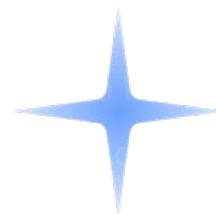




Listen AI Industrial

Deeply



Beyond Machine Vision: Machine Hearing



Visual inspection has been automated by AI,
but auditory inspection still relies heavily on humans in manufacturing.

Automated Visual Inspection



- ✓ Most visual inspections of PCB, wafers, etc. are already automated
- ✓ Widely adopted across large-scale manufacturing lines
- ✓ Market maturity, with an average annual growth rate of 6.4%
- ✓ Visual AI has largely replaced manual inspection tasks

Non-Automated Auditory Inspection



- 100% manual auditory checks for motors, speakers, connectors
- Dependent on human inspectors' ears for final inspection
- Large-scale manual inspection lines required
- Issues: shortage of skilled workers, costly training, inconsistency

Automated AI for Vision, Next Comes 'Listening AI'



- For PCB and wafers, visual AI has largely replaced manual inspection
- Auditory inspection remains an untapped area
- With growing awareness of on-site AI training and inference, and rising demand for new AI adoption, Sound AI solutions are gaining attention.
- Our case: Since 2024, inbound inquiries on Machine Sound AI have increased significantly

Human-Dependent Auditory Inspection, High costs, inconsistent accuracy

Pain point

3



Motors · Speakers · Smart devices

Manual auditory checks in manufacturing



Motors, Gears, Bearings

Client A: Full inspection after motor production, over 60 auditory inspection lines (anechoic chambers)

- Production downtime: 0.5 sec × 80 workers / 24 hr shifts
- Annual inspection cost: \$40M, replacing ~20 production lines

Client B: Full inspection after motor production

Speaker Devices

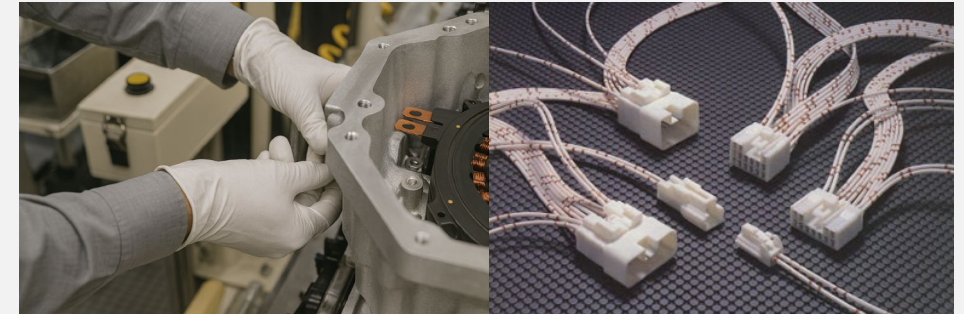
(Earphones, Mobile, Speakers, Microphones, Tablets, Smartphones)

Client C: One factory with over 100 auditory inspection lines (anechoic chambers)

Client D: Full inspection in speaker production lines

Connector fastening processes

From home appliances to automobiles, still reliant on manual labor



Connector Fastening

Client A: Loose connections during EV production halted entire production after assembly

Client B: Large-scale issues with “soft connections” identified at Hyundai Group exhibition

Client C: Washing machine connectors produced without proper fastening created noise defects

