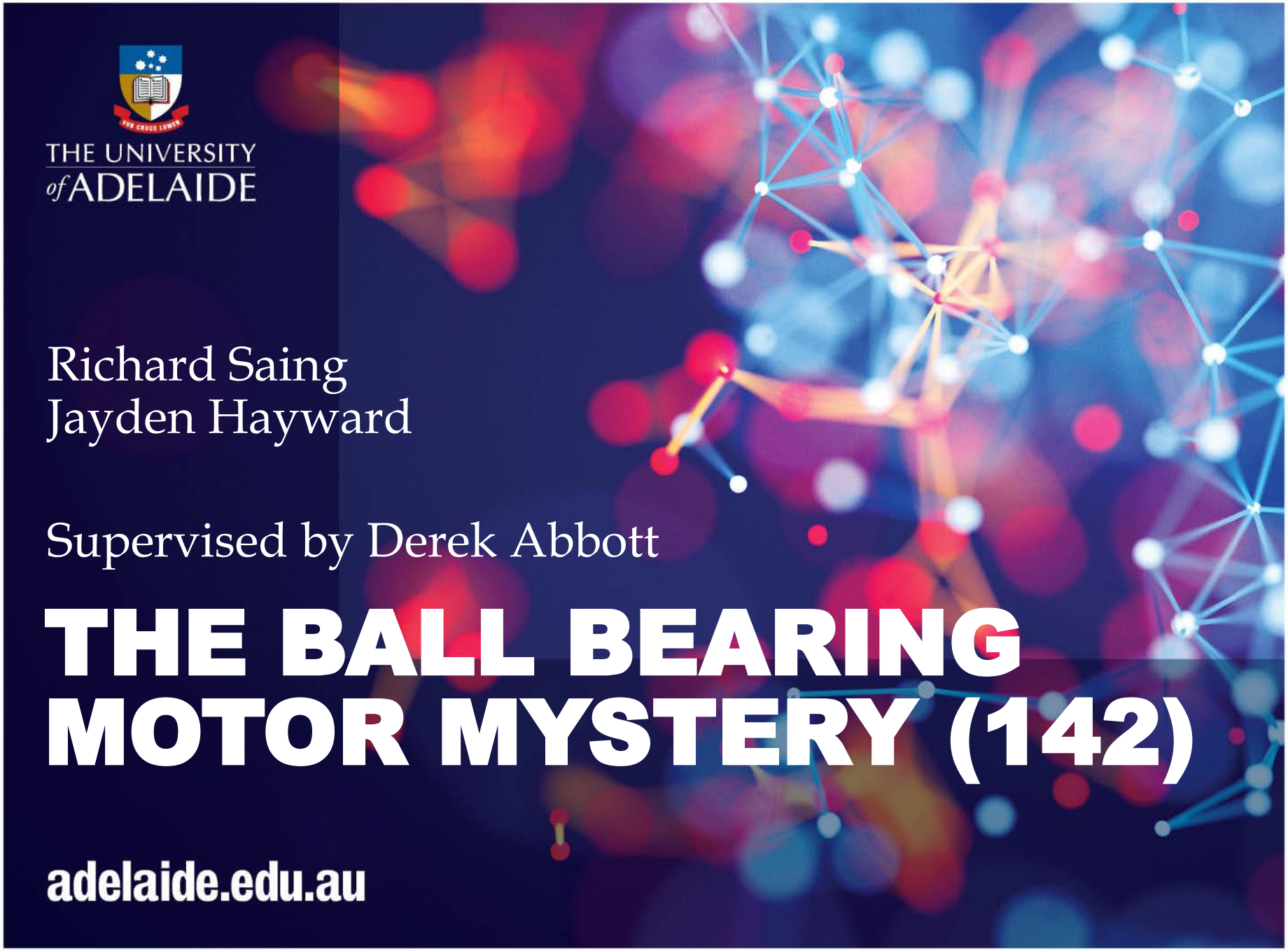


THE UNIVERSITY of ADELAIDE

Richard Saing
Jayden Hayward

Supervised by Derek Abbott

THE BALL BEARING MOTOR MYSTERY (142)

adelaide.edu.au

Outline

- Background Information
  - What is the mystery?
  - Description of the motor
  - Disadvantages
- Motivation
  - Applications
  - Purpose of study
- Experiments
  - What are we looking for?
  - Simulation setup
  - Physical setup
- Management
  - Budget
  - Timeline
  - Risk management
- Conclusion

