Koito sensor cleaner system

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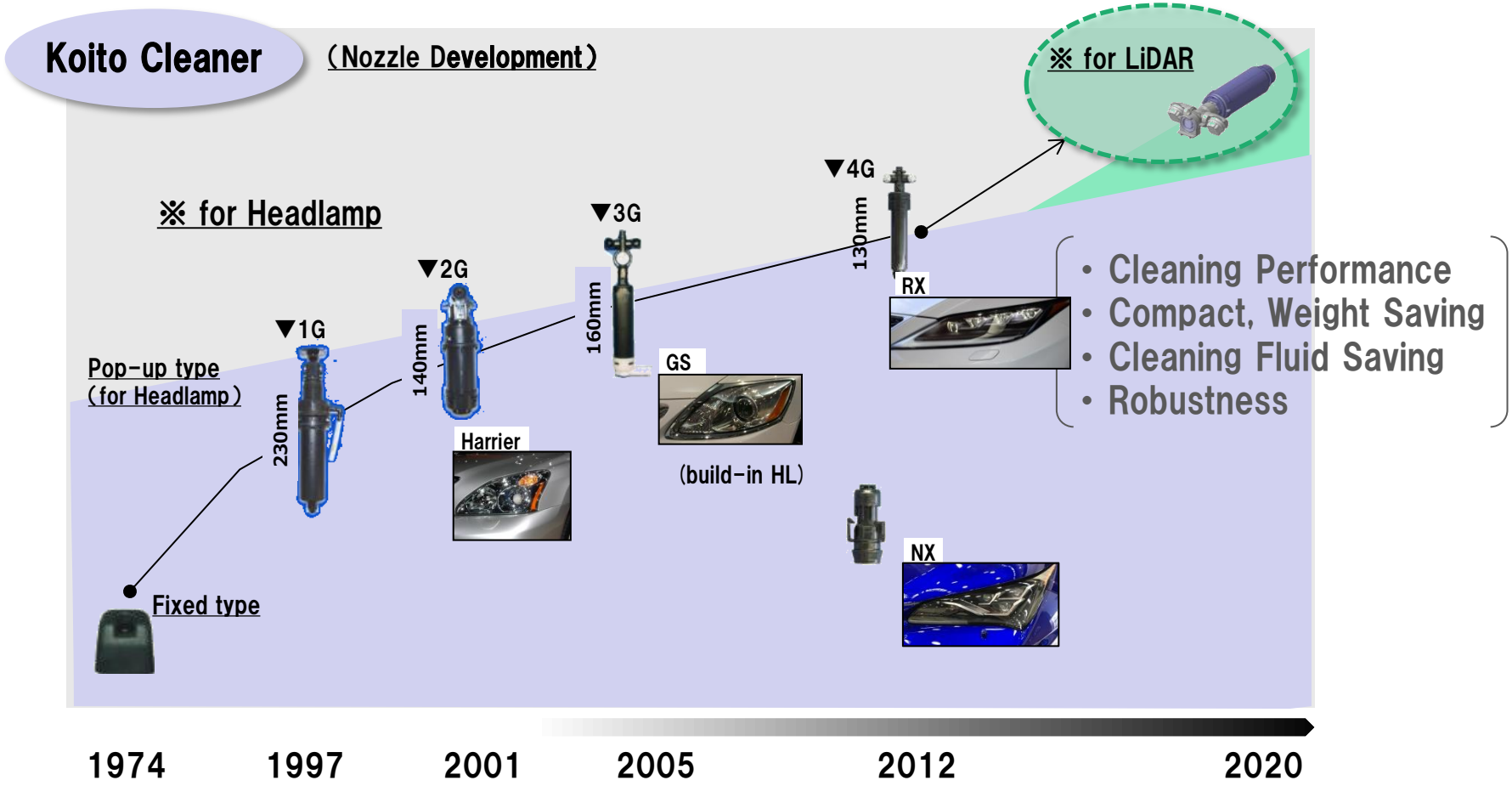
Koito Cleaner System History