Global Market Trends & Growth

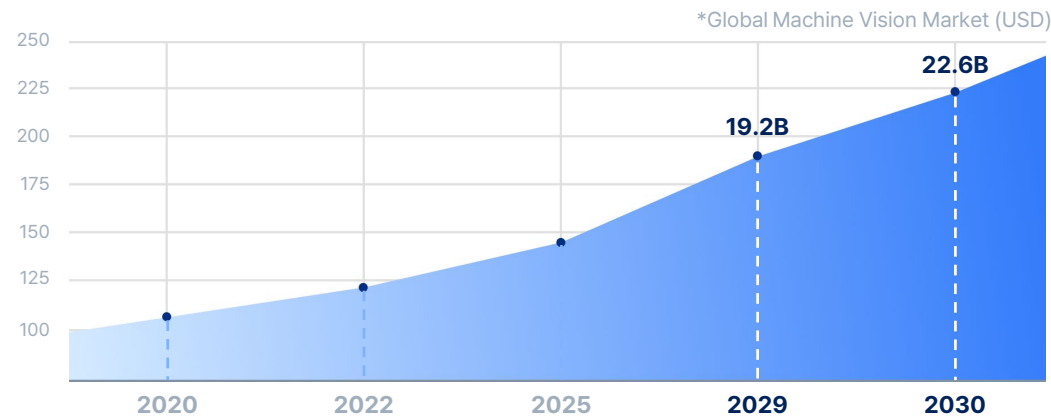
Global market trend

4



QC Alternative for Precise Machine Sound Analysis

Machine Hearing Market Growth Outlook(2020-2033)



1. Current Workforce Structure (Assumption)

- **Line count: 10 (example)**
- **Line FTE: 2.3–3.9 people (2–3 shifts)**
- **Total FTE: 23–39**

2. Annual Labor Cost (Based on 2025)

- **Avg. cost per inspector: \$0.5M per year**
 - Includes training, overhead, management, and turnover
- Estimated cost for 10 lines: \$10M+

3. Automation Benefits

- **Automation ratio: 70~90%**
(varies by on-site policy and risk profile)
- **Key effects:**
 - Reduced labor costs
 - Consistency and traceability in inspections
 - No line cycle-time bottlenecks

Labor cost savings: \$11.5M – \$19.5M

Global Adoption Examples

Hyundai Mobis – Acoustic AI

Building a sound-based quality monitoring system in the Changwon EPS plant

Volkswagen Group - Skoda

Developing an AI “Sound Analyser” for engine and component diagnostics, covering 10+ parts

Porsche - MHP

Developing AI-based acoustic inspection software “Source” to detect anomalies in assembly or EOL lines

Siemens

Providing integrated solutions combining vibration sensors with AI-powered sound analysis

Market Transition Trend

Machine Vision + Machine Hearing

Physical AI Auditory Inspection Solution: 'Listen AI Industrial'

