Notes — January 2nd, 2026

↳ learning about the water main break that happened maybe 1-2 days ago.

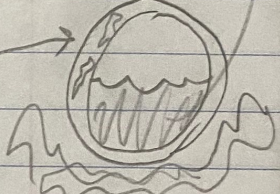
↳ Happened on december 30th

↳ These pipes were created in 1975. It was said by the building company that they could last "almost 100 years". However, that doesn't seem to be the case here.

↳ What I need: Access to that document (the long one) created after the bearspaw 2024 water main rupture

REASONS FOR RUPTURE

CRACKS



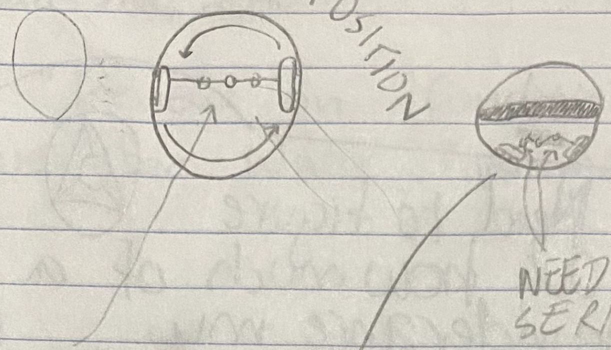
water pressure dropping

elevated Chloride levels in soil outside

↳ ALSO, today, I ~~talked~~ found a city booth at Vivo and it was an advisory booth with steps on how to mitigate water usage during this time. Talked to her and she said I could contact 311 (call best option) and ask them to connect me with an engineer working on this issue. (Pro tip: Ask them for a follow up email or call so they don't lose you).

DESIGNS / PROTOTYPES.

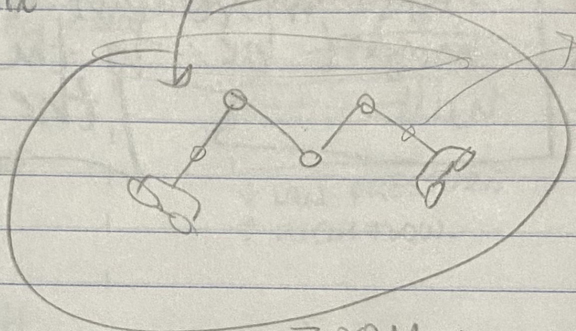
NORMAL POSITION

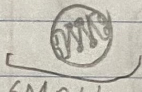


NEED A DOUBLE SERVO

ACTUALLY: Need more because these situations:

The straight line design makes sure the robot stays in place while moving



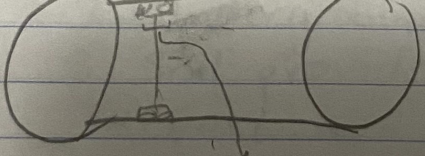


SMALL DIAMETER PIPE.

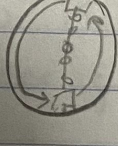
ZOOMED IN VIEW.

MOVEMENT

SIDE VIEW



TOP VIEW

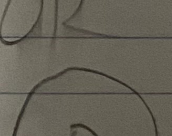


1 REVOLUTION.

Move LENGTH [of robot] PER REVOLUTION

EVERYTHING MUST BE WATERPROOF.

OR GYROSCOPIC smartball



Camera

Motors

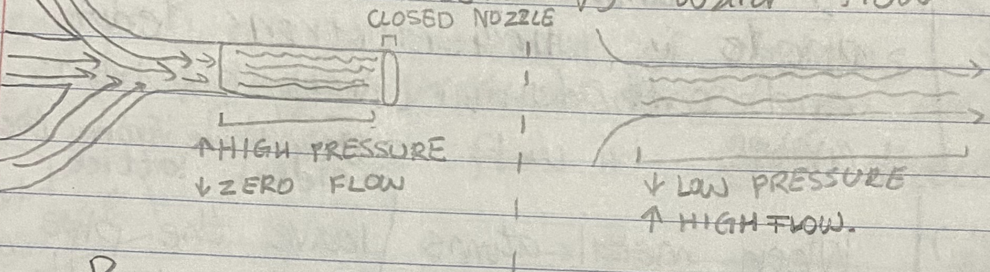
definitely an easier design, novelty? dunno.

Jan 3rd, 2026

→ Read "Review on Condition Monitoring Techniques for Water Pipe lines".

NOTES:

Water Pressure Vs water flow.



Pressure = PUSH
Flow rate = MOVEMENT.

Pipes remain ↑Mainly underground because of:

1. Protection (impacts, weather, etc).
2. Underground temp. is stable
3. Soil provides easy & uniform structural support.
4. Keeps surfaces clear for other infastructure such as roads.
5. Pipes last longer due to less exposure from outside factors

↳ BUT this just makes <u>inspection</u> technologies <u>harder</u> to access.

→

Cathodic protection.

they leave in the first place because of 1. wet soil increases electrons leaving 2. oxygen levels are not uniform 3. Many more reasons.

↳ #1: Corrosion = loss of electrons from a metal.

• This is how corrosion happens

So basically, in any metal, there is an anode and a cathode, anode is where electrons leave and cathode is where electrons arrive.

Also, anodes & cathodes are only possible where there is a:
1. Metal
2. Electrolyte (ex: water, wet soil, salt.)
3. Electrical path

↳ A pipe (underground) checks these boxes, hence it is subject to corrosion.

When metal atoms leave the pipe (they leave from the metal lattice) (via anode points), they turn into ions, and react with soil. These ions later react with oxygen and water to form rust, and that rust exposes more metal, repeating the process. Corrosion is localized. ← NOTE.

Well, why do pipes still corrode if we have cathodic protection & coatings? (Just a layer to protect the pipe from soil (electrolytes).)

→ C.P. current is uneven (soil resistivity, long distances, etc).
→ Under-protection ↳ Not enough current
↳ Over-protection ↳ TOO MUCH current.

↳ They can
↳ Crack
↳ Age
↳ Get damaged

↳ So the engineers building this technology said "Why dont we just either:

1. Use a DC power source to literrally constantly push electrons through the pipe - so there are no anode areas.
2. Put a "sacrificial anode" piece of highly reactive metal adjancent to the pipe. This extra metal easily loses electrons, and those electrons flood the normal pipe, creating a kind of "constant" electron flow.

Continued: Jan 4th, 2026

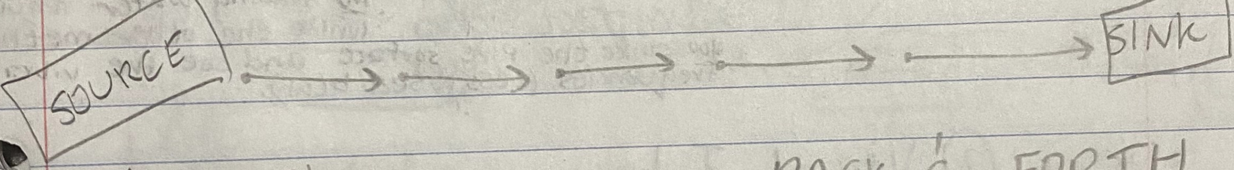
My tech → STATIC LEAK DETECTION.
↳ Because it is continuosly monitoring the pipe, unlike dynamic leak localization systems which go in once and are retrieved shortly after.

------ Jan 4th, 2026 ------

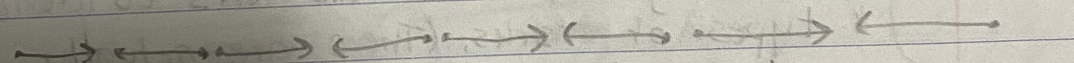
AC vs DC current: (Just to know)

Like water [flow vs. pressure]:
Current = movement of electrons.
Votage = pressure forced on electrons

DC: Electrons flow in ONE direction.



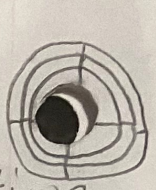
AC: Electrons move BACK & FORTH



- No permanent source or sink
- Pirection reverses many times (eg. 60Hz = 60 reversals per second) ↳per sec.

HIGHER VOLTAGE = LOWER CURRENT.
(And vice versa) → Interestingly. ☹

→



Techniques to determine pipe deterioration

① Acoustics.

↳ Leaks in pipes cause hissing noices which can be detected at certain frequencies by hydrophones. (listen to the water)

ⓐ Other ways.

- ↳ Listening sticks: Pipe vibration
- ↳ Correlators: sensors listen for leak noise, get it at different times.
- ↳ Remote loggers: Long term acoustic monitors.
- ↳ Transient waves: Pressure waves released, checked for reflections, etc.
- ↳ Sonar profiling: Like an underwater ultrasonic sensor looking for anomolies.
- ↳ Impact echo: NO flowing water required (unlike the other methods)! you strike the pipe surface and see the vibration frequencies. (Less used btw).

② Visual Techniques

↳ Using AI subfaces like CNN's to identify certain types of cracks. (There are actually many different names for specific types of cracks, so look at the top left of pg. 5 for more details).

↳ Using lazer scanning techniques via technologies like LiDAR.

WATCH Videos on each technique to understand visually.