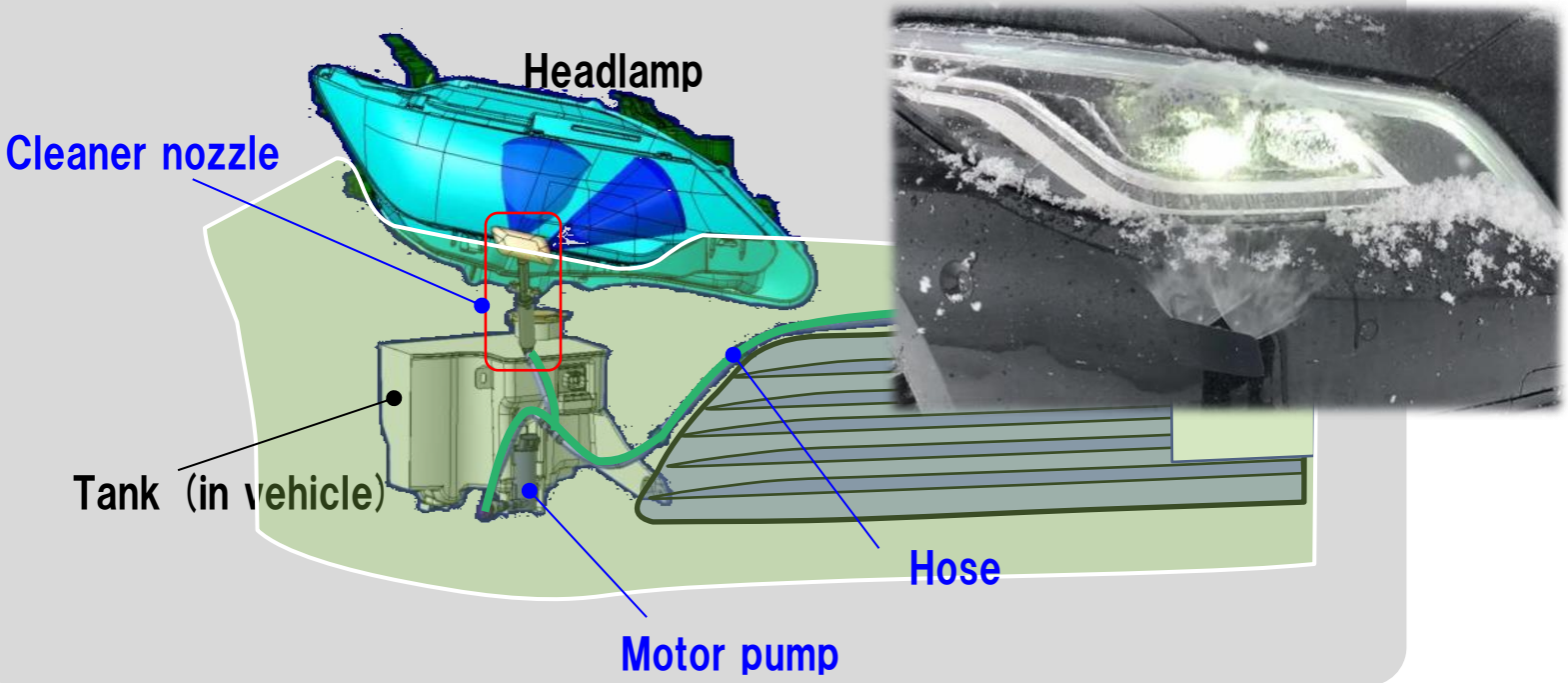
- Koito commercialized the first headlamp cleaner system (HLC) in 1974.
- Since then, Koito has been developing headlamp cleaning system products.
- In 2018, we shipped HLC about 2.4 MLN pcs for about 100 models,10 OEMs.



Koito Headlamp Cleaner System

- This cleaner system preserves the head lamps' photometry performance by power washing the lens using a standard cleaning liquid.
- The system consists of a cleaner nozzle, a hose, and an electric motor pump which is integrated into the washer fluid tank (in vehicle) .
- The manufacturing locations are Japan, China and Thailand.

Overview of the headlamp cleaner system



Needs for LiDAR cleaner

- The LiDAR system is very effective at measuring the distance to and recognizing the shape of objects on the road ahead, but when the system is soiled, the measuring performance degrades significantly.

➔ **The dirt must be removed by a cleaning system**

Examples of soiled LiDAR systems

Clear	Dirt on the LiDAR system (transmittance: 70%)	After cleaning
Point cloud appears to measure the distance to objects ahead	Point cloud disappeared	Point cloud was restored by cleaning
		

Requirements for LiDAR Cleaner

- Installed at a low height, the LiDAR system is easily and heavily soiled.