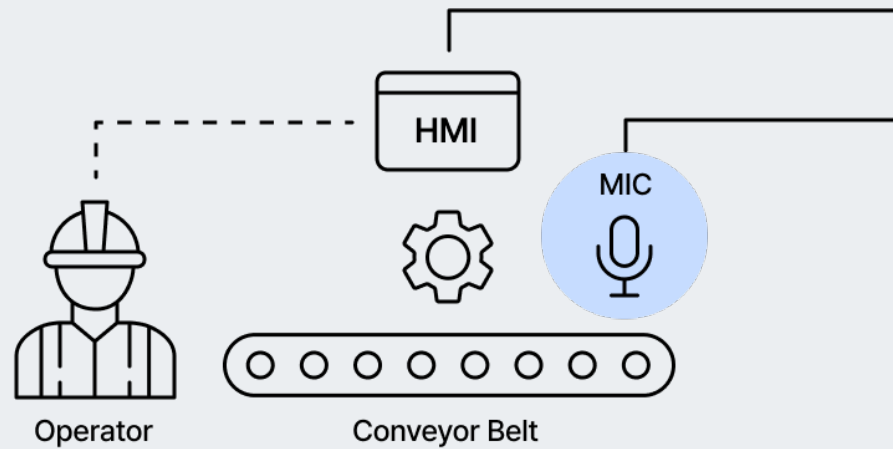
Our Solution

5



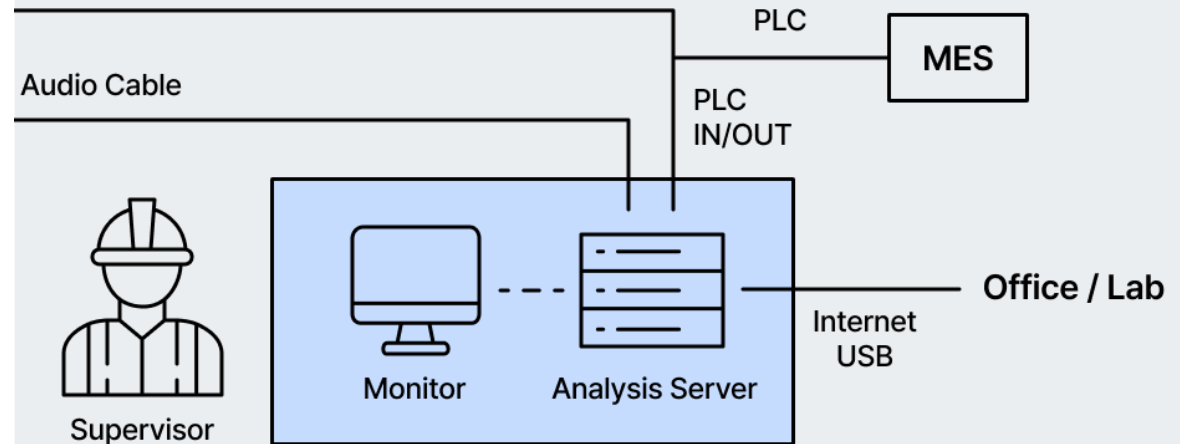
Solutions that Accurately Analyze Machine Sounds for Quality Inspection

① Anomaly Detection



- **Evaluate 20+ microphones** based on SNR, directionality, sensitivity, etc. to find the **optimal combination**.
- Ensure **high-quality data** that factory-specific AI can learn and infer from.

② Analysis & Management



- Real-time deployment of optimized AI models detection via dedicated servers.
- **Integrated with PLC (Programmable Logic Controller) systems** for data collection, model learning, and real-time prediction.
- Scalable to include vibration, ultrasonic sensors, etc. for various industrial applications including **PdM (predictive maintenance)** and **quality inspection**.

Customer Use Cases

PRODUCT

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Client A – Noise & Vibration Line: Sound AI Adoption (2025)



- Differentiates between normal and defective products (Factory H, Products A & B)
- Product A: Avg. 55 dB, detects normal/defective within 1.4 sec
- Product B: Avg. 40 dB, detects normal/defective within 0.4 sec
- Production line: Product A every 6 sec, Product B every 9 sec
- 30 auditory inspectors at this plant, 24h operation, two-week shifts

Product A

Normal



Defective



Client B – Noise & Vibration Line: Sound AI Adoption (2025)



- Transformer assembly inspection at Factory T
- Soft connection issue
 - LAN cable / connector not fully fastened
 - Human inspectors cannot differentiate; AI successfully detects
 - Detection SNR: 1.77dB, 3.79dB
- Installed at Mexico Monterrey plant

**Target
Process**





Acoustic Equipment & Server Setup for Anomaly Detection

20+ Dedicated
Microphones

(Optimal selection
based on environment)

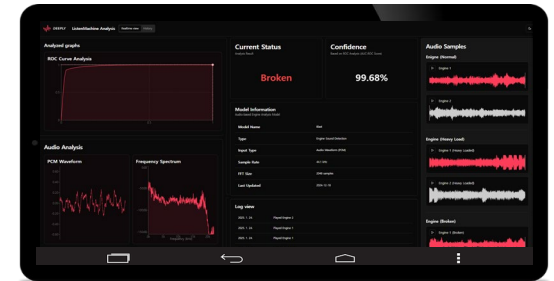
**Server &
System**

- Deployment of dedicated audio devices and servers for anomaly detection
- Optimized installation tailored to customer sites such as factory production lines

Monitoring & Analysis Results

1. Dedicated Dashboard

- Independent dashboards for operators and managers
- Real-time monitoring available directly on-site



2. Integration with existing systems

- Platform integration via API
- Manufacturing system integration with MES / PLC



Overview of Listen AI Industrial

A deep-learning-based solution that automates auditory inspection in manufacturing, overcoming the limitations of labor-dependent quality checks.

