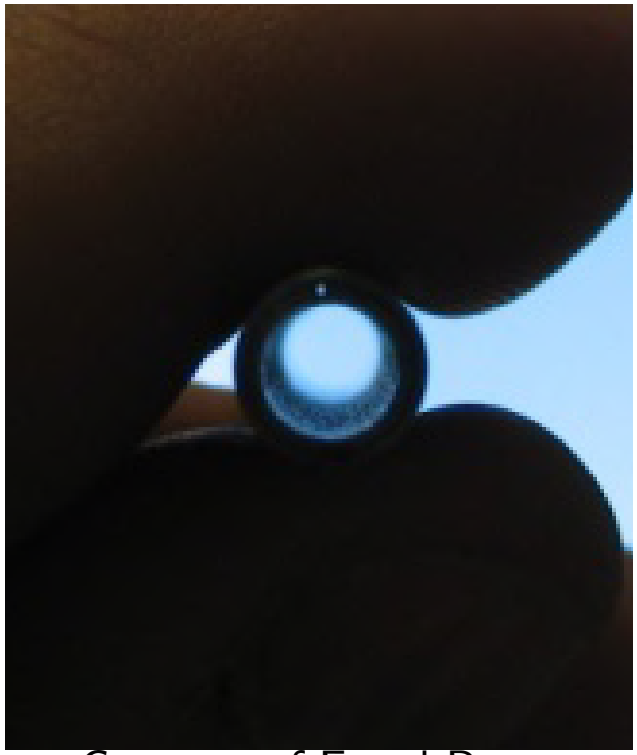
- Inaccurate
- Limited mobility
- Insufficient

Improvements

- Direct measurement
- Accuracy (≤ 1.3 mm)
- Improved visualization

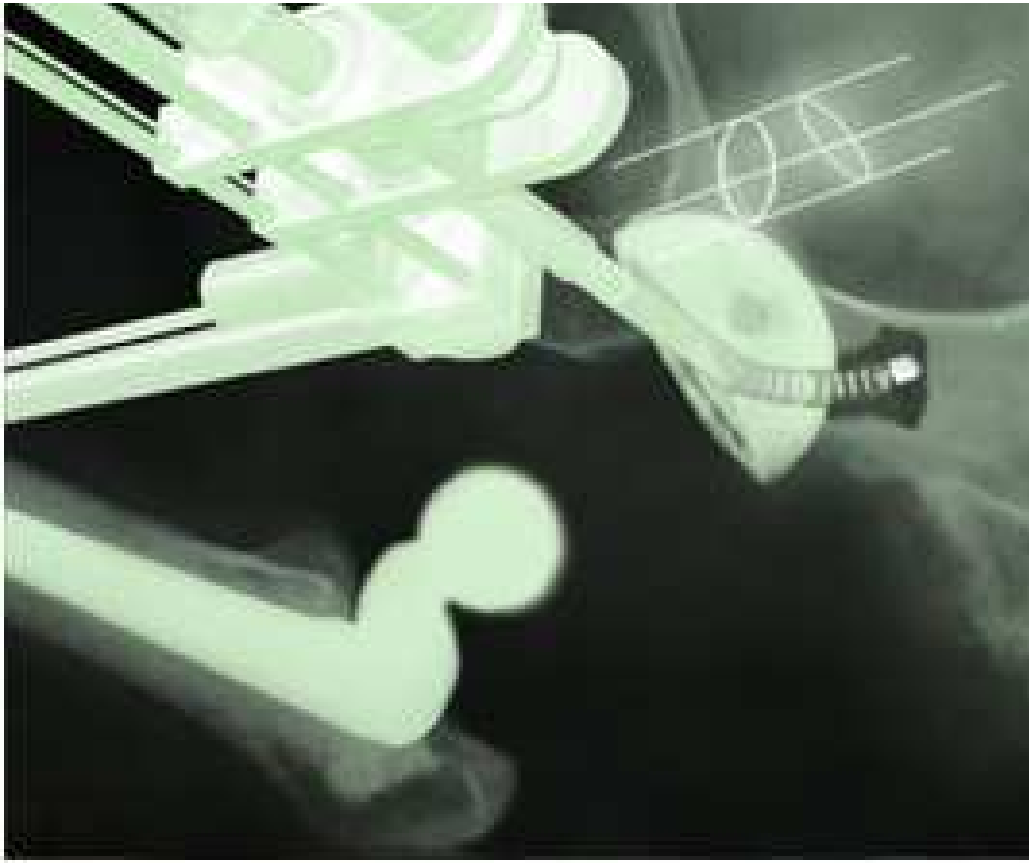
Implementation plan

- Optical hydrophone in end-manipulator
- Measure ultrasound at tip
- Calculate US time of flight
- Multilateration from multiple sources
- Display data back to operator