⇒ To extend the cruising range of autonomous vehicles, more powerful cleaner system is required to remove the dirt from the LiDAR effectively.

Audi A8 (2017)

BMW 7 series (2019)

LiDAR is normally equipped under license plate

How improve cleaning power w/o bigger pump?

- Key factor is the impactive force of the sprayed fluid droplets.
- Concentrating the spray of fluid droplets increases the impactive force, but the range of diffusion is reduced.

  ⇒ How solve this trade-off?

  Effectively use a technology that oscillates the spray (fluidics effect).

Theoretical formula:

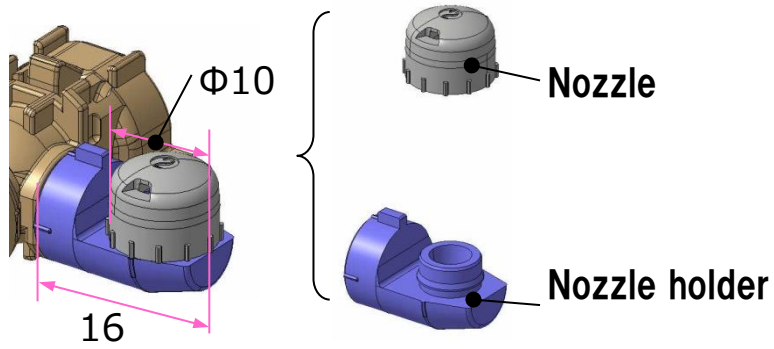
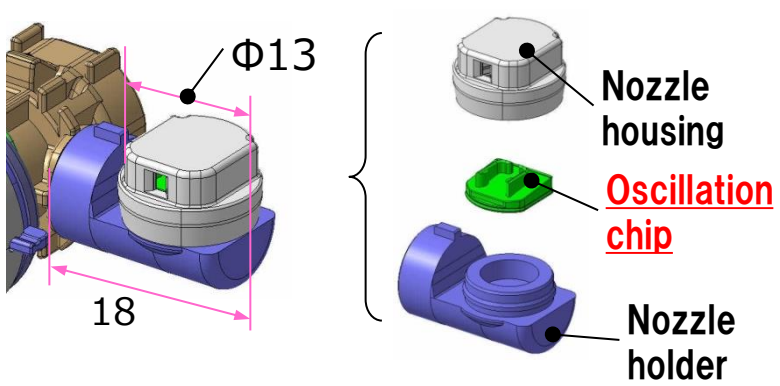
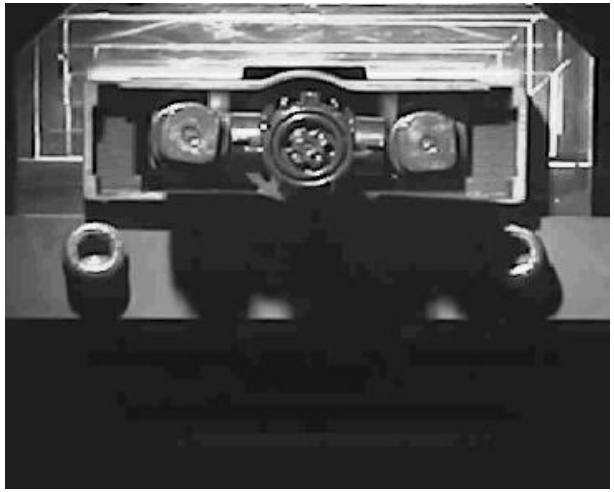
•Impactive force $F = \frac{mv}{\Delta t}$ (m: mass, v: speed, Δt: time)

⇒The larger (heavier) the fluid droplets , the higher the impactive force

Fluid droplet: Small	Fluid droplet: Large
Impactive force (low)	**Impactive force (high)**
Fluid droplet (small)	Fluid droplet (large)
Fluid droplet size ≈ 0.5 mm	Fluid droplet size ≈ 2.0 mm
Cleaning surface of the LiDAR system	Cleaning surface of the LiDAR system
Nozzle	Nozzle
	Trade-off: Reduced range of diffusion