Precision Acoustic Analysis

- Wide-band analysis including ultrasonic range
- Real-time anomaly detection powered by deep learning
- Accurate identification of even subtle sound differences
- Optimized sound recognition for production environments

Production Line Customization

- Tailored installation for each factory environment
- Automated system integration with MES / PLC
- Adaptable from anechoic chambers to live production lines
- Continuous 24/7 monitoring

Data-Driven Quality Management

- Real-time recording of digital DX inspection data
- Root cause identification and anomaly tracking
- Automated quality trend analysis and reporting
- Discovering improvements based on statistical insights

A future manufacturing solution that achieves both **labor cost reduction** and **quality stability** through automated auditory inspection.

Comparison with Conventional Methods

Comparison between manual auditory inspection, vibration-sensor-based inspection, and Listen AI Industrial.

Automated Acoustic Inspection
Solution for Manufacturing

Category	Manual Auditory Inspection	Vibration-Based Inspection	Listen AI Industrial
Accuracy	★★★★☆ Dependent on inspector skill	★★★★☆ Natural detection	★★★★★ High-precision real-time detection
Cost	High labor cost (≥ \$200K per line annually)	High sensor installation cost (requires multiple high-end sensors)	Low maintenance cost after initial setup (labor savings)
Data Collection	✗ Not possible	✓ Partial recording possible	✓ Full data recording & analysis
Detection Timing	Real-time but subjective ⌚ (human-dependent)	⌚ Detected only after failure	⌚ Early anomaly detection
Consistency	✗ Varies by fatigue & individual inspector	✓ Affected by surrounding vibrations	✓ Maintains high consistency
Scalability	👤💰 Requires additional workforce	🔧💰 Requires additional sensors	📄📈 Rapid deployment & expansion possible

Benefits of Adopting Auditory AI

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Quantitative analysis of effects such as defect reduction, shorter inspection time, training cost savings, and labor efficiency.

✔ Quantitative Benefits

Defect detection accuracy: **95~99.6%**

Accuracy improvement vs. vibration-based solutions **+40%**

Inspection time reduction: **Up to 60% shorter**

Defect rate reduction: **average 75% improvement**

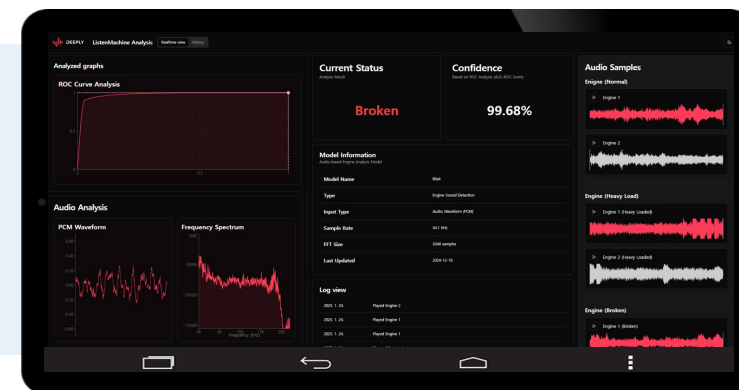
ROI after installation: **6~9 months**

⚙️ Operational Benefits

- **Reduced dependency on skilled inspectors:** AI-based standardized judgment eliminates reliance on experience.
- **24/7 operation:** Continuous monitoring without shifts, reducing costs and increasing productivity.
- **Training cost savings:** No need for complex auditory judgment skills.
- **Data-driven decision-making:** Anomaly patterns stored in a database enable automated quality analysis.
- **System integration:** Compatible with MES and PLC for unified quality management.

Real-World Customer Results

- ▶ **Client H:** Product A/B inspection efficiency **improved 2x**
- ▶ **Client P:** Motor defect rate **reduced by 82%**
- ▶ **Client T:** Connection error detection rate: capable of detecting signals **down to SNR -1.77 dB**



Adoption & Implementation Process

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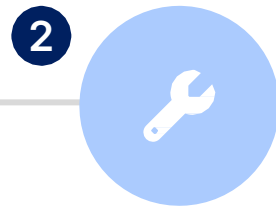


The 4-step process for effective deployment of Listen AI Industrial.