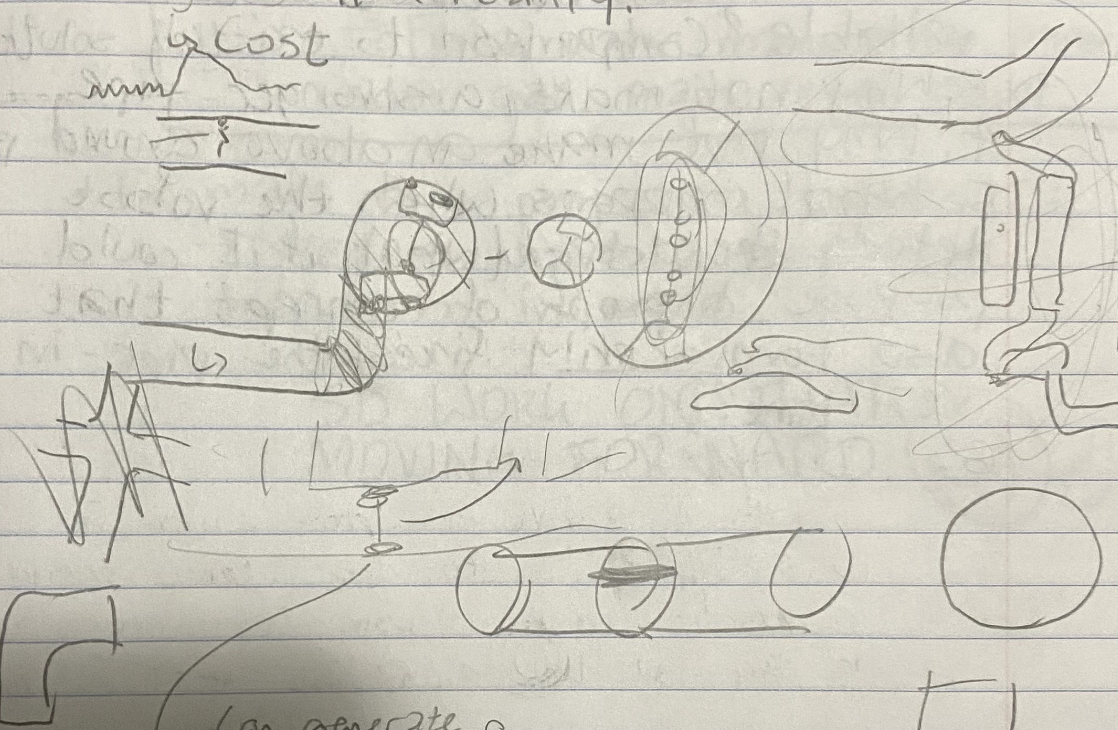
③ Electromagnetics.

↳ on OTHER PAGE

Concerns:

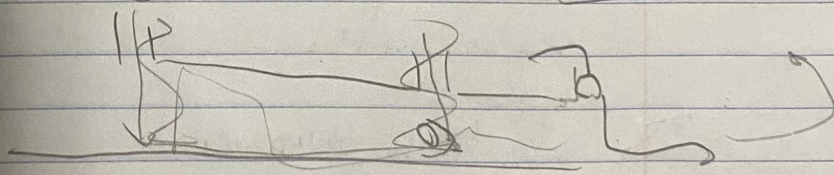
↳ Well even if the pipe detection mechanism sees that the pipe is broken, fixing it would be still a reality.

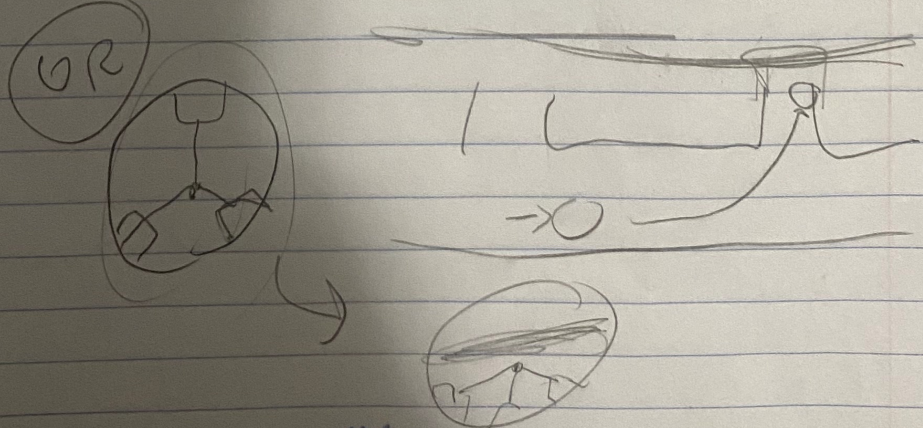
↳ Cost

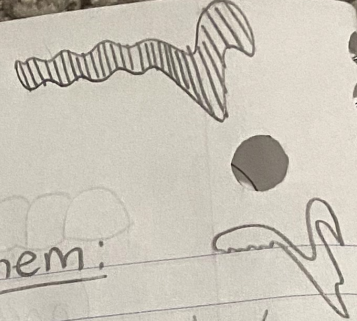


Can generate c

power by itself.







Concerns & How to refute them:

1. How do you make sure the blades/ cutters that remove debris don't just break the pipe?
2. How much would it cost to be reliable? Comparison to existing solution.
3. Why not make a stronger pipe
4. Why not make an above ground pipe?
5. What happens when the robot detects the defect (what if I could propose a proof of concept that also temporarily fixes the pipe - in real time?)
6.

WA
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January 7th, 2026.

→ Watched: Explaining the depth of Calgary's water crisis – The Big Story (on Spotify).
→ Speaker: Prof. Kerry Black, UofC er department of Civil Engineering.

TO DO: Finish LinkedIn, send resume and project plan then CONTACT.

→ You can contact with questions referencing this podcast (and ask what happened this time and if she can give mentorship on my pipe project idea).

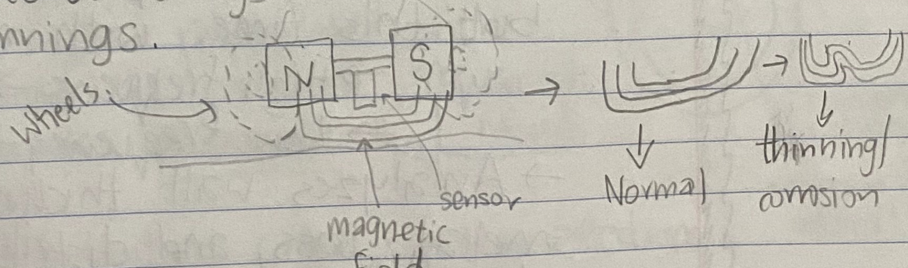
Continued: Techniques to determine pipe deterioration. (water pipes)

→ Electromagnetic Techniques

Used to detect defects MAINLY IN: Metallic pipes
→ Carbon steel
→ Cast iron
→ Ductile iron

① Magnetic Flux Leakage
→ Non-destructive sensing

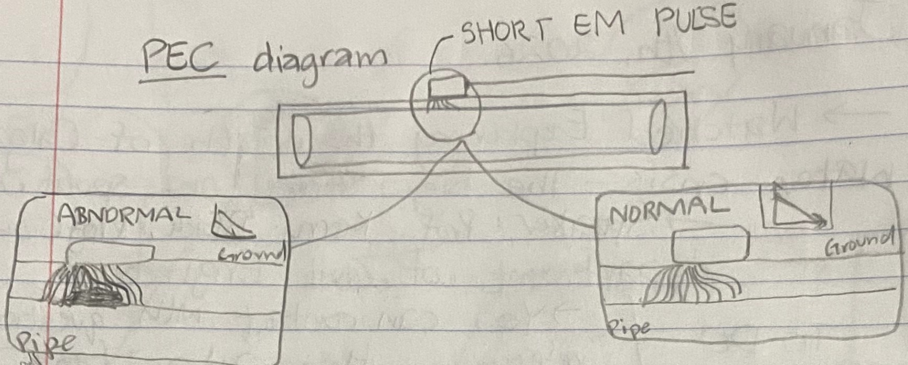
This technique, used in ferromagnetic pipes (things that attract magnets), detects things like corrosion and wall thinnings.



② Pulsed Eddy Current
↳ Device sends a short electromagnetic pulse into a metal pipes and observes how the eddy currents decay over time. →

Hilroy

PEC diagram



↳ Works through insulation and coatings
↳ Detects corrosion and wall thinning
↳ Can see deep defects

③ Remote field eddy current

· An interesting method: ~~this is very hard to understand, good~~ It is too large for normal pipes - won't be using this one.

④ Broadband electromagnetic.

↳ Looks at the pipe pretty much the same way as PEC and RFEC, but this time, with multiple frequencies.

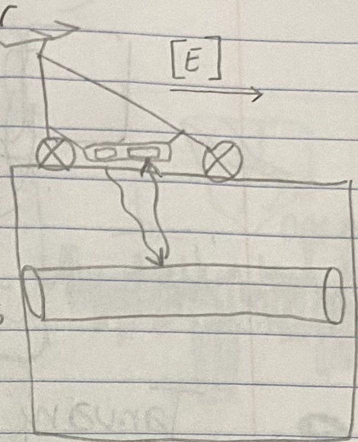
→ High frequency → Inner wall/surface
→ Low frequency → Outer wall

→ Analyzes wall thickness, depth of metal loss, and distribution of corrosion.

→ Limitations: Complexity, lower spatial resolution than MFL, sensitive to noise, and calibration.

∴ Mostly used for condition assessment, not pinpointing cracks.

⑤ Ground penetrating radar



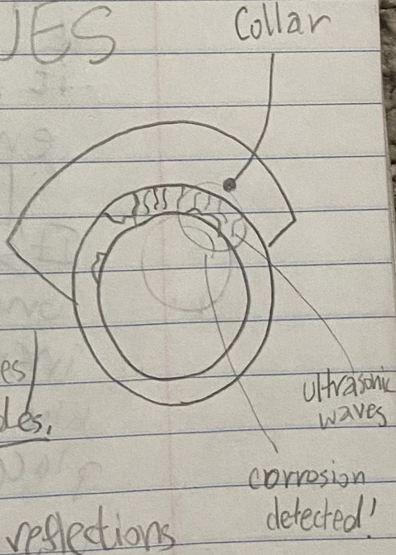
→ Subsurface sensing method. NOT a direct (in-line) inspection tool. GPR send short EM waves (across the spectrum) and records reflections.

→ Leaks in water pipes cause wet soil zones (disturbance), and a GPR can detect that. You call this a diaelectric contrast.

→ Limitations: Time consuming, performance degrades in wet or clay soils. Indirect leak localization.

→ ULTRASONIC TECHNIQUES

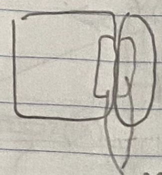
① Guided Wave Ultrasound.



· The collar (transducer) excites the pipe wall with ultrasound at selected frequencies/modes.
· The waves propogate through the wall.
· Any deformities cause partial reflections
· ToF finds distance to defect
· Limitations: Complexity.
One sensor can run through hundreds of meters of pipe in one run.

Hilroy

how to waterproof the wheels



magnets

↳ MAGNETIC TECHNOLOGY

January 4th, 2026

→ As I was listening to morning 660 News, the reporters were talking about how Calgary's water usage is still in the RED zone. This means that if emergency departments need urgent water, it will be hard for them to get it. This PROVES that in the end;

[PEOPLE DONT CARE.]

It's an unfourtunate reality, but one we need to live with. Pipe inspection robot MAKE SURE damage like this doesn't happen in the first place

More prototyping

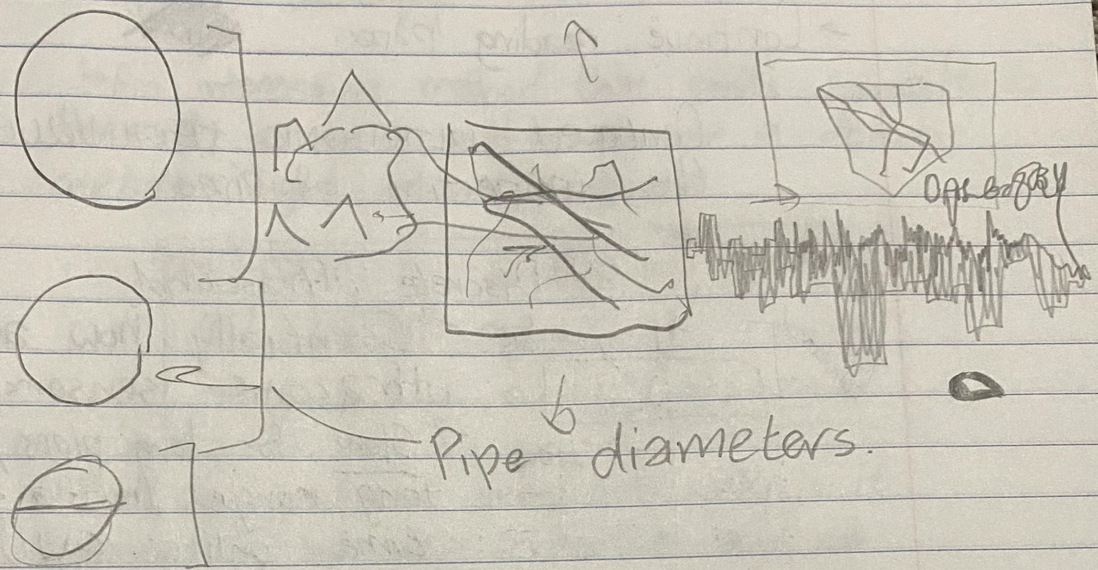
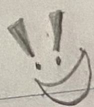
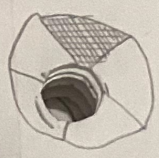
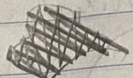


Figure out the cost of each pipe diameter and how much it costs when fails.



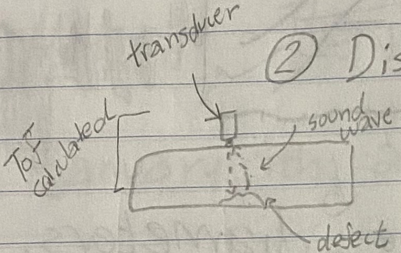
January 10th, 2026 - BACK AT IT!!!!



→ Continue reading paper.

Continued ULTRASONIC TECHNIQUES for the inspection of pipes:

② Discrete ultrasound

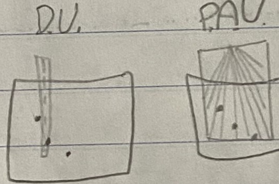


→ Essentially how arduino ultrasonic sensors work:

→ Slow for long pipes, not long range in a short time, unlike GWU①.

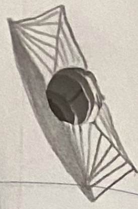
→ Resolution is high, however, compared to GWU.

③ Phased array ultrasound



→ A much better/precise alternative to disvete ultrasound: while ② hits one beam, one angle, one point in time, ③ has many small ultrasonic elements in a probe, all firing with a slight delay (with diffenent angles and depths).

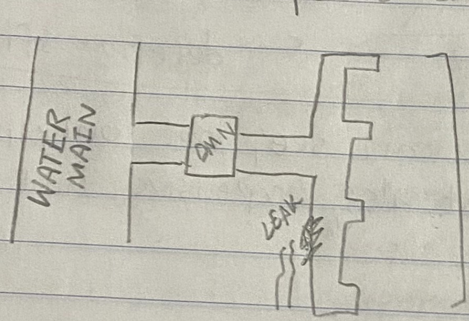
→ It does haves more complex hardware and data. Still local.



© District metered area

↳ Basically points across a pipeline system that are stationary and detect things like inflow rate and water pressure.

But these "points" are interesting;



The leak happens after the DMN. So, the rationale is, if the DMN is getting constant flow at night (when ppl don't use that much water), then that means someone (in their house) is trying to get water and they take a long time to get it because there is a leak on the way the water reaches their pipe.

You can understand the basis behind this more w/ Ms. Young.

ⓓ Linear polarization resistance

↳ LPR works by producing a tiny electrical current on a pipe surface. If it is actively corroding, eletron-transfer reactions respond strongly, producing a large current response. VERY LOCAL, HOWEVER.

Learning

across a circuit — through circuit:

Voltage vs. Current vs. Power

- the potential of electrons to move
- The movement of electrons (flow)
- A factor of both Voltage and current to do work.
- A function of $\frac{energy}{time}$

BACK TO PAPER:

pipeline monitoring systems

STATIC [VS] DYNAMIC ∴ PMS

- STATIC: fixed
- DYNAMIC: moving

→ There is no "best" system, but what if I could create a hybrid system to get the best of both worlds?

IDEA: The robot initially stays static, gathering energy up at a pipe extraction point. Then, when it detects an anomolie, it goes right away from the extraction point, finds and pinpoints the leaks, then just travels to the next extraction point.

② TriopusNet

↳ A basically deployment + replacement system for sensor nodes.

↳ So say you had a dead node inside the pipe:

↳ First you insert a fresh node in the pipe

↳ Then, using a pressure + gyroscope, this fresh node localizes and finds the dead node.

↳ Then once it finds it, it uses built in motorized mechanical arms to attach beside it and start working

↳ Interesting note: dead sensor nodes aren't just like cut off and recorded, they just leave them there because it would be too "complex" to do allat.

③ Sahara - Pure technologies / Xylem

↳ A ~~tethered~~ cable inline inspection tool

↳ Has a hydrophone and a camera and is pulled and controlled through pressurized mains.

↳ Can only run 1 mile (1.6 km) at a time

⟶

④ SmartBall

- Free-swimming foam ball with sensors inside. (aluminium alloy core; shell → foam)
  - Acoustic — leaks and gas pockets
  - Gyroscopic + magnetic → leak location and pipeline mapping
  - Temp
  - Accelerometer
- Periodically emits "pings" for above ground tracking/localization
- Can detect pipes diameter 8 inches or greater
- Works in all different types of pipes
- Needs extra things (such as motors) to inspect lengthy pipelines.

⑤ RAMP

- Research concept
- So basically it's just an add on to existing robot systems but improving localization with RFID. (search it up)

→

How to improve things:
↳ According to this paper.

↳ Read that part of the paper

Questions to asu proffesionals

↳ What are the most important metrics you use to test your robots?

My personal testing metrics:

↳ How well it can traverse different pipe sections ↱ Fluid dynamic simulations

↳ DEPENDANT ON pipe type!!!

↳ How well sensors work.

↳ So figure out which sensors are most needed and like if there are sensors that can do another sensors job.

Novelty Claim

↳ Cost

↳ Static/Dynamic hybrid (on paper)

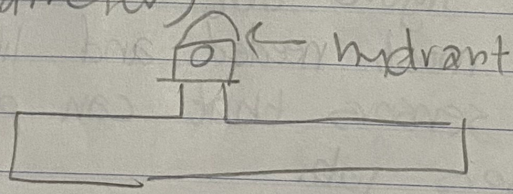
↳ Acc

My novel contributions in this project

1. Make it so it is
   - Easy to put into mains
   - Easy to retrieve out of mains

target
↑
2. Smaller diameter pipes (OR EVEN BETTER: A system that can go from really small to really big pipe systems.
3. Better sensor integration
4. Have a static/dynamic hybrid ("hub" system).

Access point: Fire hydrants (approx $2\frac{1}{2}$ inches — $4\frac{1}{2}$ inches in diameter)



January 21st, 2026

↳ Watched a webinar on how to craft a good research topic.

NOTES:

Q. What makes an idea research-ready?

① Well-defined
- ↳ Makes sense in communicating to the general science community
- ↳ Understand definitions in pipeline stuff.

② Focused
- ↳ Clear direction
- ↳ Choose ONE angle to explore deeply

③ Feasible
- ↳ Doable within a timeline

④ Relevant

⑤ Presentable
- ↳ Understandable content

Q Does your research idea have to be very unique?

It is okay to use existing work, BUT you must BUILD on it.

"Incremental Contribution"

You don't need to have a TOTALLY novel project heading in.

Q. How do you ensure that you are not duplicating research?

- LITERATURE REVIEW
  - Just keep on reading current research.

Q COMMON MISTAKES?

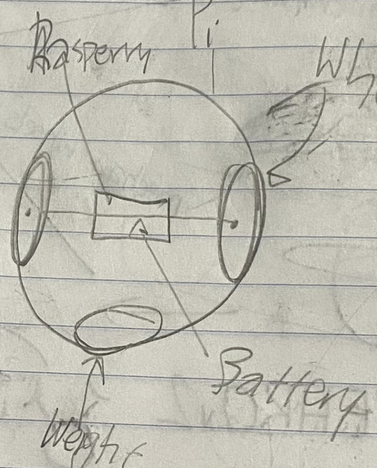
- Trying to do to much at much
- Optimizing for "impressive" instead executable
- Skipping reading and assuming novelty.

Inspired by the SPHERO

HOW TO: Build the spherical robot.

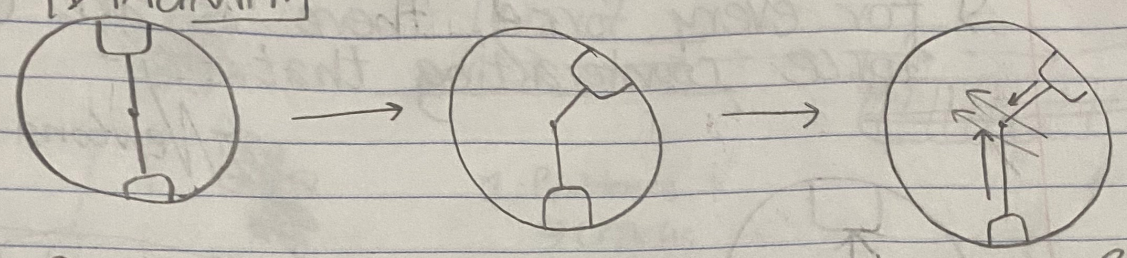
Name: ESP-Roll

USED: Flux- PCB Design software
↳ I want to learn this too!!