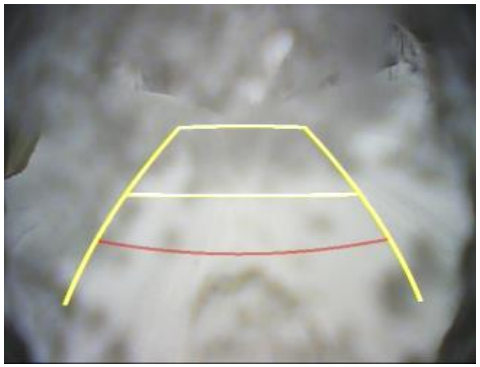
Developed Oscillation Nozzle

- Add an oscillation chip to a conventional nozzle to oscillate the fluid stream

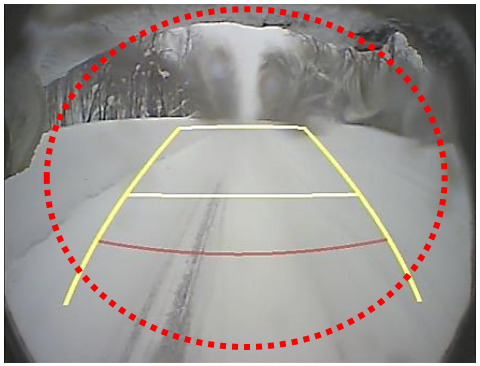
	Conventional nozzle (HLC nozzle)	Developed nozzle (prototype) PAT
Structure		
Spray pattern	 *Filmed with a high-speed camera (1/2,000 sec)	 *Filmed with a high-speed camera (1/2,000 sec)

Fluid-saving Technology

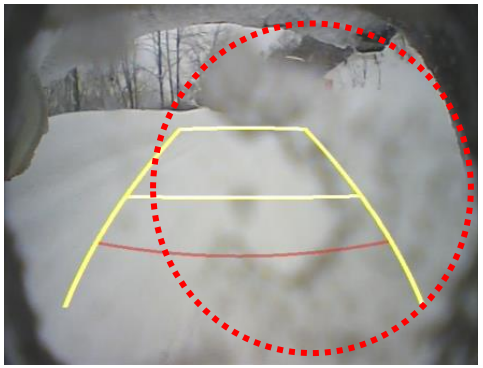
- Fluid cleaner issues



- Poor visibility



- The camera lens is cleaned by fluid camera cleaner, but lens surface is still wet



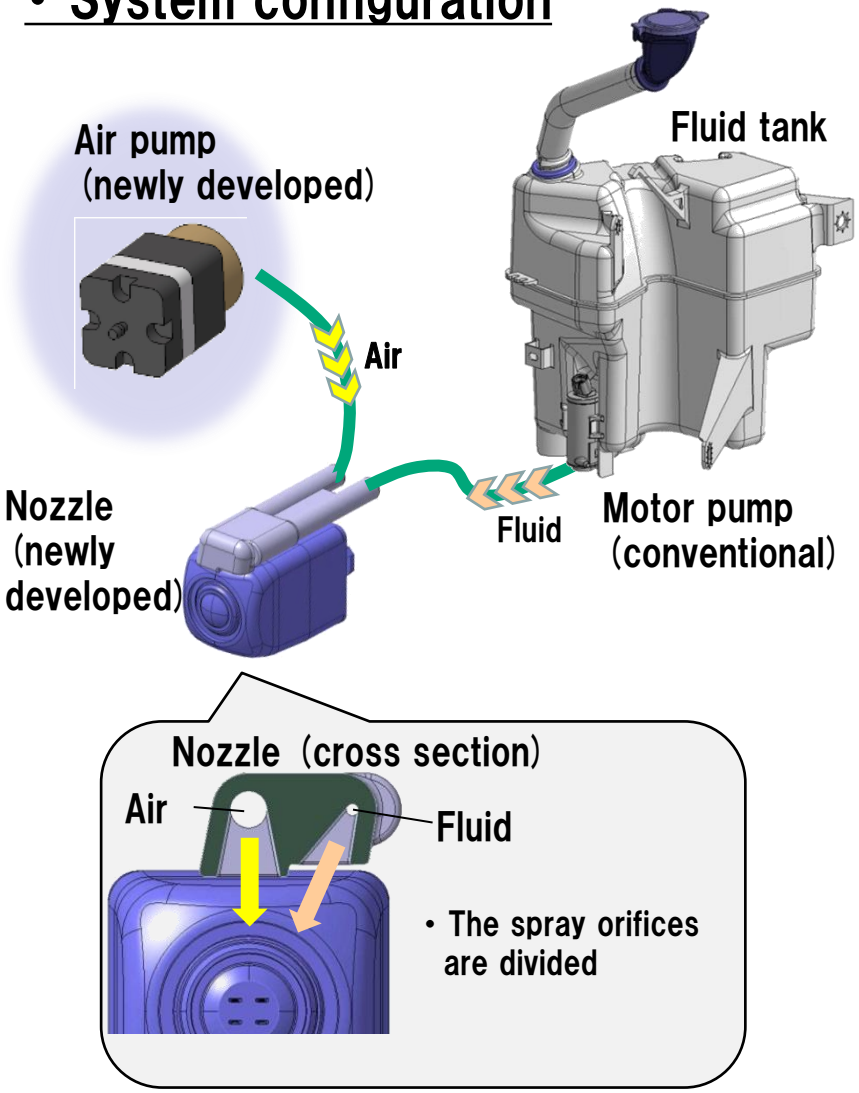
- Within a few seconds, catches snowflakes again