Background Information

The Huber Effect

Pair of railway wheels

Steel axis

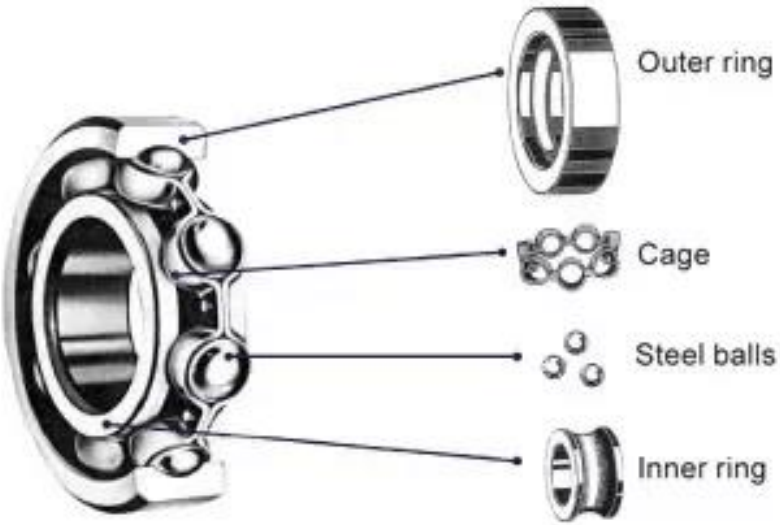
If current is applied across these wheels, then a *small force* begins to act.

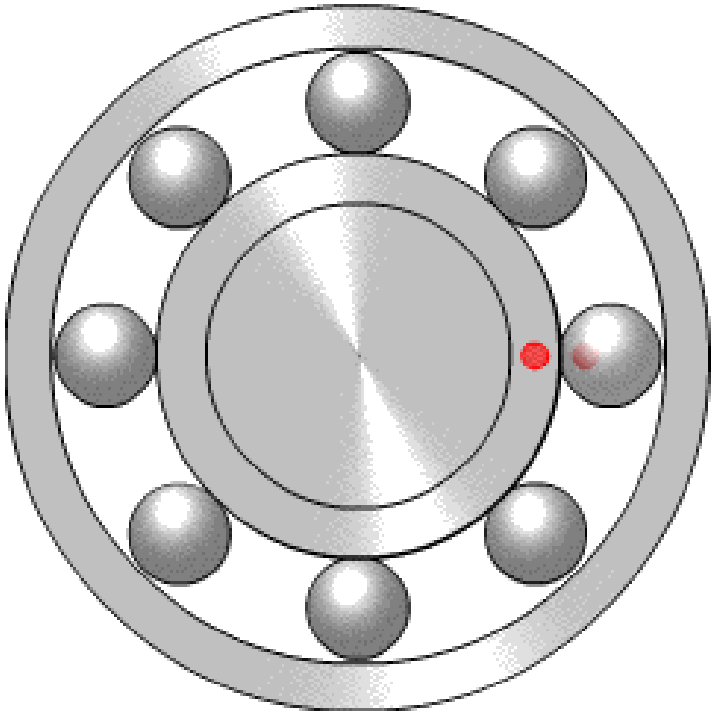
When the wheels start to roll, the strength of this *small force* increases.

https://cdn1.vectorstock.com/i/thumb-large/38/75/pair-of-train-wheels-vector-20753875.jpg