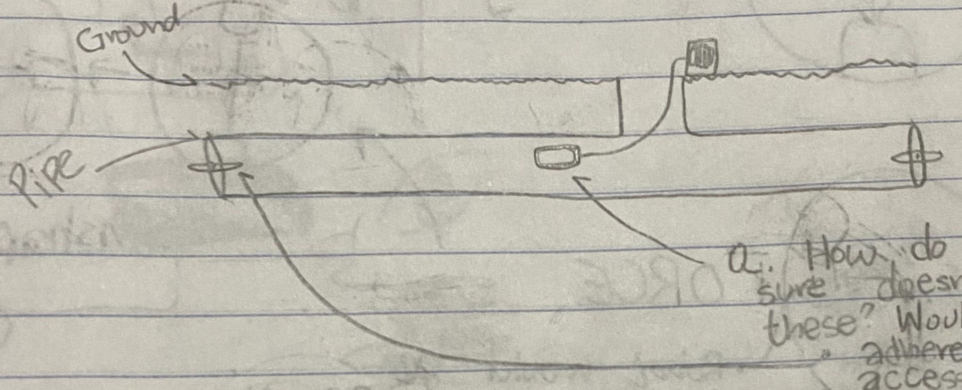


Questions:

DIAGRAM:



Q. Why does this happen? What is happening?



Q. How do we make sure doesn't touch these? Wouldn't this not adhere to my accessibility objective? (More personell needed)

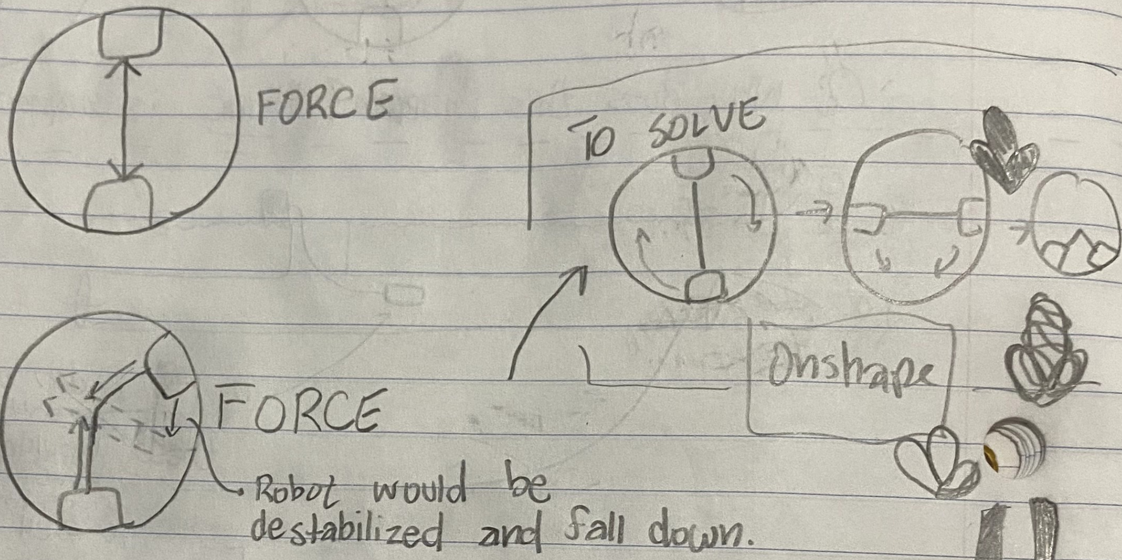
↳ OK actually this really depends on the pipe type.

ALL ABOUT DIFFERENT PIPES

Understanding why the "vortex" design doesn't work.

F=ma

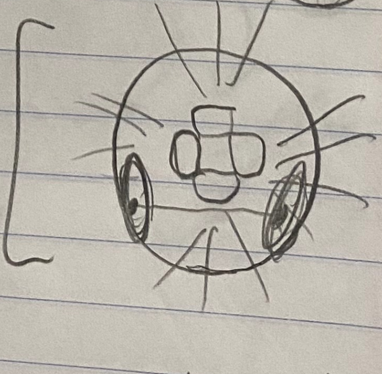
For every forse, there is an equal force counteracting that.
-Newtons law.



BUT this idea, overall is too bulky and complicated and might take too much time.

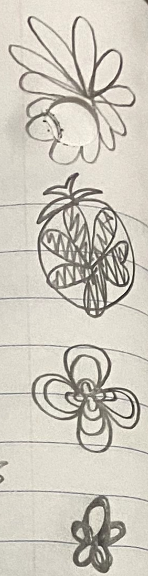
[Rasberry Pi
↳ w/ wifi module.]
↳ Batteries
↳ IMU.

[Work on robot design



today.
[look into current solutions]

From: Slingshot Challenge Webinar

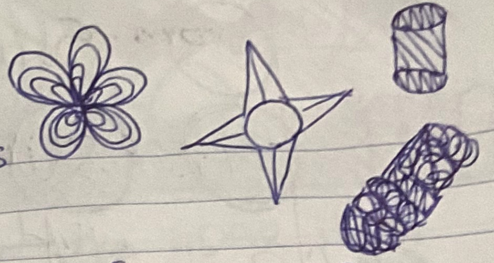


Videomaking Tips

↳ Film in Natural light
↳ Center people and your community
↳ keep audio clear and natural
↳ Add captions
↳ Leverag motion to guide the viewer's eyes & attention
↳ Use music to support emotion
↳ Always think in the audience's perspective
  ↳ Show family or friends video to get feedback on confusing parts.

Storytelling Framework:

1. Hook
2. Problem
   a. Background info.
   b. Stats.
   c. Exigence (connecting your specific niche to the bigger, overall issue.)
3. Solution
   a. Goal/Mission statement
   b. Inspiration - NatGeo explorer (Slingshot challenge specific)
   c. Course of action
   d. Resulting impact
4. Forward looking conclusion



Types of pipeline faliures

1. Leaks
   - ↳ Caused by corrosion, joint faliures, or cracks

2. Bursts
   - ↳ Caused by excessive pressure or lots of deterioration.

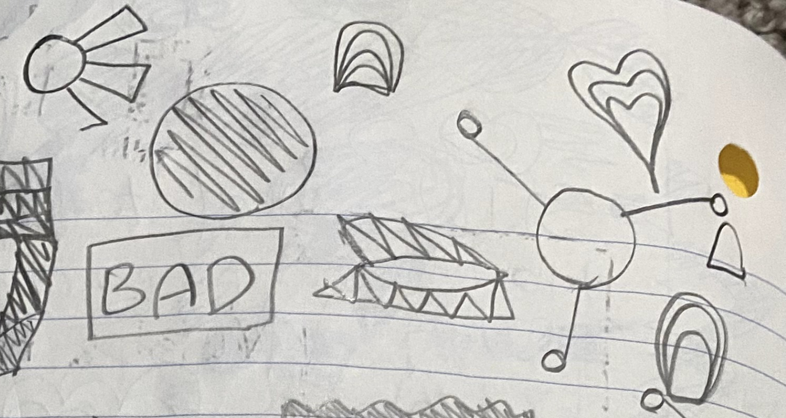
3. Corrosion
   - CAUSED BY ↳ Moisture, chemicals

4. Joint faliures

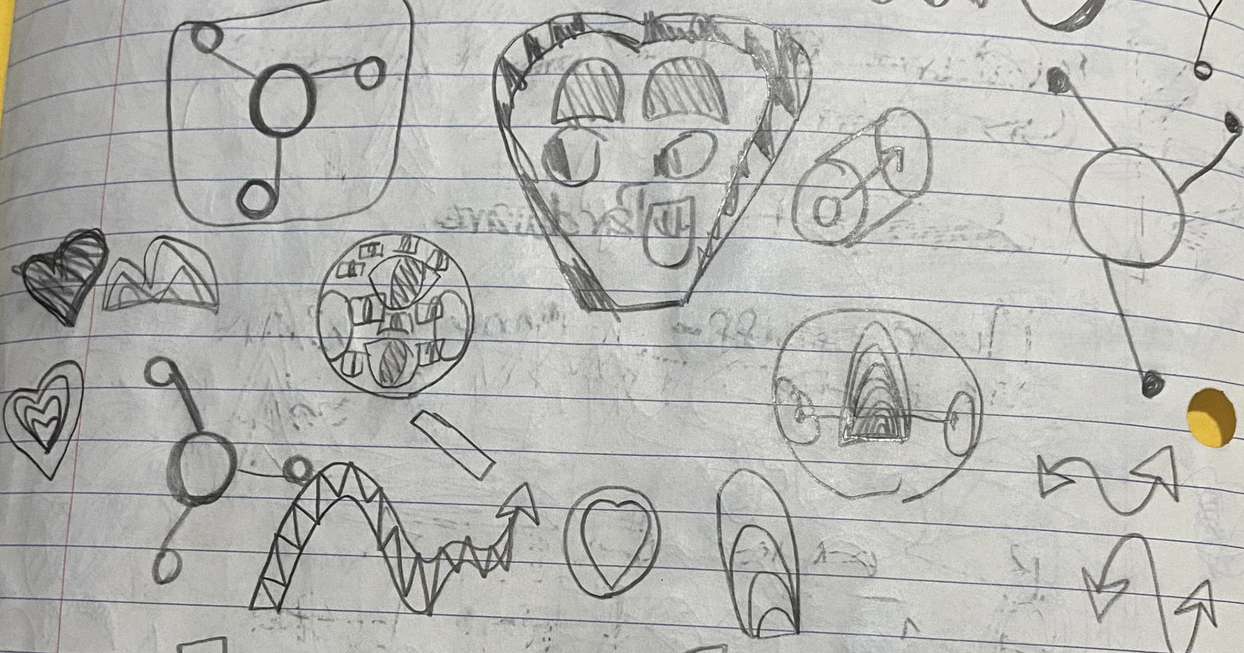
5. FIGURE OUT, reason for ~~Jan~~ December 25 Pipe burst - calgay.
   - ↳ High Chloride levels in the soil.

