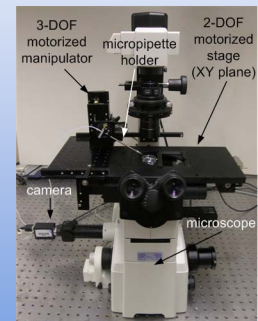


Summary:

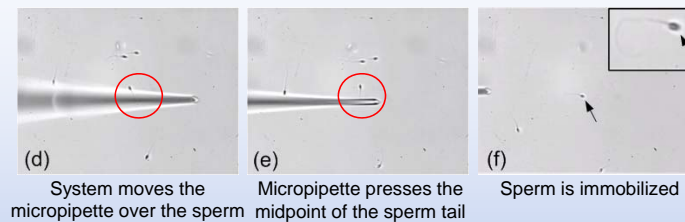
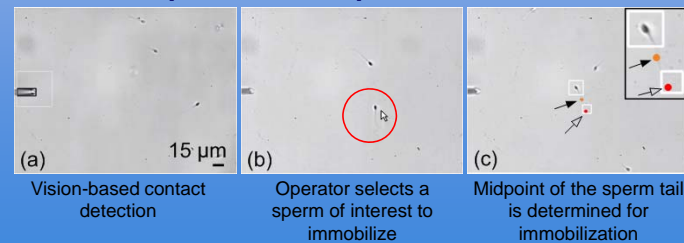
Conventionally, sperm immobilization is performed manually in intracytoplasmic sperm injection (ICSI), which entails long training and stringent skills. This abstract presents a robotic system for automated sperm immobilization for ICSI. The automated system is capable of immobilizing sperm with a success rate of 88.2% (n=1000 trials).

1. Automated System Architecture

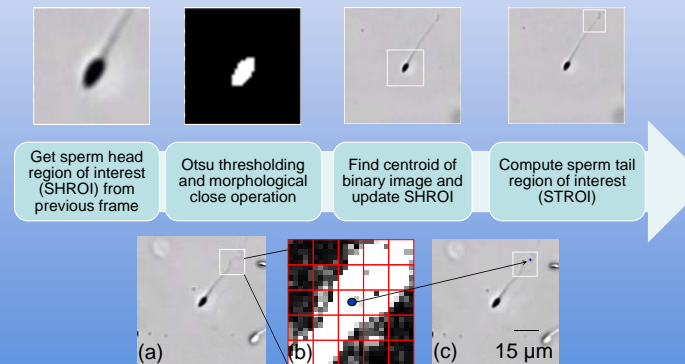


- Standard ICSI system components
- Robotic motion control devices
- Robust computer vision sperm head and tail tracking algorithms for calculating the target midpoint of the sperm tail to press with micropipette
- Requires only one computer mouse click
- Operator skill independent
- High reproducibility

2. Overall Operational Sequence



3. Sperm Head and Tail Tracking



- STROI is found.
- A 5x5 window (represented by the red boxes) is used to scan and find the 5x5 section with the highest intensity sum in the image. The center point (blue dot) of the 5x5 window with the highest intensity sum is the tail location.
- Frame displaying the estimation of a point on the sperm tail. The head and tail positions are averaged to find the tail midpoint position.

4. Experimental Results

Based on 1000 trials, the system demonstrated:

- a sperm immobilization success rate of 88.2%
- an average immobilization speed of 6-7 seconds

Speed v ($\mu\text{m}/\text{sec}$)	# immobilized / total	# failed for each failure case					Success rate
		(a)	(b)	(c)	(d)	(e)	
$40 < v \leq 55$	66/81	1	2	2	2	8	81.5%
$25 < v \leq 40$	301/345	3	11	4	17	9	87.2%
$15 < v \leq 25$	261/315	1	15	18	17	3	82.9%
$5 < v \leq 15$	189/191	0	0	1	1	0	98.5%
$0 < v \leq 5$	65/68	2	1	0	0	0	95.6%
Total	882/1000	7	29	25	37	20	88.2%

Failure cases:

- Micropipette disturbs culture medium
- Sperm is above micropipette
- Sperm tail is not in required orientation
- Sperm tail changes orientation upon immobilization
- Sperm increases speed upon immobilization

Acknowledgement:

