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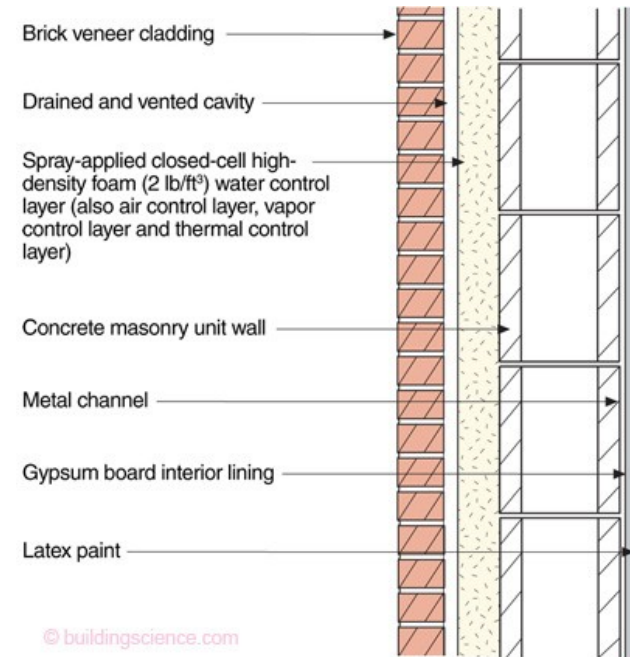
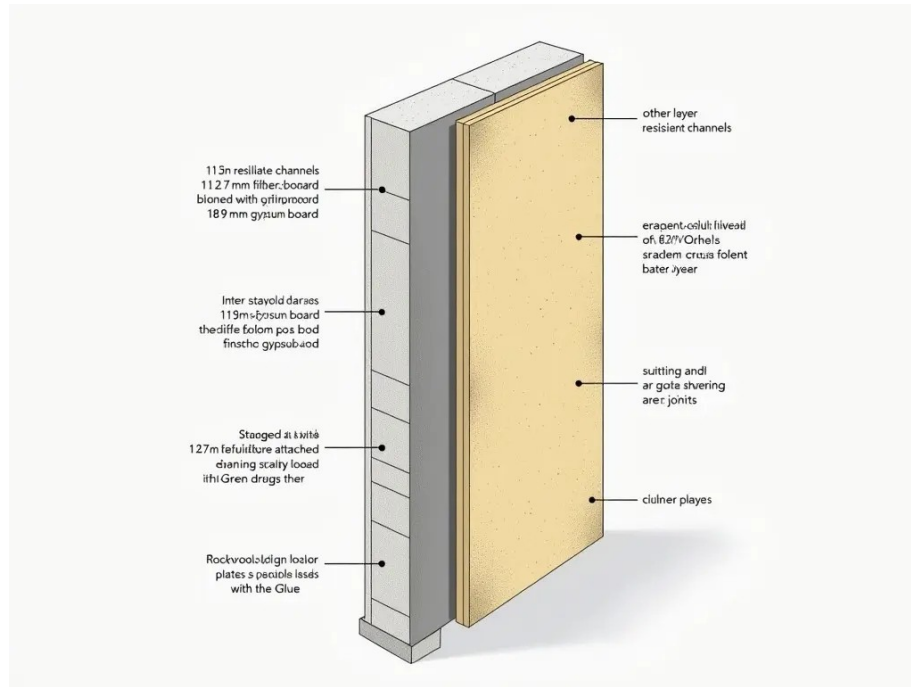
CRACK DETECTING ROLLER

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Introduction

- This project aims to address an innovative ultrasonic-based crack detection system to identify internal cracks early and prevent structural failures.
- Cracks in the inner walls of structures, especially those invisible to the naked eye, pose serious safety risks and maintenance challenges.
- Existing inspection methods often require manual effort, are time-consuming, or fail to identify hidden cracks.

Wall Structures and its layouts



- Scope

Many cracks, including micro-cracks and subsurface ones, are often invisible to the naked eye, making it difficult for traditional methods to determine their severity, leading to unnoticed propagation, higher costs, and potential safety risks.

- Aim

To design an innovative roller-based device capable of detecting inner wall cracks efficiently and reliably using ultrasonic technology to improve structural safety in industries like construction, manufacturing, and civil engineering.