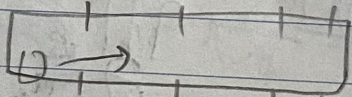
idea #1

BAD

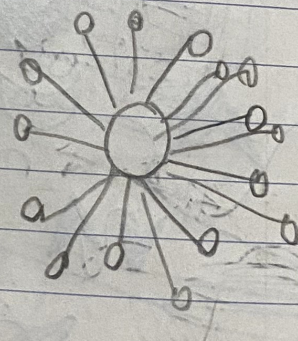


↳ Operating conditions: Live main





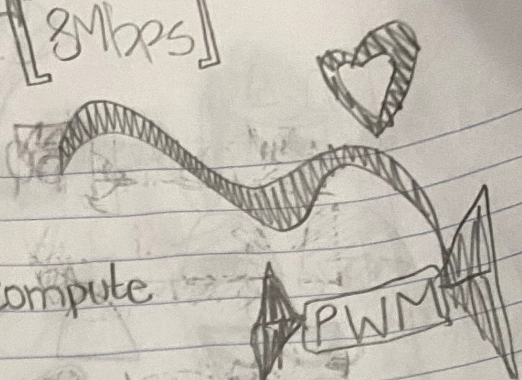
Sample rate
is low at
such a high
pressure.

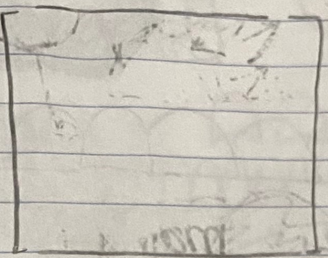


- Sonar doesnt have very high accuracy.

turning ← - Stereoscopic vision for depth
  └ two cameras | perecisia / Diy version
  Photogramitry.

[ ] [8Mbps]





Visual compute

These are different!

Raspberry Pi] — Computers (small)
Jetson Orin

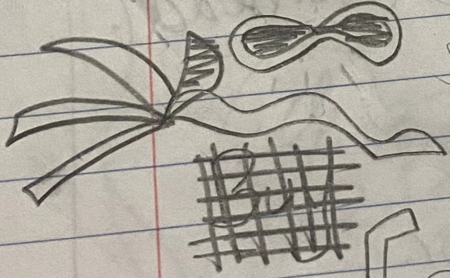
Arduino] — For Hardware

Motor stuff — Arduino] CAN protocol to communicate between two devices.
Visual stuff — Jetson

Brushed vs Brushless.

Brushed
└ From Stallery

Brushless
└ Way better
└ BUY these ones
  └ and a motor controller for it.



Stereoscopic C

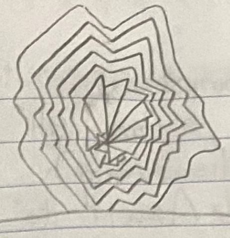
[2] [CAN 2.0]

slow

[SPI
I²C
UART

Other's:

1. Whats broken/Why it matters



Plan

1. Abstract
2. Introduction
   (a) Inspiration
   (b) Problem (The current issue) – Magnitude, environmental impacts, etc.

BRIEF

   (c) Background research
      (a) How pipes system work underground — Water Pipes only
         (a) Pipe types, materials, etc.
      (b) Main causes of pipe breakage / types of pipe breakage
         (a) FORMAT: Type of pipe breakage THEN main causes of it. – Just write statistics on how often these happen.
      ~~(c) Why this technology is important / The future of infrastructure robotics~~
      (c) Literature review on state of the art systems
         (a) With limitations after each section
      (d) Written above (↑2)
   (d) Project scope and objectives and problem statement (process-based question)
      (a) Be clear | summarize limitations and introduce your novel angle
3. Materials and Methods
   (a) Chassis design iterations
   (b) Sensor design iterations
4. Analysis
   (a) Analysis on chassis design iterations
   (b) Analysis on sensor design iterations
   (c) Analysis on the robot as a whole
5. Conclusion
   (a) Discussion
   (b) Project limitations / future work
      (a) Show how you are going to mitigate these / how you already are
   (c) Project applications
   (d) Concluding statement
6. Bibliography

For these sections, look at winning CWSF and CWSF [illegible] (and Anish Rathod) projects to improve

Hilroy

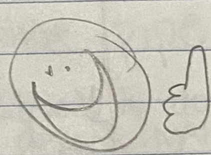
Jan 6th, 2026

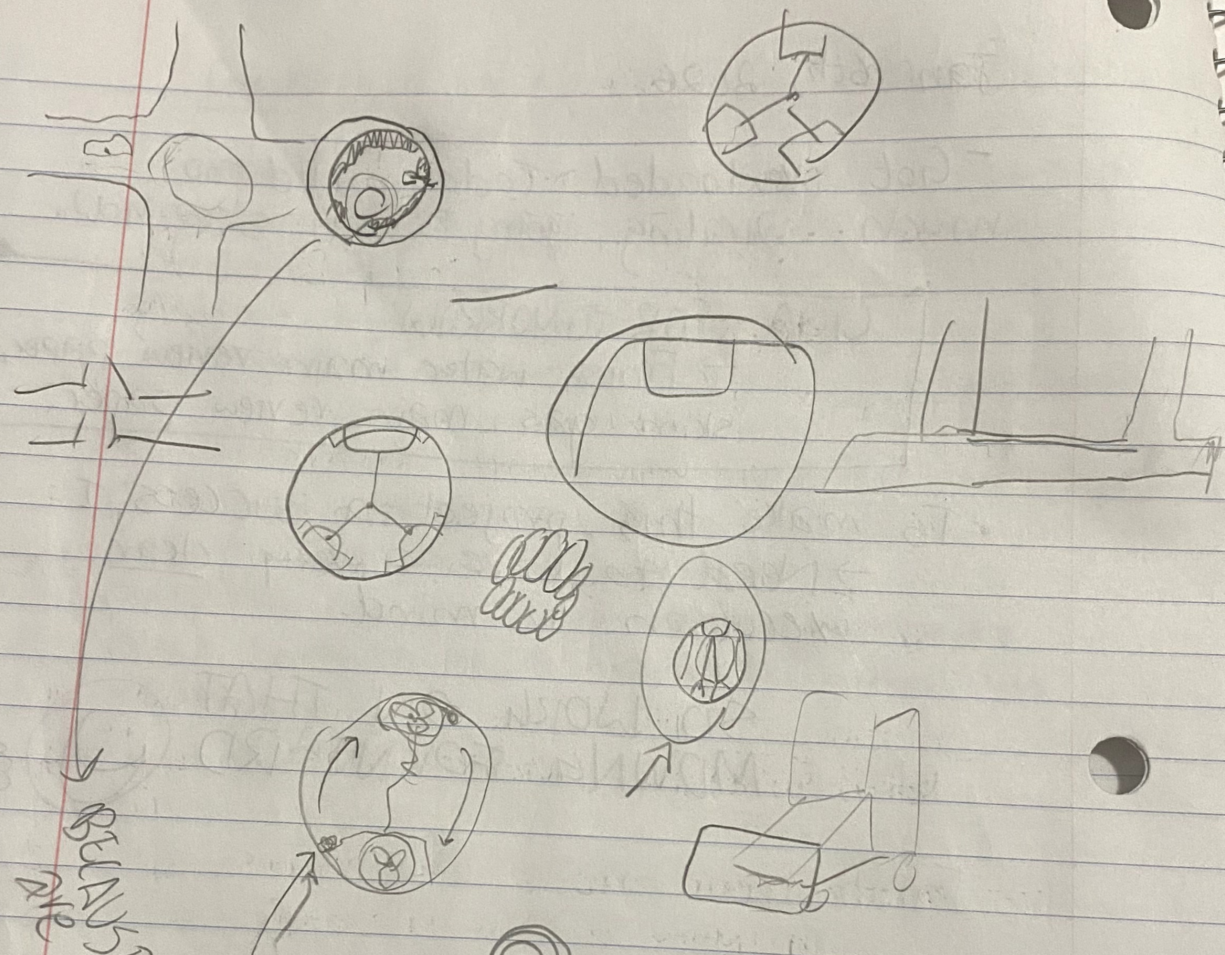
- Got overloaded today, did too much spiraling, going to get sleep now.

GOAL FOR TOMORROW:
→ Finish water main review paper, skim gas main review paper.

- To make this project a success, I:
  → Need to have a very clear execution in mind.

SO WORK ON THAT MOVING FORWARD.



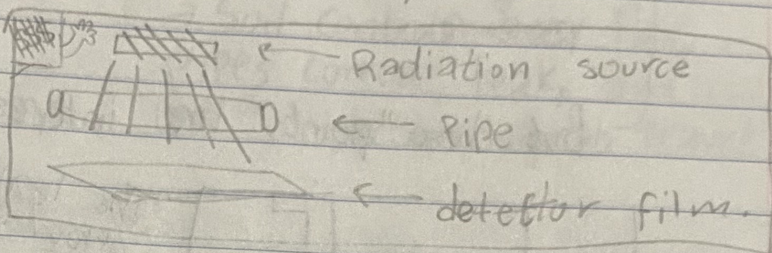


BECAUSE
are dirty pipes I can
use these circular
motors
as the

OTHER TECHNIQUES

(a) Radiographic technique

↳ An interesting method that emits gamma/x-ray through a tube and sees how a detector captures light intensity.

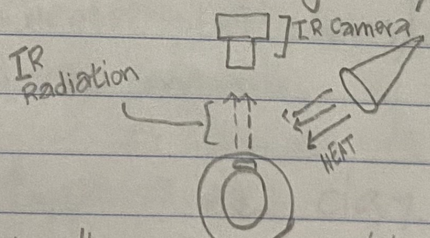


↳ But, as you can see, not only is it dangerous, but also expensive and not practical.

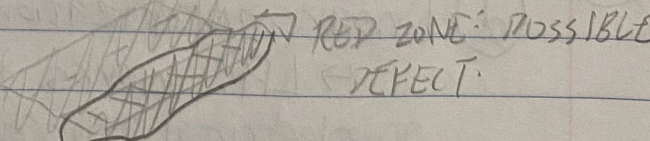
(b) Thermographic technique

↳ Detects thermal anomolies through 2 main methods:

[1] Active thermography: Excitation to find decay rate of temp.



[2] Passive thermography: Literally just viewing subsurface with a heat camera to see anomolies.



·Why? Because if a pipe bursts, then the surrounding soil is affected, creating distinct soil patterns. PROBLEM (w/ active): Environment? but maybe not too much.

Hilroy

(e) Soil characterization

↳ An indirect monitoring technique that looks at soil samples.
Because:
→ Soil controls how fast pipes corrode, leak, and how well inspection signals travel.

PROPERTIES:

[1] Soil resistivity: How easy electrical current can flow through the soil.
Low ress. → High corro. risk
high resis. → low corro. risk.

[2] Moisture content, → Higher moisture = more aggresive corrosion

[3] Soil chemistry (pH, ions) → Acidic soil accelerations corrosion.

[4] Soil type → ex. clay is bad, sand is good.

(f) Close internal survey

→ Calculates voltage between pipe and surrounding soil. If very negative, that is good. Used to see how well cathodic protection is working.

Jan 14th, 2026

- Understanding state of the art static systems.

① MISE-PIPE

- Inside / Outside pipe sensors
  - Inside:
    - Pressure
    - Acoustic
  - Outside:
    - Soil properties

Sensors combine data to make predictions ~~and send to a~~ base station.

↳ Problems: Power, reliabity, maintenance, complex (kinda), no real-world deployment (room for development)

- How do these static systems communicate with base stations if Wifi/Bluetooth gets absorbed by soil, water, and concrete? So they communicate with magnetic fields, which pass much more easily. [MAGNETIC INDUCTION]

② PipeNET

↳ More practical than MISE-PIPE
↳ Inside sensors
- Pressure - hydraulic changes
- Accelerometers - vibration
- pH sensors - water quality

↳ Collects lots of data, very fast

↳ Problems: Power hungry, low communication underground, hard to scale.

NOTE: Accelerometers are attached onto the pipe line in some static systems (LeakFinder/PipeNET) where they can feel vibrations and those come from leaks

③ Leak Finder

↳ Real-world mature system
↳ Just like how correlators work, finds leaks via hydrophones
↳ Industry gold standard

④ Permalog / Perma NET

↳ Small acoustic loggers on valves/hydrants
↳ They listen mostly at night
↳ Due to it being quiet and high pressure
↳ Problems: Struggles on plastic pipes.
↳ They are durable and robust, and specifically designed for easy installation in more challenging areas.

⑤ Smart Pipe

↳ Non-intrusive pressure monitoring system that sits on the outer edges of the pipe
↳ When pressure of the pipe changes, it deforms slightly, and this detects that.
↳ Easy installation, no pipe access required
↳ PROBLEM: Indirect measurement

⟶

⑥ FIDO AI

↳ Software only

↳ You already have the acoustic files, vibration data, and sensor logs, now you upload them to this service and AI compares the before [vs] after and gives a leak likelihood and confidence score

↳ Self explanatory for problems (hopefully)

· Understanding state-of-the-art dynamic WPMS. (interchangeable)

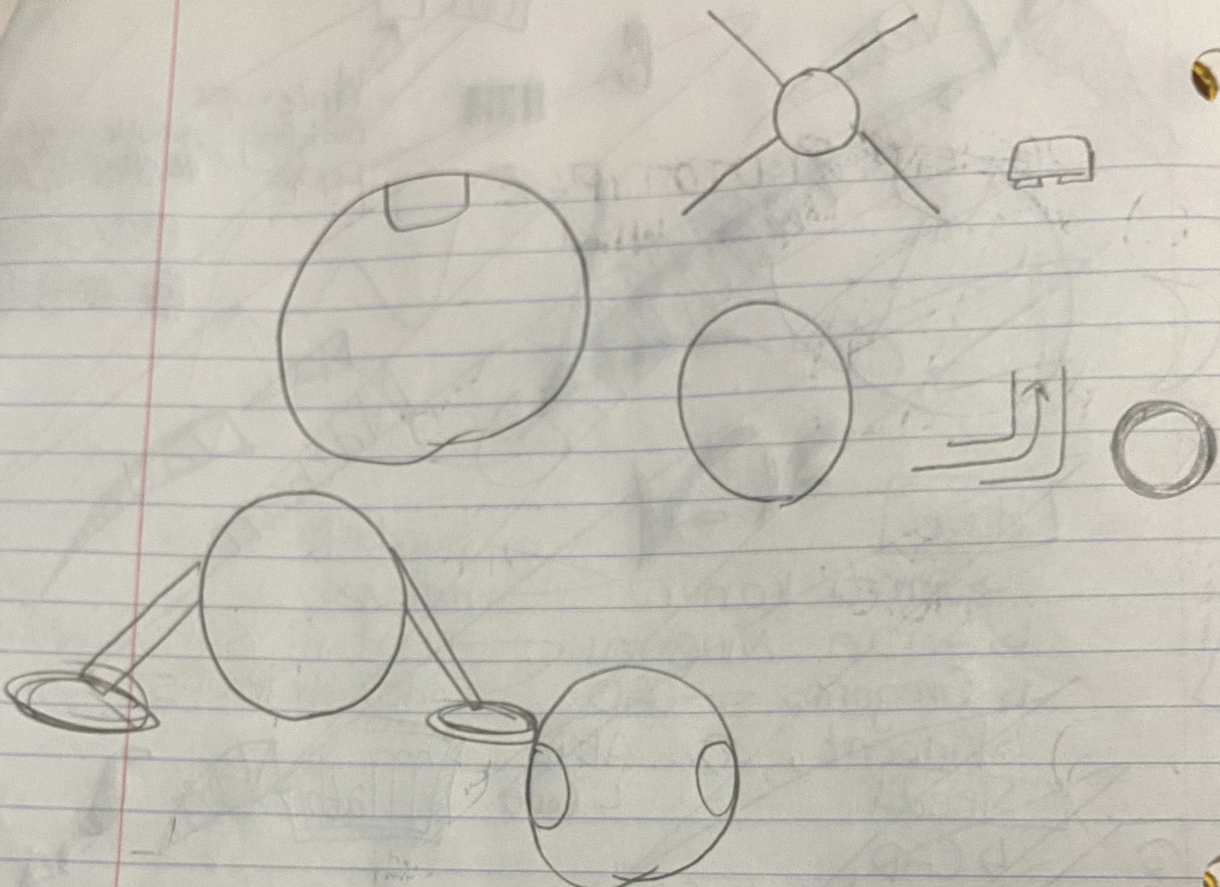
① Pipe Probe

· A capsule ("sensor droplet") that floats with the water flow to map the 3D layout of Pipes. "hidden"

· How it works

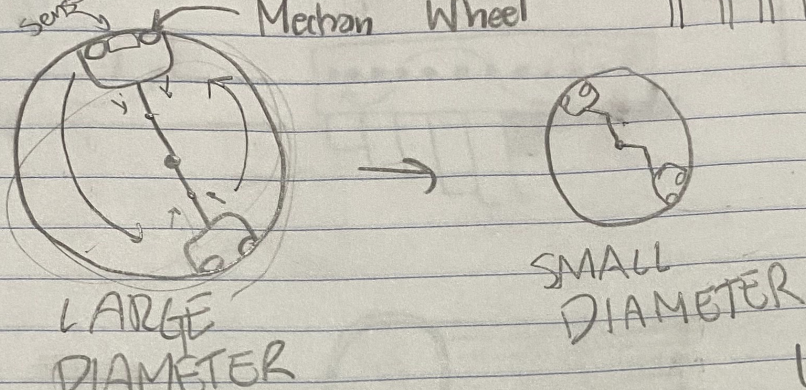
1. Insert capsule into pipeline
2. Pressure sensor records height
   ↳ Pressure increases when low
3. Accelerometer detects motion lon and the robot infers turns and geo
4. 3D profile is created!

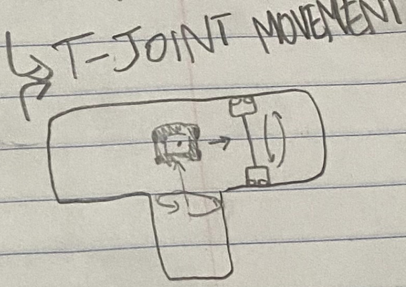
↳ But accelerometers can't detects cracks and leaks here, only the general geometry of the pipes.