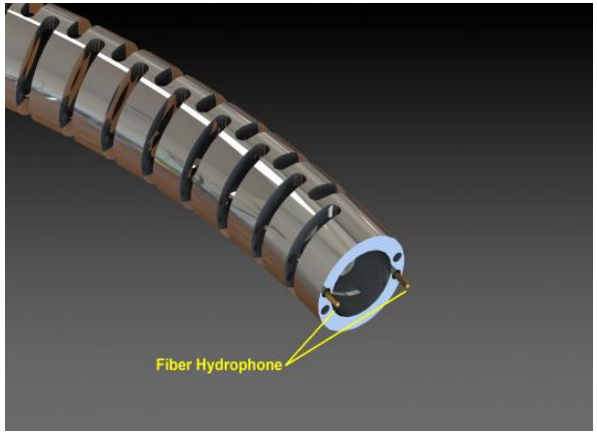


Courtesy of Emad Boctor

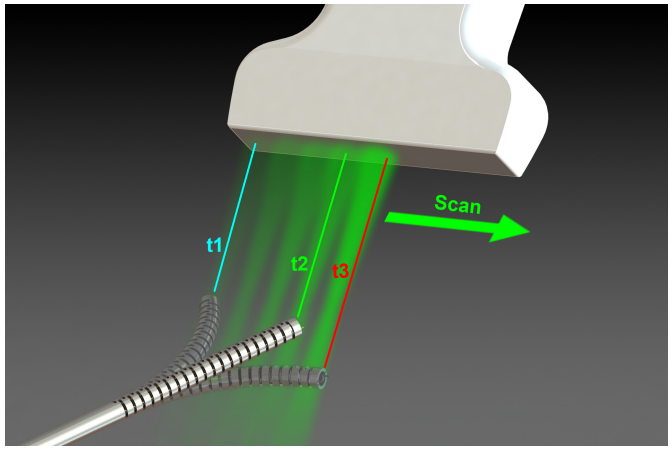
Use case scenario



Kutzer et al.