Fluid tank capacity is limited (~5 liters) and commonly used with window shield washer system. This means cleaner activation times are restricted.

➡ **How save the fluid consumption?**

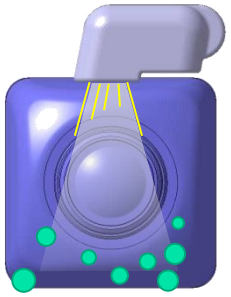
Concept of Air-fluid Cleaning

• System configuration



• How it works

✔ Continuous air blow



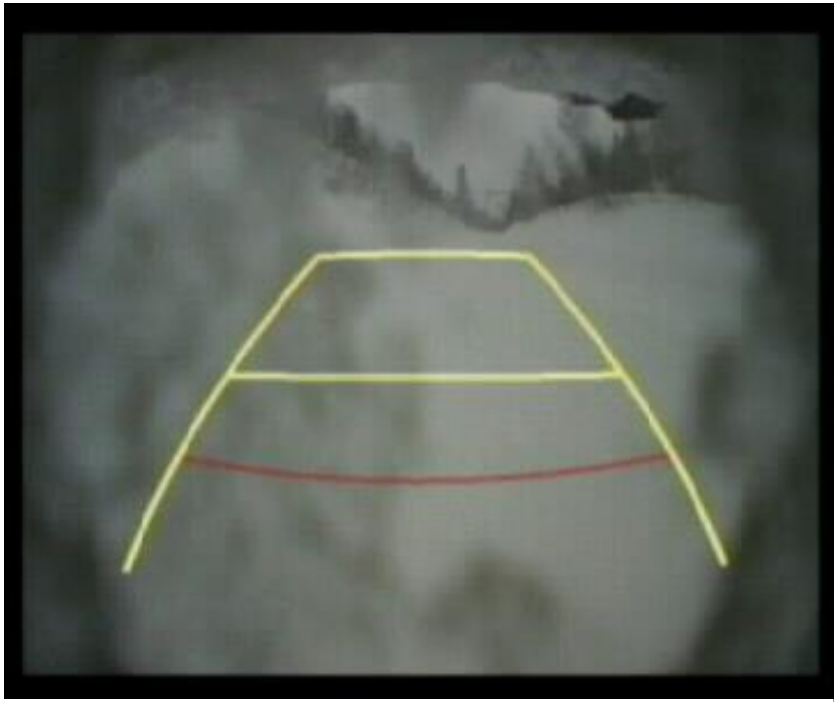
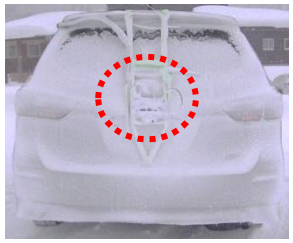
→ Ejects light dust & water drops (in this case, only air blow is enough)

✔ When dirt is stuck…

→ Washes it away with fluid spray
→ And blows away traces of fluid that attract new dirt

Saved fluid consumption could be about 75% averagely in our evaluation

Air-fluid Cleaner evaluation result on actual vehicle

Fluid type	Air-fluid type
	
 	 
Fluid consumption = 160 cc/20 km	Fluid consumption = 0 cc/20 km

Recap

- Koito has developed a LiDAR cleaner system with improved cleaning performance, scheduled for market launch in 2020.