DESIGN PROTOTYPES

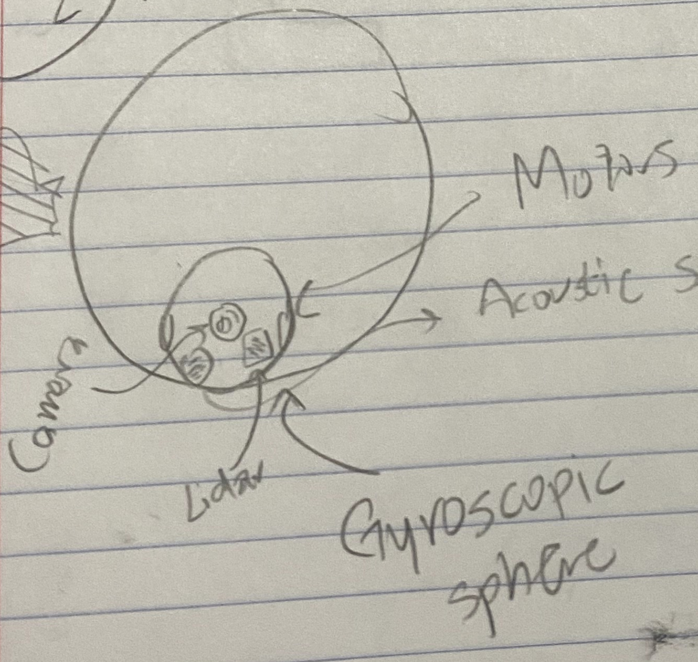
1

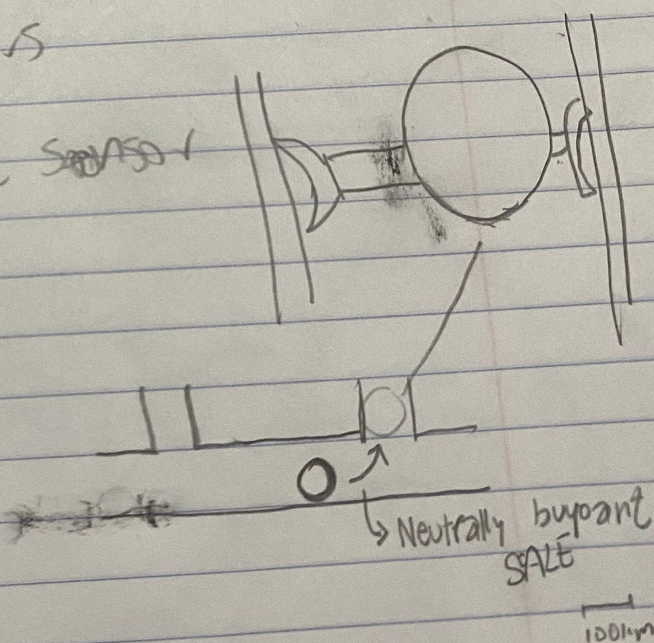


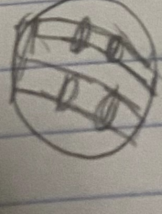


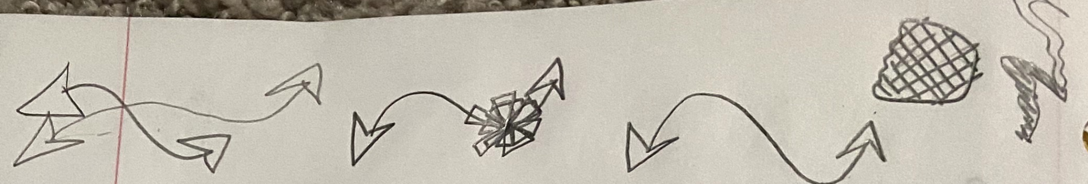
2. SPHERE ROBOT

Eddy

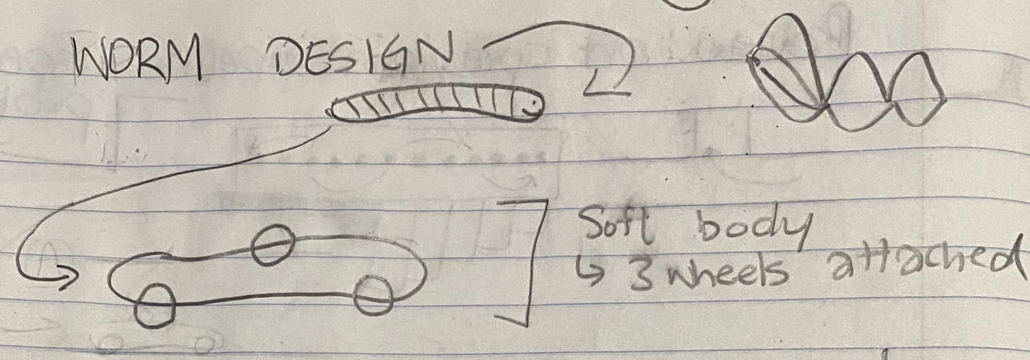




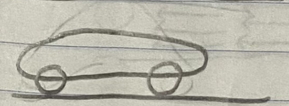




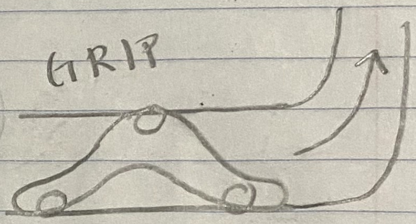
WORM DESIGN

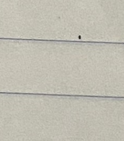


A MOVING



(B) GRIP



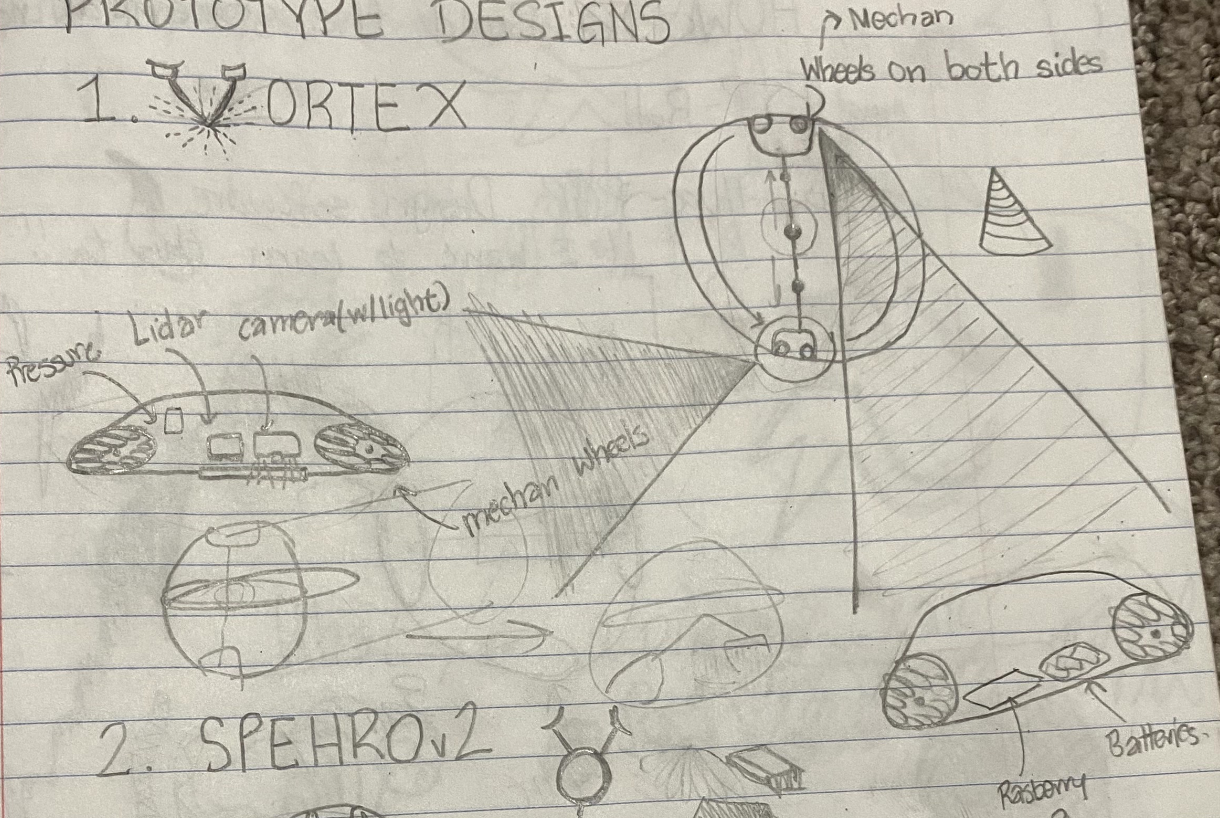


1pm

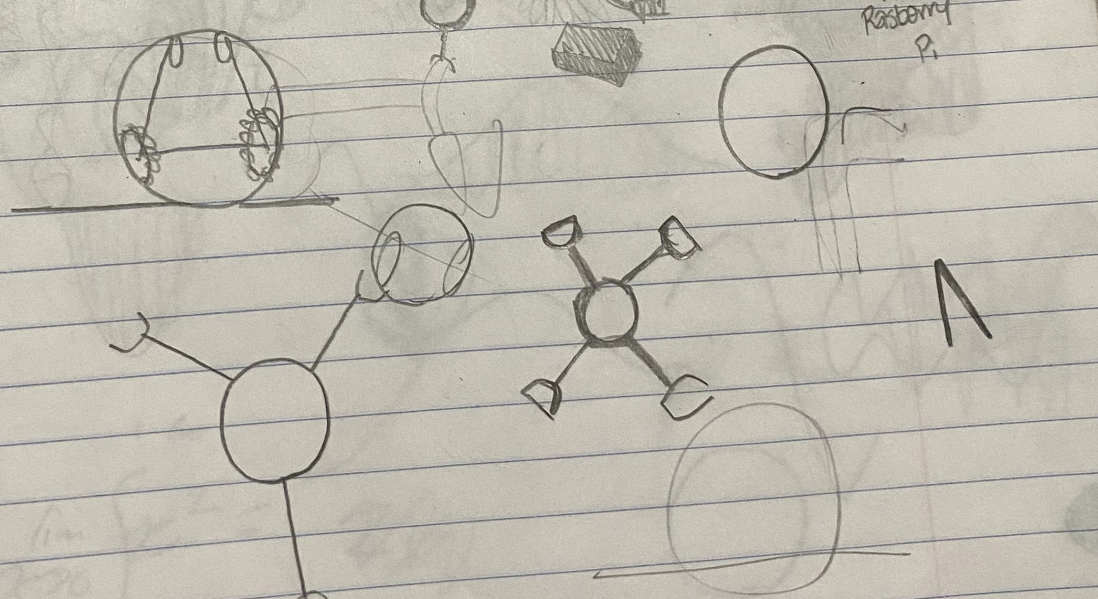
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6

PROTOTYPE DESIGNS

1. VORTEX



2. SPEHROv2



Feb 1st, 2026

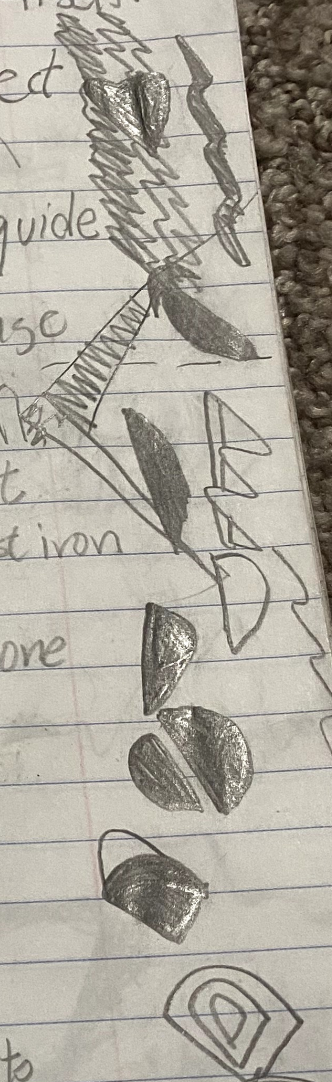
LiDAR

Creates a "Point Cloud"

the LiDAR itself.

Uses satellites and imu to detect X, Y, and Z coords.