Courtesy of Xiaoyu Guo



Courtesy of Xiaoyu Guo

Use case scenario

Courtesy of Xiaoyu Guo

Deliverables

Minimum

1. Software and circuitry to measure time of flight
2. Able to determine manipulator position within 5 mm

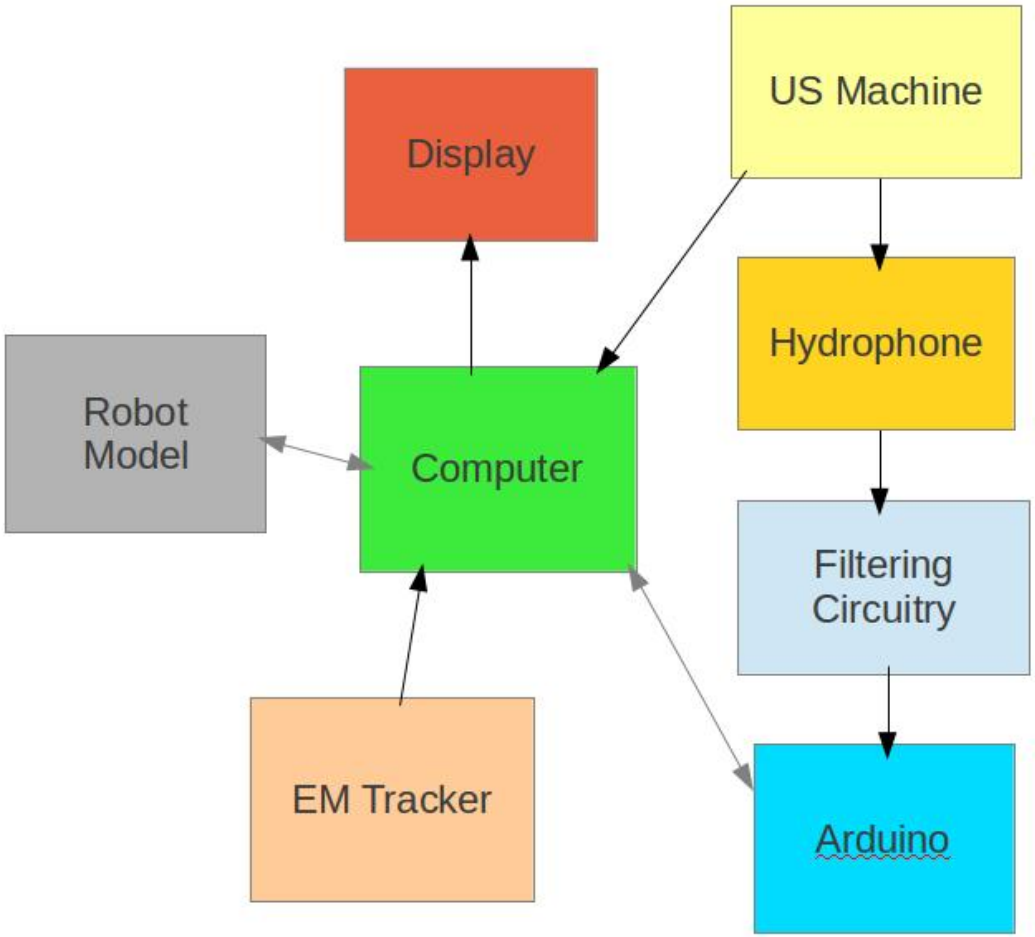
Expected

1. Software and circuitry to measure time of flight
2. Able to determine manipulator position within 1 mm
3. Rudimentary visualization, shows position

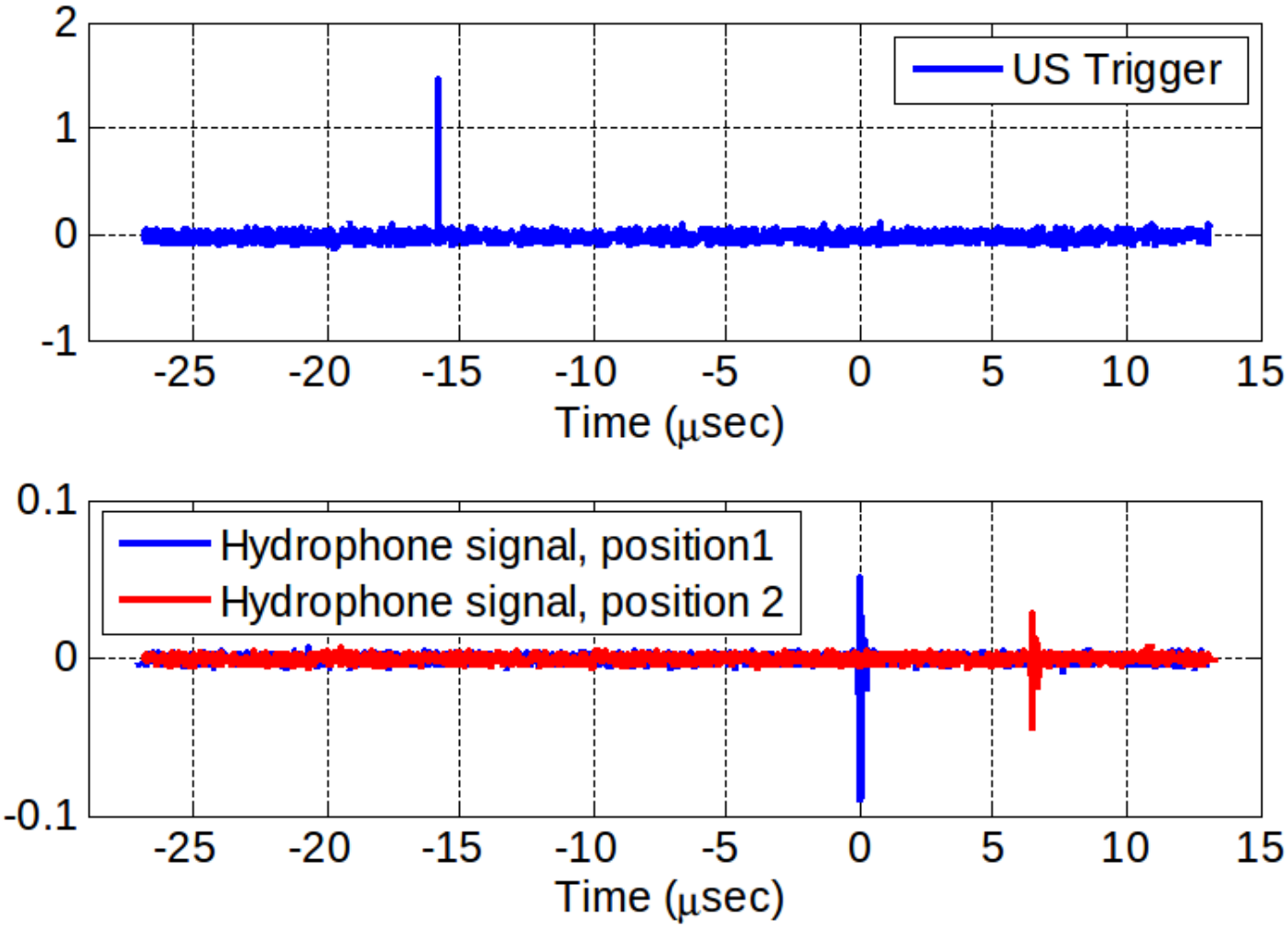
Maximum

1. Software and circuitry to measure time of flight
2. Able to determine manipulator position within 1 mm
3. Able to determine manipulator orientation within 5 degrees
4. Clean visualization, shows progress, material to remove