- Objective

To address the interior damage promptly to prevent significant structural complications.

To enhance the efficiency and productivity of construction work.

Market Study



Product Name	Cost	Accuracy	Aesthetics	Precision	Sensor Type	Time
Ultrasonic Flaw Detector	High (\$1000-\$5000)	High (sub-mm)	Compact, Portable	Excellent	Ultrasonic Transducer	Fast (Real-time)
Infrared Thermography Camera	Medium (\$500-\$3000)	Medium-High	Sleek, Handheld	Moderate	Infrared Sensor	Fast
Ground Penetrating Radar (GPR)	Very High (\$5000+)	Very High	Bulky, Rugged	Superior	Radar Wave Sensor	Medium-Speed
Rebound Hammer	Low (\$200-\$500)	Low-Medium (Surface)	Simple, Durable	Low	Mechanical Impact Sensor	Fast
Pulse Velocity Tester	Medium-High (\$1000-\$4000)	High	Portable, Durable	Excellent	Ultrasonic Transducer	Medium-Speed
X-Ray/Radiography Tester	Very High (\$10,000+)	Extremely High	Bulky, Industrial	Superior	X-Ray or Gamma Sensor	Slow

Commerical Products



Pulse Velocity
Tester



Infrared Thermography
Camera



Ultrasonic Flaw
Detector

User Study



Lime Slurry
Application



Whitewashing
Observations



Natural Indicators (Plant
Growth)

Persona & Scenario

1) Tapping and Listening

"Well, tapping and listening sometimes seems intuitive, but very subjective. You don't feel the difference unless you experience it between the hollow sound and normal vibrations. Moreover, tapping of vast areas is tiring to do manually, and deep cracks might be left untouched."

- Vinod Shanker, Palode, TVM-13

2) Application of Lime Slurry

"Lime slurry application is easy and shows cracks very well as it soaks into them, but messy and not suitable for glossy or painted surfaces, besides being time-consuming, it works only on surface-level cracks."

- Joyi Anthony, VTK,TVM-13

3)White washing Observations

"Whitewashing helps reveal cracks when the whitewash is dried off, though it's a preventive process rather than a detection. In case of painted walls, this cannot be employed unless you're willing to repaint as well."

Shanker, Palode, TVM-13

- Vinod

4)Mud Plaster Techniques

"This is very good for traditional homes with mud walls, but not applicable in modern construction. Also, this cracking detection method highly depends on the skill of the plasterer, making it inconsistent."

Anthony, VTK,TVM-13

- Joyi

Ideation

To use ultrasonic sensors to identify subsurface cracks within walls, offering a modern, non-invasive solution to structural health monitoring.

Design based on “Paint Roller” to be portable, efficient, and easy to operate, making it accessible for on-site inspections without requiring extensive technical expertise.

By enabling early detection of hidden cracks, the device helps prevent structural failures, reducing repair costs and improving safety in construction and maintenance.

How does it work?

Ultrasonic Principle

Ultrasonic sensors operate by emitting high-frequency sound waves (above 20 kHz) through a piezoelectric transducer.

When these waves encounter an object or surface, they are reflected back to the sensor.

The sensor measures the time taken (Time of Flight - ToF) for the sound waves to travel to the object and return. The distance between the sensor and the object is calculated using the speed of sound in air:



$$\text{Distance} = \frac{\text{Speed of Sound in Air} \times \text{Time of Flight}}{2}$$

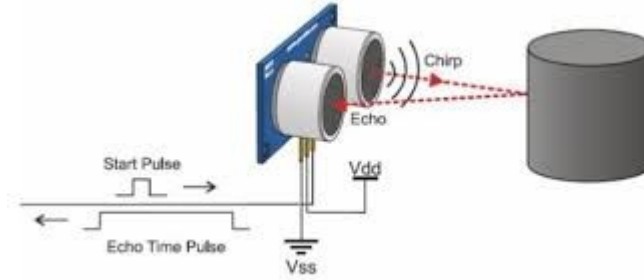
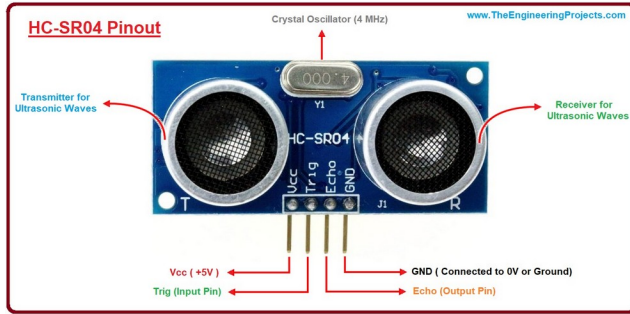
Accuracy Factors