Background Information

Description of Bearing



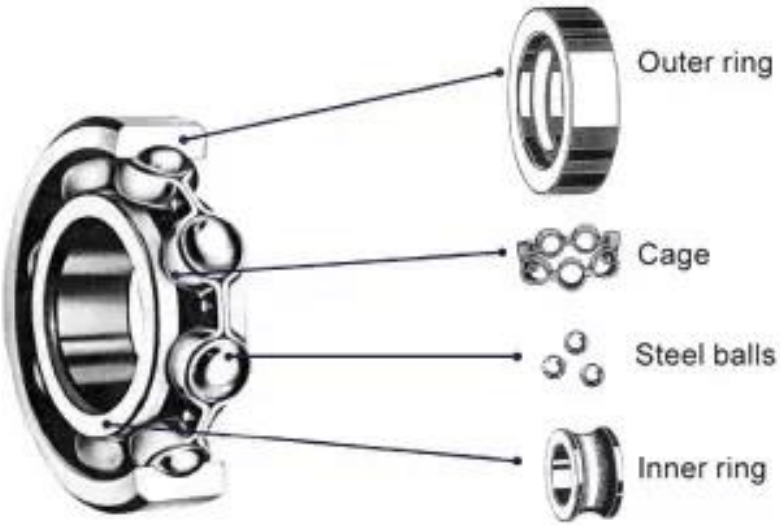


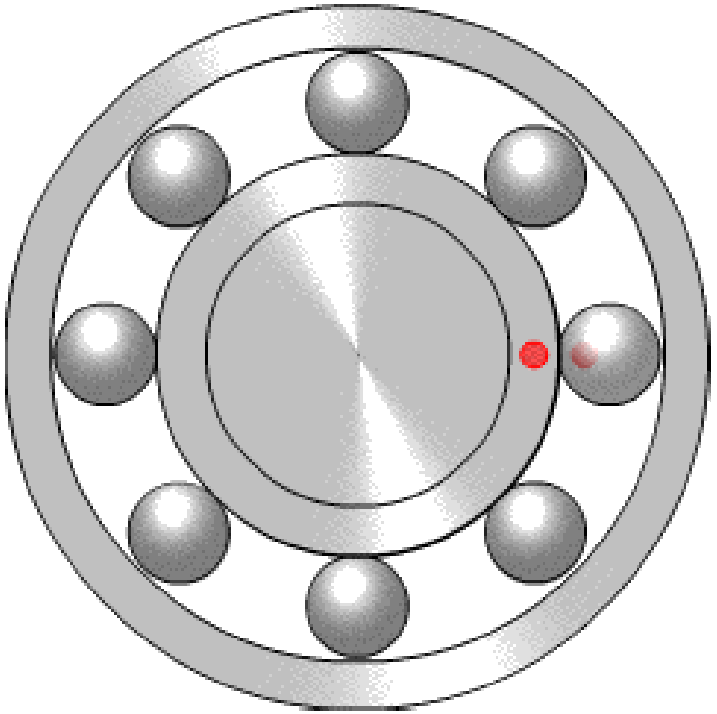
https://upload.wikimedia.org/wikipedia/commons/3/30/BallBearing.gif

https://www.quora.com/How-do-ball-bearings-work-What-are-they-for

Background Information

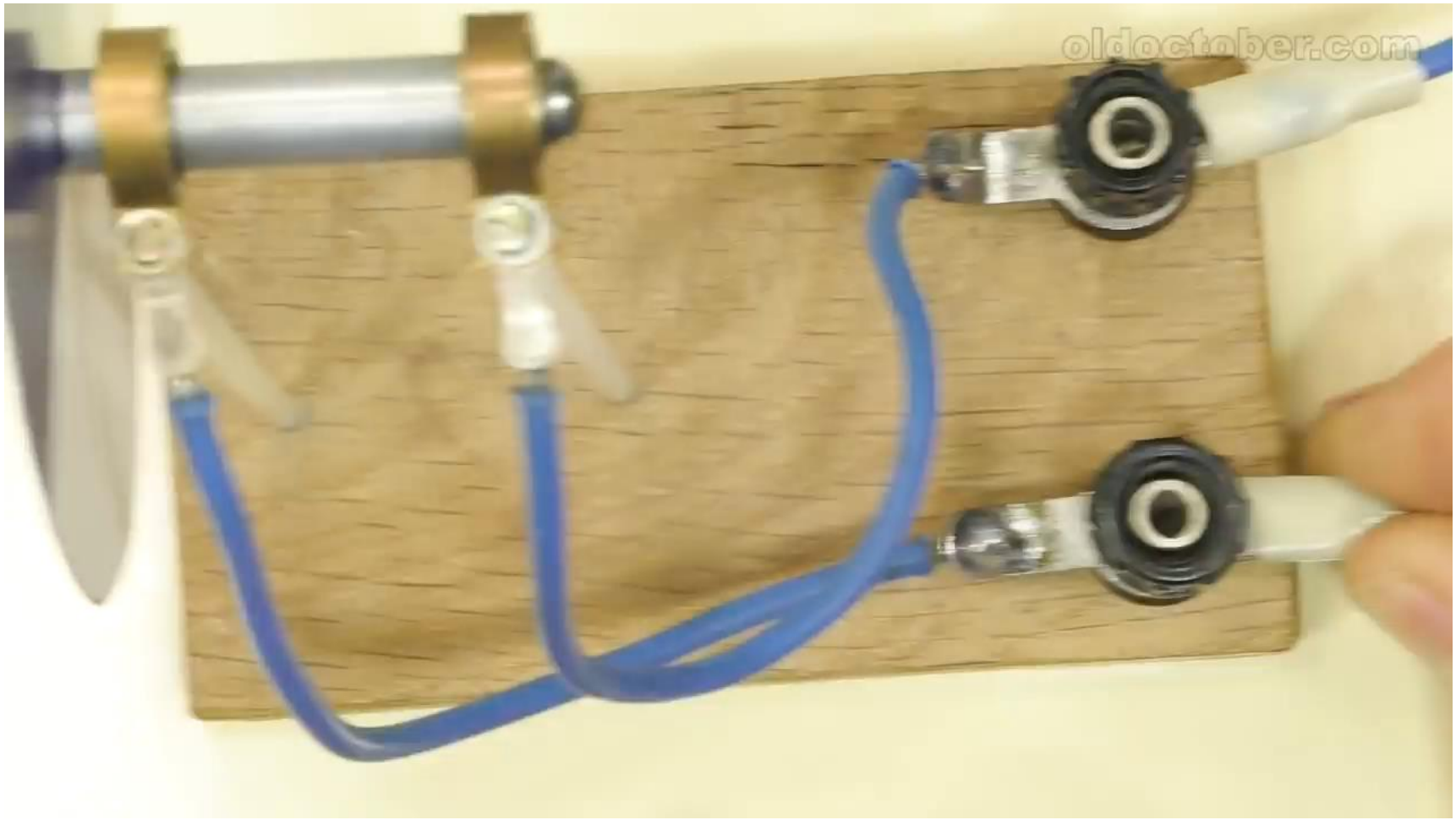
Description of Bearing





https://upload.wikimedia.org/wikipedia/commons/3/30/BallBearing.gif

https://www.quora.com/How-do-ball-bearings-work-What-are-they-for

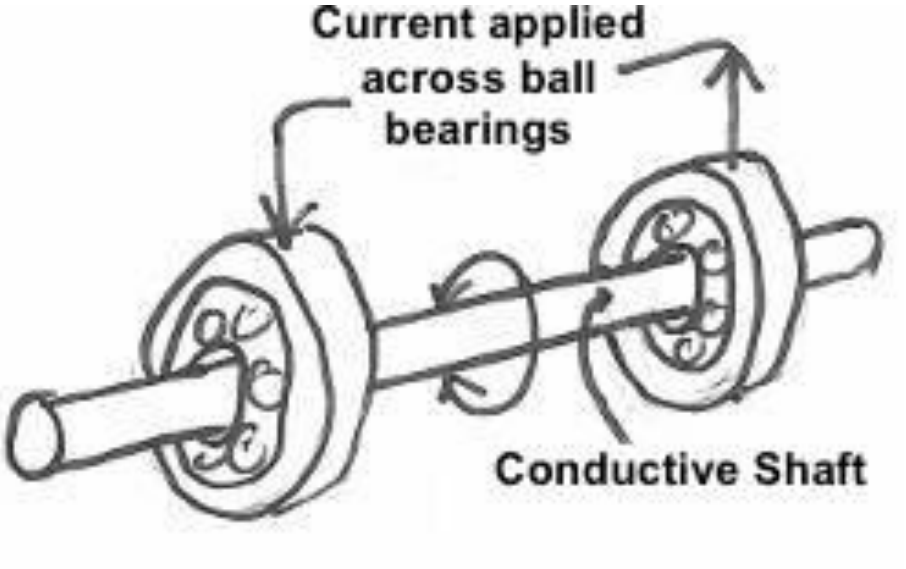


https://www.youtube.com/watch?v=8E4_SQTBye4

Background Information

Description of Motor

- High current is applied at opposite ends of the shaft.
- After giving the motor an initial spin, the motor will independently rotate in that direction.



https://www.electronicsweekly.com/blogs/engineer-in-wonderland/general-engineer-in-wonderland/ball-bearing-motors-a-mystery-2012-11/

Background Information

Disadvantages

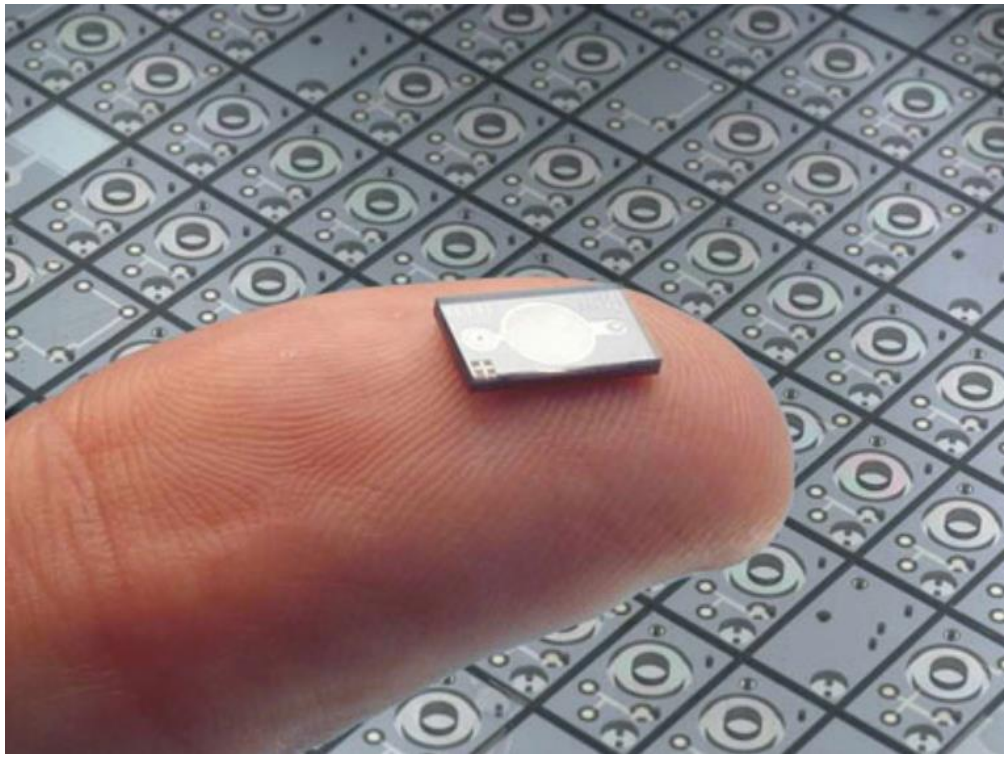
- Heats up
- Sparking occurs
- Very poor torque

https://d3vl3jxeh4ou3u.cloudfront.net/IISTD%20Damaged%20Wheel%20Bearing%20.jpg

Motivation

Application (MEMS)

- Make it smaller
- Increase reliability and velocity
- Less current
- No more overheating
- Use in Micro Electro-Mechanical Systems

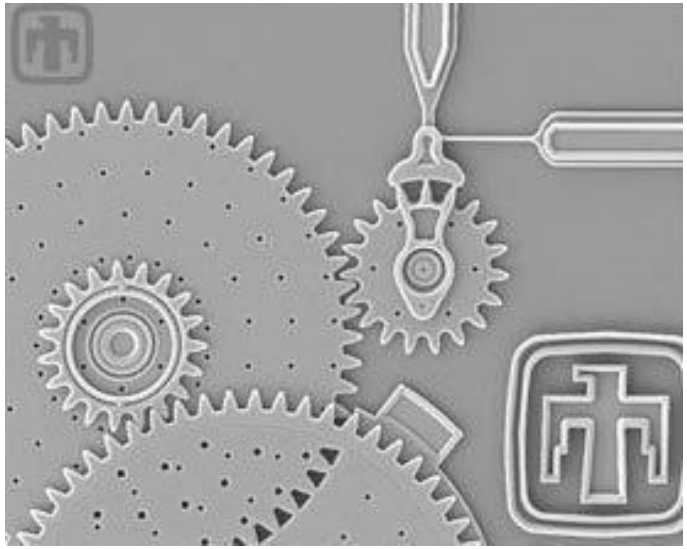


https://internetofthingsagenda.techtarget.com/definition/micro-electromechanical-systems-MEMS

Motivation

Application (Micro Motor)

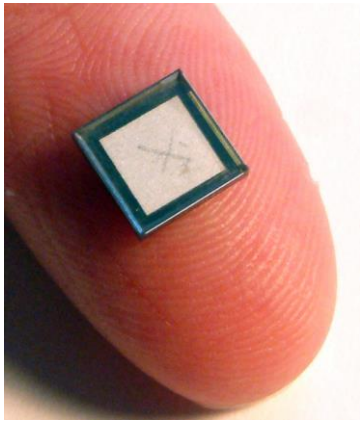
- Size in the order of microns
- Uses in the medical field



https://scienceprog.com/what-are-mems/

Motivation

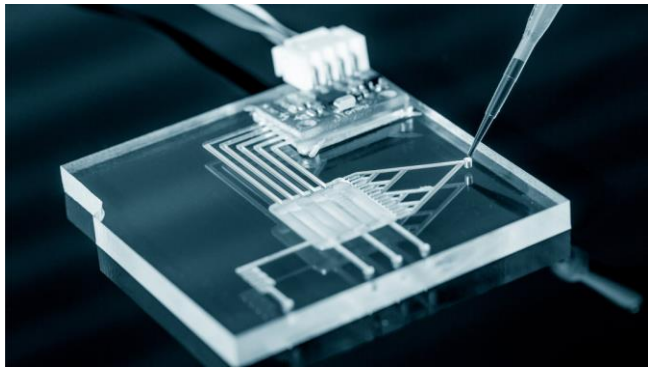
Application (Micro pump and LOC)



Micro pump

- Can manipulate picolitres of liquid
- Applications in the military

https://educalingo.com/en/dic-en/micropump



Lab on a Chip (LOC)

- About 1x1 cm in size
- All the operations in a normal lab
- Can run tests on a small amount of blood and duplicate DNA segments

https://singularityhub.com/2017/02/19/one-cent-lab-on-a-chip-can-detect-cancer-and-infections/

Motivation

Purpose of This Study

- Better understand Huber effect
- Potentially unlock new potentials for MEMS
- Might give insight to today's technical problem

Experiments

What Are We Looking For?

- **The electromagnetic force effect**
- The thermal expansion effect
- The plasma discharge effect

Relationship between angular velocity and torque?