Workflow


US Machine
Display
Hydrophone
Robot Model
Computer
Filtering Circuitry
EM Tracker
Arduino

Speed issues



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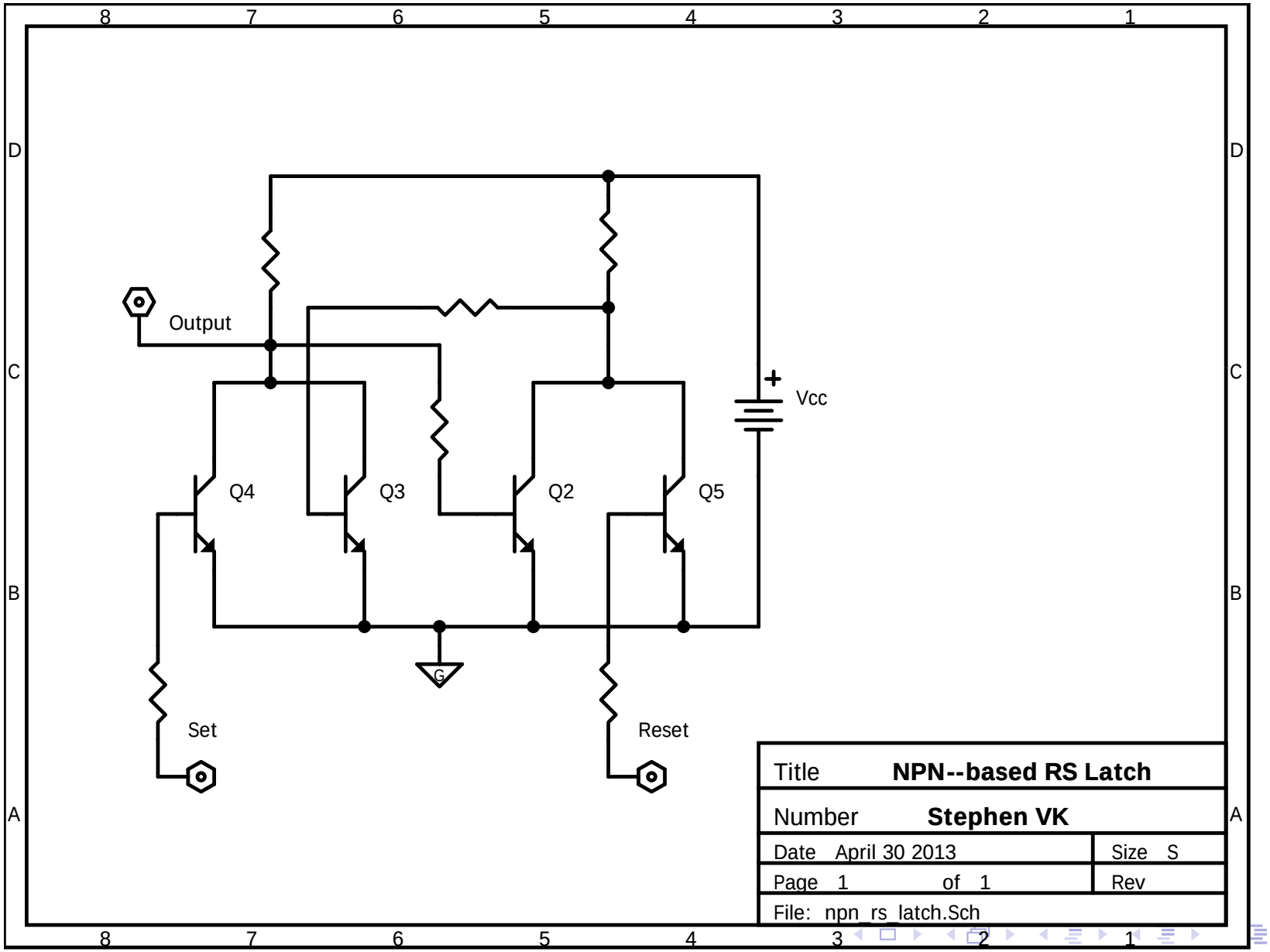
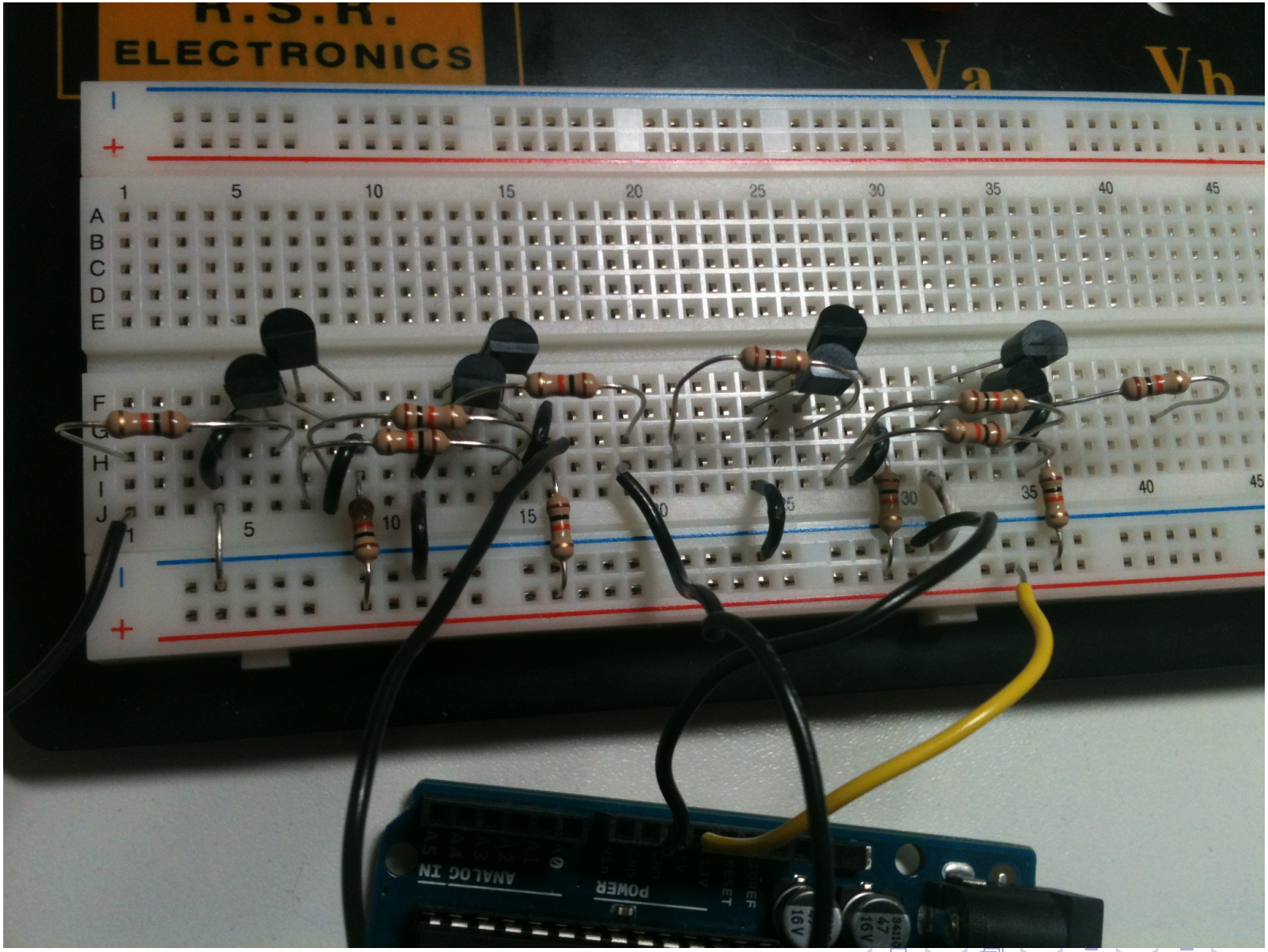
Circuit


8 7 6 5 4 3 2 1
D C B A
Output
Vcc
Q4
Q3
Q2
Q5
G
Set
Reset
Title NPN--based RS Latch
Number Stephen VK
Date April 30 2013
Size S
Page 1 of 1
Rev
File: npn_rs_latch.Sch

Circuit



Tasks to complete

- Finish Python wrapper for EM tracker software
- Get pivot calibration through Python working
- Test EM-US calibration
- Test localization against EM tracker baseline

Bibliography

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Thanks

Questions?