- Surface Characteristics: Smooth, flat surfaces reflect sound better than irregular or rough ones.
- Angle of Reflection: The sensor works best when the surface is **perpendicular to the sound waves**.
- Environmental Conditions: Temperature and humidity can alter the speed of sound, affecting accuracy.



When ultrasonic waves encounter cracks, voids, or material discontinuities, the reflections are scattered or attenuated.

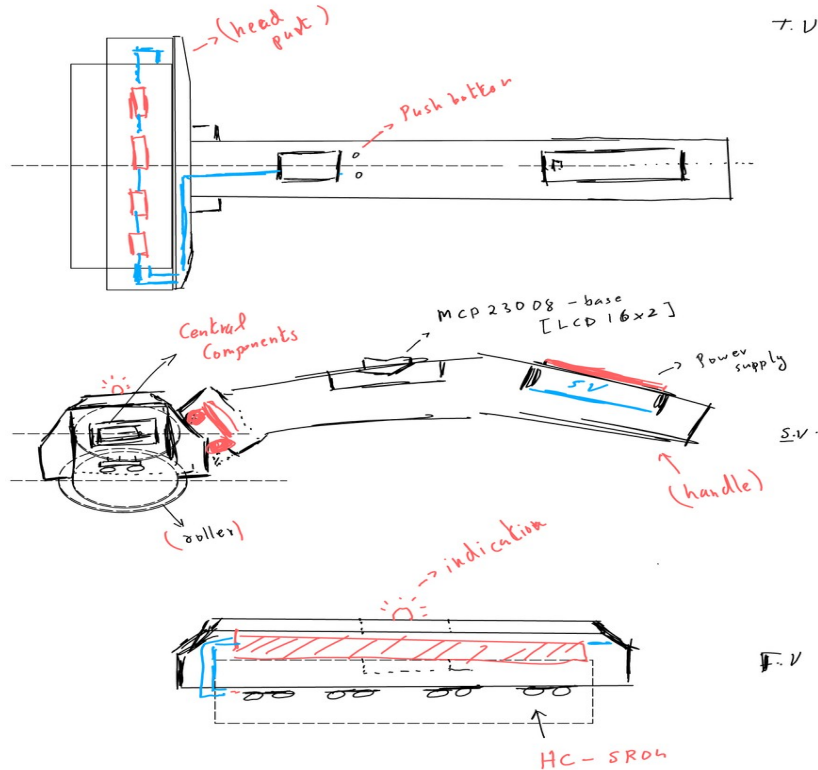
- Ultrasonic sensors like measure distances ranging from 2 cm to 400 cm, with a typical accuracy of ± 3 mm.
- These sensors are ideal for detecting structural anomalies, as they are non-invasive and capable of scanning large areas.



How do we estimate a crack ?

- First we input a valid measure for the crack detection , and add that with the radius of the roller in order to make the ranging precise. [Let 'x' be the distance and 'r' be the radius $\rightarrow \{x+r = \text{M.D}\}$]
- If the sensor detect a obsticale greater or lesser than the M.D, it well give indication of a crack.

Sketches



Crack detecting Roller;

Scope :: To make a roller that can detect cracks and alarm for larger one which may lead huge problem in future.

Aim :: To attach a Crack detecting Sensor inside a roller and give estimation on where there is a crack.