TO DO: Get chat to give a full overview + a guide on how to choose the best sensor
↳ Notes on back of page



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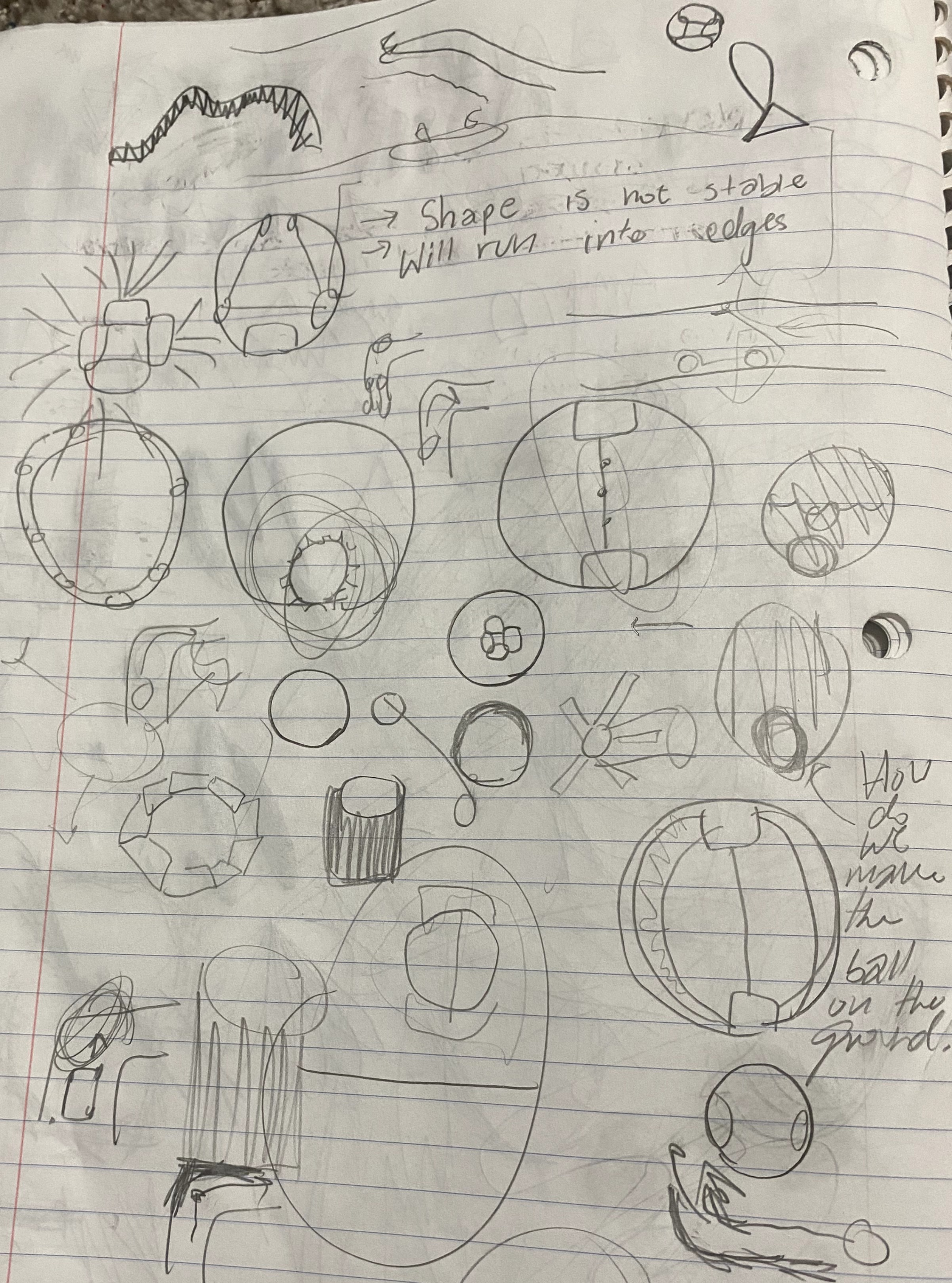
Summary of last page notes:

1. For testing: Buy PVC pipes and just say it works the same way as cast iron because:
   (a) Cracks are not exclusive to one material of pipe
   (b) Cast iron is more expensive, harder to find, and harder to stimulate test environments in.
2. Sensors I have finalized on
   ↳ LiDAR (main)
   ↳ Camera (for now, it's just to show to judes how my robot works, but it has the possibility to integrate AI/CNN technology.
   ↳ Pressure/temp. (You can try buying these, especially a pressure sensor, but they not be as it.
3. Focus on pipes 6-12 inches (most vul-nerable).
4. Buy Raspberry Pi microcontroller (but see if the same sensors work with a Jetson Orin Nano.


→ Shape is not stable
→ Will run into edges
How do we make the ball on the ground.

Encasing

↳ Silicone O-ring & epoxy

IMU + GPS: — you can make a pre-determind map.

~~Wifi~~

↑

ESP 32 C-3 (wifi, bluetooth)

~~Arduino~~

↑

Teensy 4.0 or 4.1

IMU ✓DONE

MCU ⟷ [CAN Protocol] ⟷ Jetson ORIN Nano ⟷ Stereoscopic Vision ↳ Multiple camera's?

Lighting system

PWM

Motor (2) Driver — [I2C & UART] depends on the MCU.

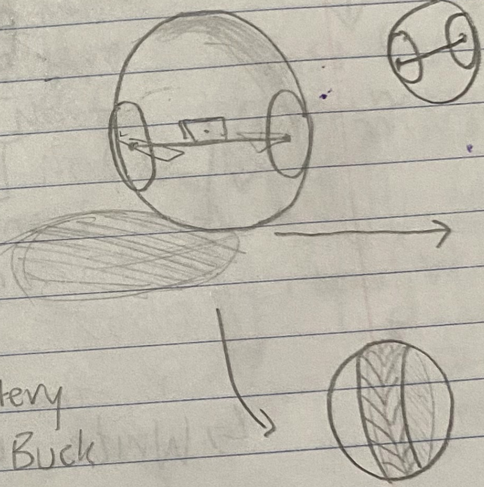
Brushed (cheap)

↑

Brushless DC motor

High Power output

Motors w/ wheels (2-4)



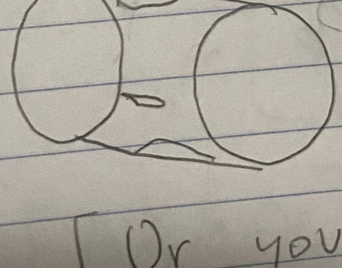
[Power system??

↳ Need help in understand how this works and how to design the system.

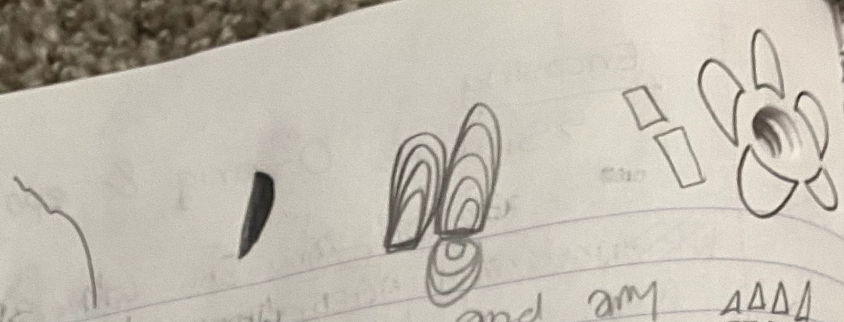
↳ 2S or 3S Li-ion pack, Battery managment System (BMS), Buck converters]

[Tomorrow, bring sphere and more questions!] (Build robot there.)

[TPU]
[Filament that acts like rubber]

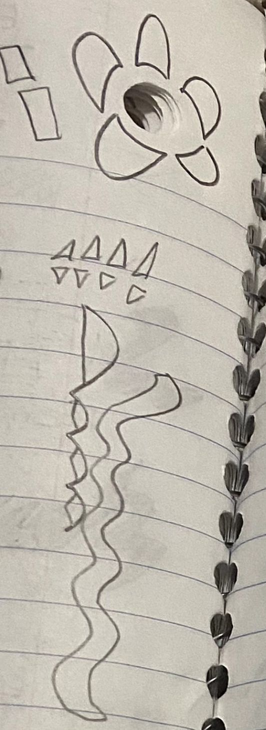


[Or you could capture acoustic audio → microplastic.]

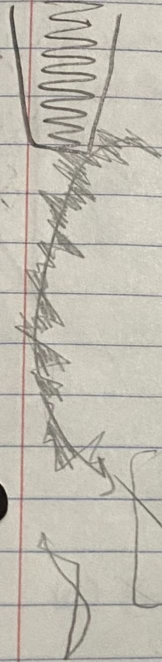


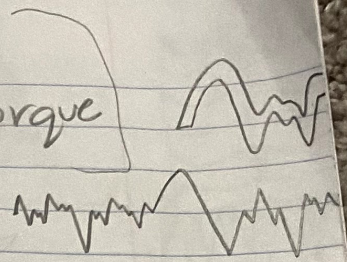
↳ Plan for tomorrow
↳ Bring sphere chassis and any other materials - 1st to school then transit ASAP (like 2:00 pm) to Solarbotics
↳ Bring your questions! :)

What to do today:
↳ Finalize robot schematic and make sure microcontroller works with everything.
↳ They don't have everything so only buy what they have in stock
✓ [↳ Ask Papa to increase money in bank account BMO ($100).]
↳ Figure out how everything about this works, as well as the power system.
↳ Write up in the report



- Instead of a high speed motor, I need a high torque motor





↳ [50:1]

5V → Amps → Power

TO BUY
- TPU filament

V= Potential energy

R= resistance

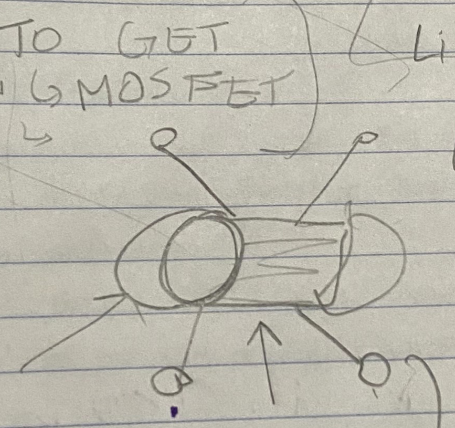
Amps= flow

FIGURE OUT
- How power system is going to work for all of this.

TO GET
↳ MOSFET
↳

Li-Po

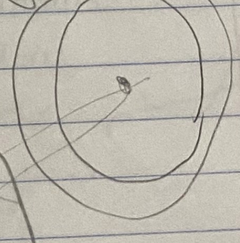
Just for right now, use PLA at home.



W

5V- is important

- Home depot
↳ PVC



Buy this and some cheap online

$V \cdot I = W$

IR=

[AC → DC] BUY
↳
120V
^

soldering iron

current

E / I R

voltage

resistance