Experiment

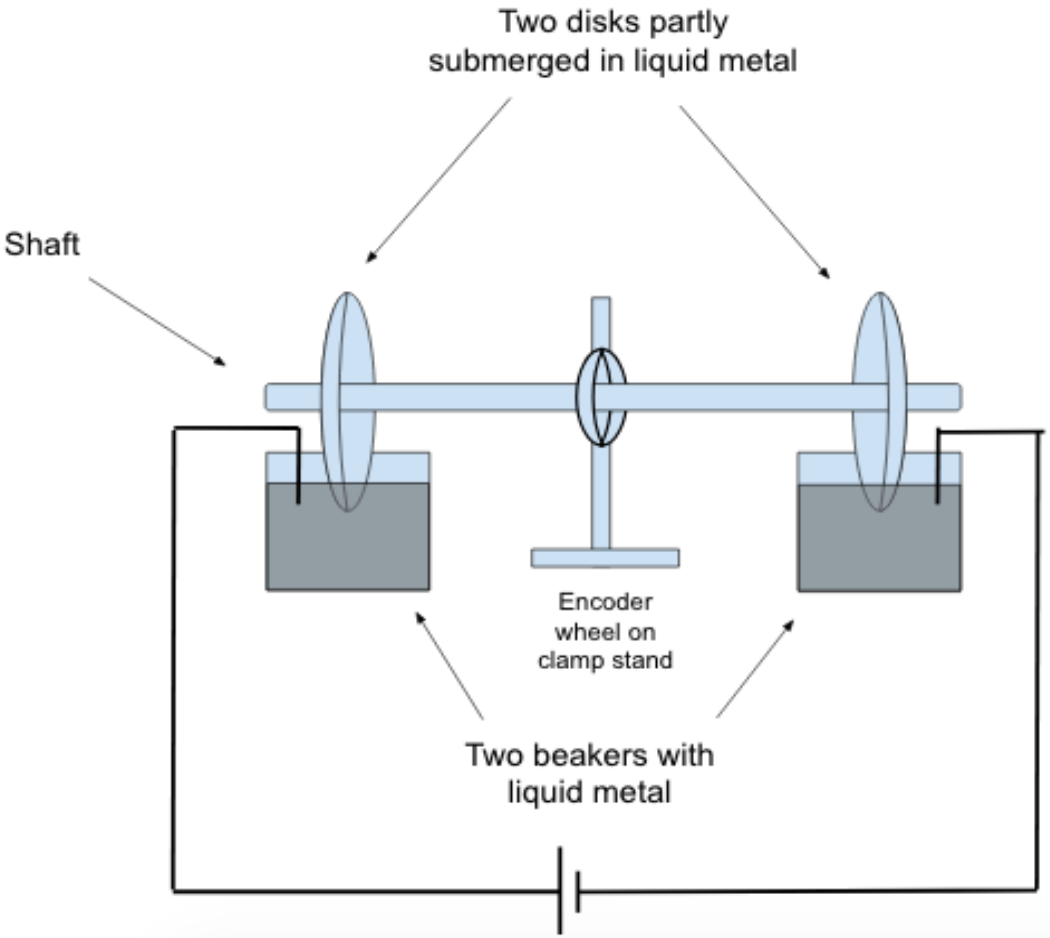
Simulation Setup

- Can create and simulate real or ideal situations
- Will be used to simulate the ball bearing motor in a frictionless environment
- Enable us to collect and compare data

https://d3vl3jxeh4ou3u.cloudfront.net/IISTD%20Damaged%20Wheel%20Bearing%20.jpg

Experiment

Physical Setup



Experiment

Gallium

https://www.businessinsider.com/gallium-safe-metal-liquid-mercury-2016-5/?r=AU&IR=T

	Gallium	Galinstan	Francium	Mercury	Caesium	Bromine
Liquid near room temperature? (Melting Point)	☑ (30°)	☑ (10°)	☑ (27°)	☑ (-30°)	☑ (-28°)	☑ (-7°)
Not toxic?	☑	☑	☒	☒	☒	☒
Fit our budget?	☑	☒	☒	☑	☒	☒

Management

Budget

- Gallium ($130 for 250g)
- Encoder wheel ($70-$100)
- Ball bearing races ($5-$10)
- Total ($205-$240)

Management

Timeline

Tasks	Start Date	End Date	Assigned to	Timeline	Status
Ball Bearing Motor Mystery Project	1/3/19	10/11/19	JH & RS		Active
Research	1/3/19	12/4/19	JH & RS		Complete
HSW Inductions	22/3/19	29/4/19	JH & RS		Complete
RA & SOP	15/3/19	29/4/19	JH		Complete
Cost Management	15/3/19	12/4/19	RS		Complete
Ball Bearing Motor Test	16/4/19	12/5/19	JH & RS		Upcoming
COMSOL Simulation	19/4/19	12/5/19	JH & RS		Upcoming
Gallium Experiment	13/5/19	7/6/19	JH & RS		Upcoming
Deliverables					
Project Wiki	22/3/19	1/11/19	JH & RS		Active
Proposal Slides	22/3/19	12/4/19	JH & RS		Complete
Proposal Seminar	15/4/19	16/4/19	JH & RS		Active
Thesis Draft	22/4/19	7/6/19	JH & RS		Upcoming
Thesis Final	8/6/19	1/11/19	JH & RS		Upcoming
Final Seminar	4/10/19	6/11/19	JH & RS		Upcoming
Project Poster	4/9/19	1/11/19	JH & RS		Upcoming
Project Exhibition 'expo'	6/11/19	7/11/19	JH & RS		Upcoming
YouTube Video	6/9/19	8/11/19	JH & RS		Upcoming

Management

Risk (HSW)

- Ball bearings get too hot to touch.
    - Mitigated by leaving to cool and ensuring the ball bearings are cool to touch before handling.

- Sparks are likely to occur.
    - Mitigated by wearing safety glasses.

- High current from car battery passing through motor.
    - Mitigated by wearing safety gloves.

Management

Risk (Project)

- Shipping may take longer than expected.
  - Mitigated by allowing more time to work on experiment.

- Simulation results differ from actual results.
  - Mitigated by simulating simple projects.

Conclusion

- On a large scale the motor is ineffective
- Has a lot of potential when made smaller
- Looking for the relationship between angular velocity and torque
- The motor will be simulated using COMSOL as well
- Motor will be modelled with the liquid metal Gallium
- See which theory the results support if at all.

Questions?

THE UNIVERSITY
of ADELAIDE

CRICOS PROVIDER NUMBER 00123M