Components

- * HC-SR04
- * Piezoelectric Ultra sonic Transducers
- * Board parts
 - (1) L > Arduino Uno
 - (2) L > ESP32
 - (3) L > Amplifier Circuit L > MAX232
 - (4) L > Receiver Module L > AP620
 - (5) L > Signal Processing L > FFT Library
 - (6) L > 5V Power Supply

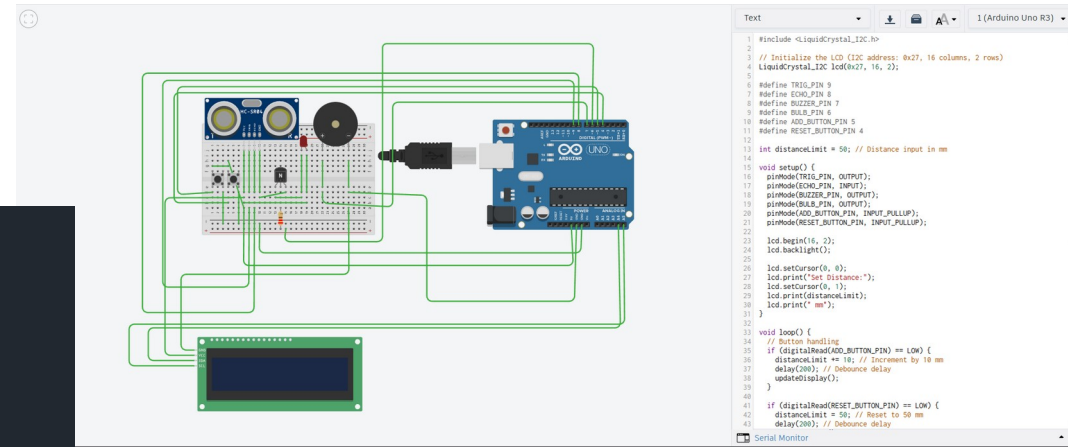
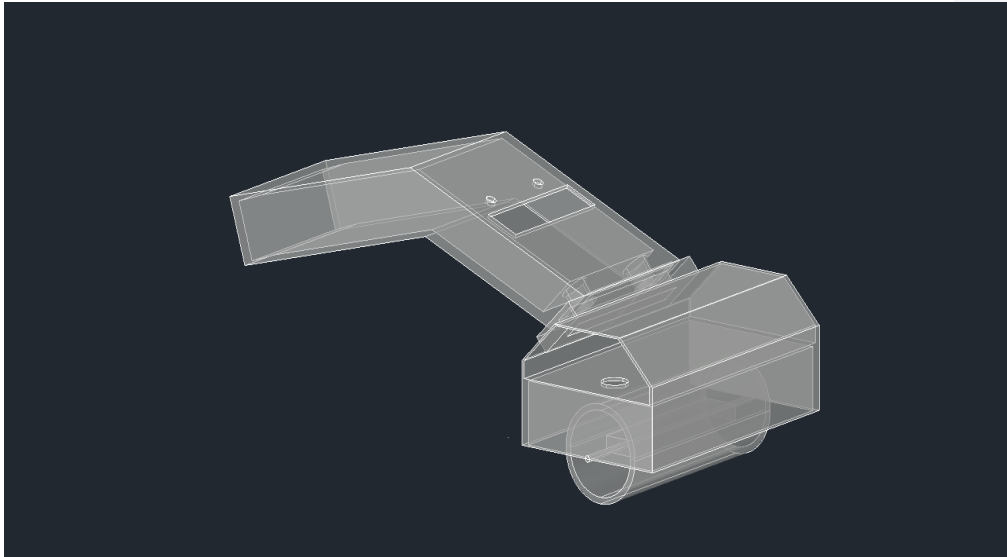
Concept Selection

Ultrasonic sensors provide a more reliable and versatile solution for detecting internal cracks in various materials compared to thermal and sound wave sensors.

- Detect subsurface cracks with high precision.
- Perform reliably in diverse environmental conditions.
- Less affected by noise, light, or temperature changes.
- Affordable compared to thermal imaging systems.
- Versatile for use across materials like concrete, wood, and metal.
- Require minimal post-processing compared to sound wave systems.

Prototype

The Prototype is still in progress.....



Conclusion

- The crack-detecting roller prototype, powered by cutting-edge ultrasonic technology, promises to revolutionize structural inspections with unparalleled precision and efficiency, setting a new benchmark for safety and innovation in construction.
- 1) Utilizes advanced ultrasonic technology for accurate detection of internal wall cracks.
 - 2) Offers a portable, affordable and user-friendly solution for on-site inspections.
 - 3) Eliminates the limitations of traditional methods by providing deeper insights into structural integrity.
 - 4) Holds immense potential to enhance safety standards and reduce maintenance costs in construction.

Thank you