Site Analysis

Analyze inspection process & environment, Measure noise & define improvements



Installation & Testing

Install tailored microphones and servers, Build dashboards, Integrate with existing MES / PLC systems



Data Collection & Learning

Collect normal/defective sound samples, Optimize AI model learning with customized data



Pilot & Operational Optimization

Continuous updates and performance monitoring, Data-driven quality improvements

Key Preparation Requirements

- ✓ **Target definition:** Specify product/part types and defect categories
- ✓ **Line environment:** Assess noise levels, nearby equipment, and installation space
- ✓ **Production speed:** Match real-time inspection with line cycle speed
- ✓ **Data availability:** Ensure sufficient normal/defect samples (50+ recommended)

Timeline & Expected Impact

Initial site analysis	2 weeks
Data collection & model training	3~4 weeks
Installation & pilot	1~2 weeks
Total deployment	3 months / 6 months
ROI achievement	within ~6 months

ROI & Economic Impact

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Economic benefits and quality improvements from adopting Listen AI Industrial

✓ Payback Period & Economic Effects

Initial setup cost: **Development + \$40K+/line**

Annual labor cost savings: **\$70K–140K/line**

Defect reduction effect: **20–30% fewer defects**

Average payback period: **12–18 months**

5-year cumulative savings: **\$7M+/line**

🏆 Key Benefits of Adoption



Labor Cost Reduction

Over 60% savings with automated inspection lines, enabling workforce reallocation



Defect Reduction

97%+ detection accuracy prevents escapes and reduces defective outflow



Recall & Service Cost Savings

Preventive detection cuts over 90% of costly recalls and after-service expenses



Improved Data Reliability

Real-time inspection data analysis enables process optimization and continuous improvement.

Long-Term Impact of Listen AI Industrial

60% labor cost reduction

99% inspection accuracy

90% recall / service cost savings

100% quality data traceability

“Initial setup is a one-time cost, but the benefits of quality improvement and data assurance provide long-term competitiveness.”



AI · Data proven in real-world ‘Machine Hearing’ products

Demo is easy. Real-world application is hard.

AI side

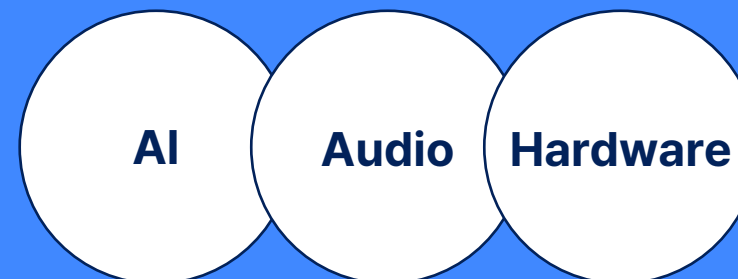
- Sound deep learning is the most challenging area compared to other AI domains.
- Factory environments are noisy and complex, making real-time detection highly difficult.
- Owns proprietary AI models (sound, hardware, anti-noise modules), not open-source.
- Proven real-world deployment experience bridging the gap between demos and actual operations.

Machine sound data is exclusive.

Data side

- Collects hundreds of thousands of samples daily; data never exposed externally.
- Factory data is not shared externally → Closed Data.
- Proprietary audio database built exclusively by Deeply.
- On-site recorded/curated data, irreplaceable and highly valuable.

AI · Audio · Hardware Integrated Product Capability



Product side

- **AI Modeling:** Specialized noise detection algorithms, optimized for low false positives.
 - **Audio Expertise:** 20+ mic types tested; best fit per environment.
 - **Hardware Integration*:** Edge servers, mics, PLCs tailored per site
- Not just AI — we handle **audio design + data capture + tuning + device integration.**



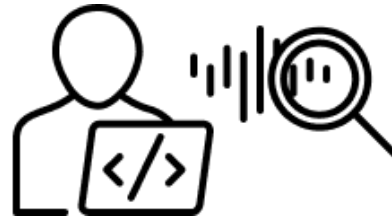
7 Years Focused Solely on Nonverbal Sound



* By h-index ranking

Not just hearing like a human,
but hearing better.

- Sound is complex — a mix of patterns, frequencies, and physical signals.
- It's not about converting sound into text, but about understanding the sound itself.
- Deeply has repeated **thousands of cycles of signal processing, deep learning, and real-world testing** to achieve this.