- Further, to reduce the consumption of cleaning fluid, an air-fluid type cleaning system is under development.
  - ➔ Conducted a trial test on rear cameras on snowed roads and confirmed the effects of using air.
  - ➔ Will continue the study for future use for LiDAR systems

    ＊Current technical issues

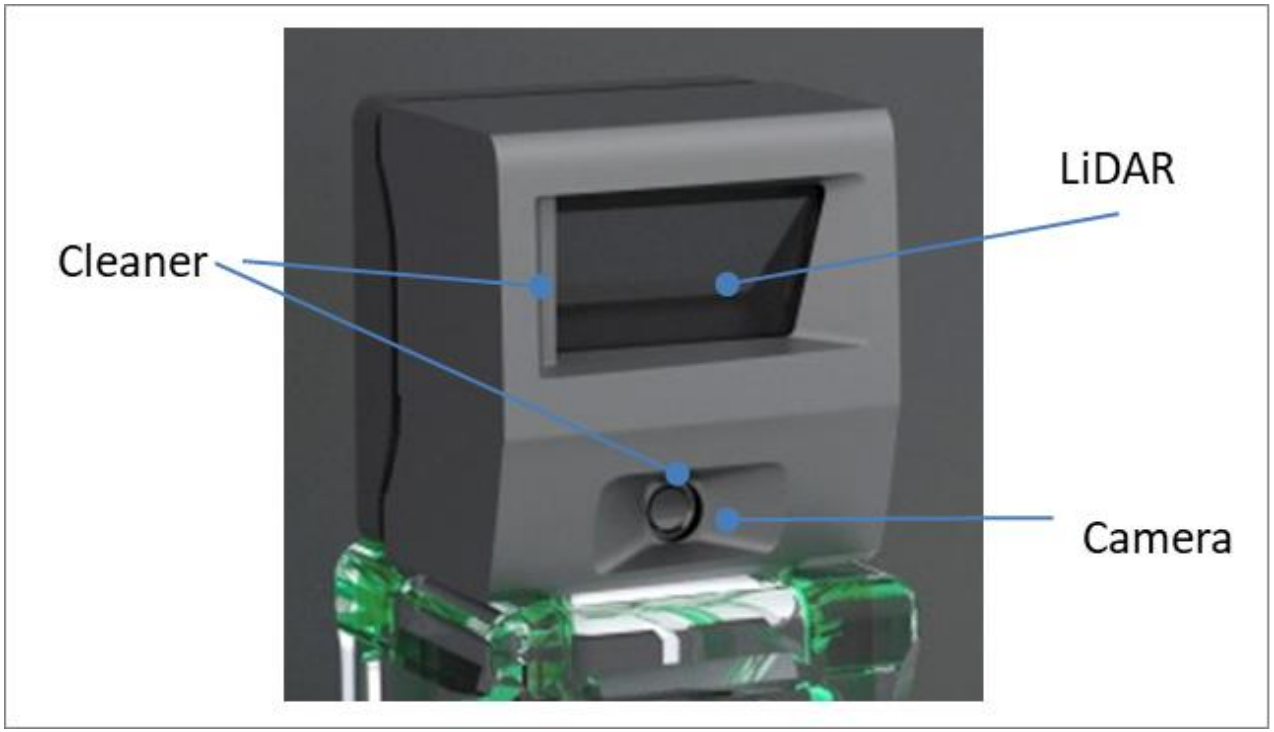
    •How increase to be cleaned area for LiDAR?

    (i) Determine optimized air blow speed
    (optimum air pump size/power consumption, etc.)

    (ii) Improve the nozzle
    (orifice design & size, etc.)

Meet at CES2020 (Jan. 7-10. 2020)

Koito will showcase "Compact Sensor Module" at CES2020 in Las Vegas that LiDAR/Camera are integrated into a compact module with cleaning system.



Meet at CES2020 (Jan. 7-10. 2020)

Koito booth
#5220
@LVCC North Hall

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