Overcome
Sound AI Challenges

- Unlike vision AI, sound AI has no standard models.
- It must handle **noise, echo, real-time demands, and accuracy** — all at once.
- We've overcome this with **7 years of focused R&D**.
- Published at **ICASSP 2024/2025**, the world's top signal processing conference.*



LLMs Run on Capital.
Sound AI Runs on Grit.

- LLMs are trained on the internet with enough GPUs — anyone can chase it with money.
- But nonverbal **sound AI requires closed data, physical access, and hands-on learning**.
- It's not a race of scale — it's a race of who's been on the ground the longest.

DEEPLY

: Built on Years of Listening Technology



B2C Sound AI, Baby/Home

Built datasets and models for nonverbal/baby sounds in the home

- 2017 Deeply Inc. Founded
Co-developed technology with Facebook and Google
Joint development of nonverbal speech AI with LG CNS;
partnerships with Amazon AWS & Junggle
Launched and operated baby cry platforms BABBA and WAAHS
Secured investment from New Flight (2018)

B2B/B2G Sound AI, City

Commercialized over 20 projects in urban safety and public environments

- 2023 Pivot to B2B/B2G — Real-World Commercialization Begins
- 2024 Launched **Listen AI Safety** for emergency sound detection
Started **Listen AI Industrial** for factory/machine sound analytics
- 2025 Selected for Singapore HTX HATCH, Dimension X, and more

B2B Sound AI, Industrial

Commercialized projects across 5 industrial sites

- 2025 Exhibited at CES and INTERSEC
Official launch of Listen AI Industrial for machine anomaly detection



Key Deployment Achievements

Industrial Market



Safety Market



Other Partners & Clients



- 2025.03 **Hyundai Transys:** Abnormal fastening sound analysis
- 2024.09 **Korail:** Railway machinery anomaly detection
- 06 **Incheon Transit Corp.:** Chemical hazard detection
- 04 **Sejong Gov. Complex:** Cultural/sports facility hazard detection
- 2023.07 **DL E&C / Lotte E&C:** Construction site noise & hazard monitoring
- 05 **Incheon Startup Park:** Hazard monitoring service
- 04 **Kangwon Casino Land:** Resort hazard monitoring (High1)
- 2022.07 **Korea Army HQ:** Drone engine & anomaly sound detection
- 05 **Kookmin Bank, ITP:** Anti-fraud & anti-theft sound project
- 03 **KT (Korea Telecom):** Senior care & IoT communication projects
- 01 **Ministry of Health and Welfare:** 3,000 senior care devices deployed
- 2021.10 **LG CNS:** Emotion detection, military tech & sound AI projects
- 2020.09 **Amazon AWS:** Disaster response collaboration
- 2019.06 **Google:** Joint solution with Google for Startups
- 2018.09 **Meta:** Asia Startup Program (with Asia Foundation)

Proposal & Inquiry

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Experience a Listen AI Industrial solution tailored to your manufacturing process.

Customized PoC & Demo Proposal

- ✓ **On-site assessment:** Tailored solution design for your production environment
- ✓ **Free demo:** Verify performance directly on your production line
- ✓ **Step-by-step PoC:** Validation process customized to your facility
- ✓ **ROI analysis:** Estimate cost savings and quality improvement benefits

Contact & Inquiry Information



Phone

+82-70-7459-0704



Email

contact@deeplyinc.com



Website

www.deeplyinc.com



Address

2F/3F, 30 Baekbeom-ro 24-gil, Mapo-gu, Seoul, Korea



Contacts

Suji Lee, CEO (+82 10-4250-3474)
suji@deeply.co.kr

Jeongsoo Kim, Manager (+82 10-9412-1674)
harry@deeply.co.kr

Experience the Difference of Listen AI in Your Factory

"Demo is easy, real-world application is hard."

We provide solutions proven in actual production sites. If you are considering automating auditory inspections tailored to your factory environment, contact us today.



Demo Request: contact@deeplyinc.com



Thank you

2nd Floor, 30 Baekbeom-ro 24-gil, Mapo-gu, Seoul, Deeply (04149)070-7459-0704

contact@deeplyinc.com

<https://www.deeplyinc.com/>