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Gas Innovations Inspiring Clean Energy

(WW3 – 2)

Buried Pipe Detection Technology and In-pipe Traveling Robot Technology

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Y. Higuchi, M. Tsunasaki, M. Yamagami
Osaka Gas Co., Ltd.

M. Konno, R. Sato
Tokyo Gas Co., Ltd.

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Y. Higuchi
Osaka Gas

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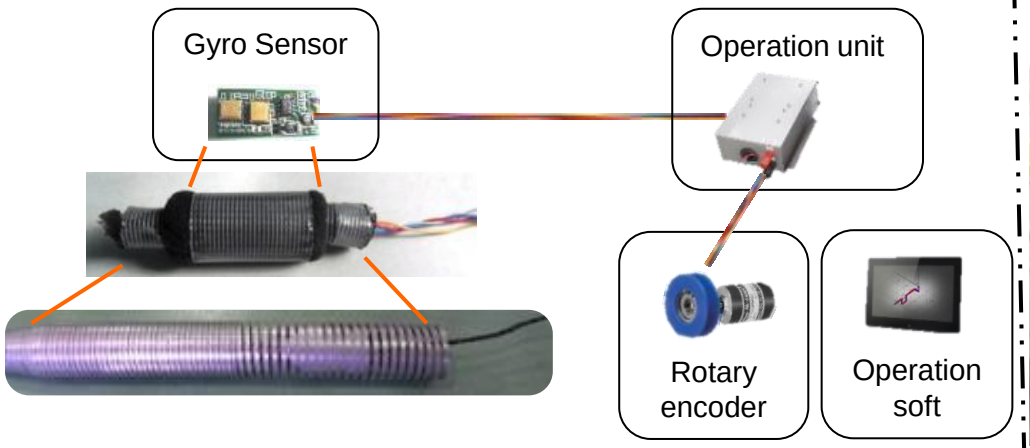
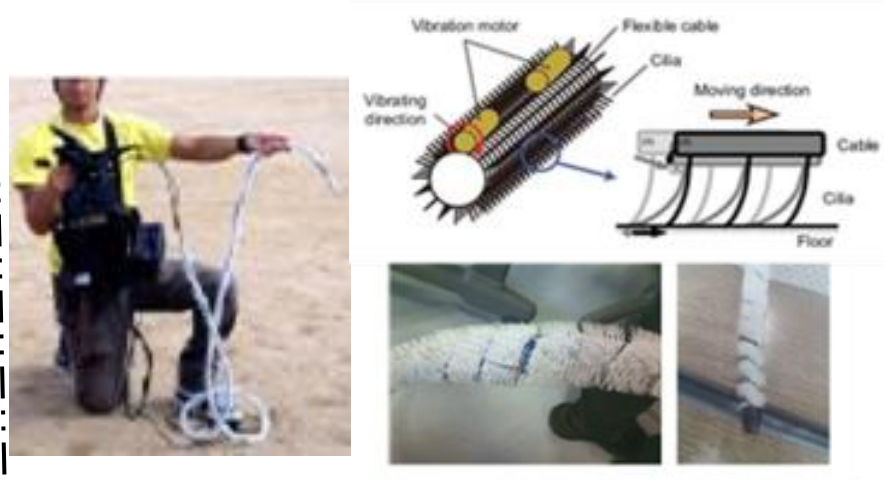
  : Active Scope Camera for in-pipe delivery inspection
- Conclusion including Future Issues

M. Konno
Tokyo Gas

Gyro Locator



Active Scope Camera



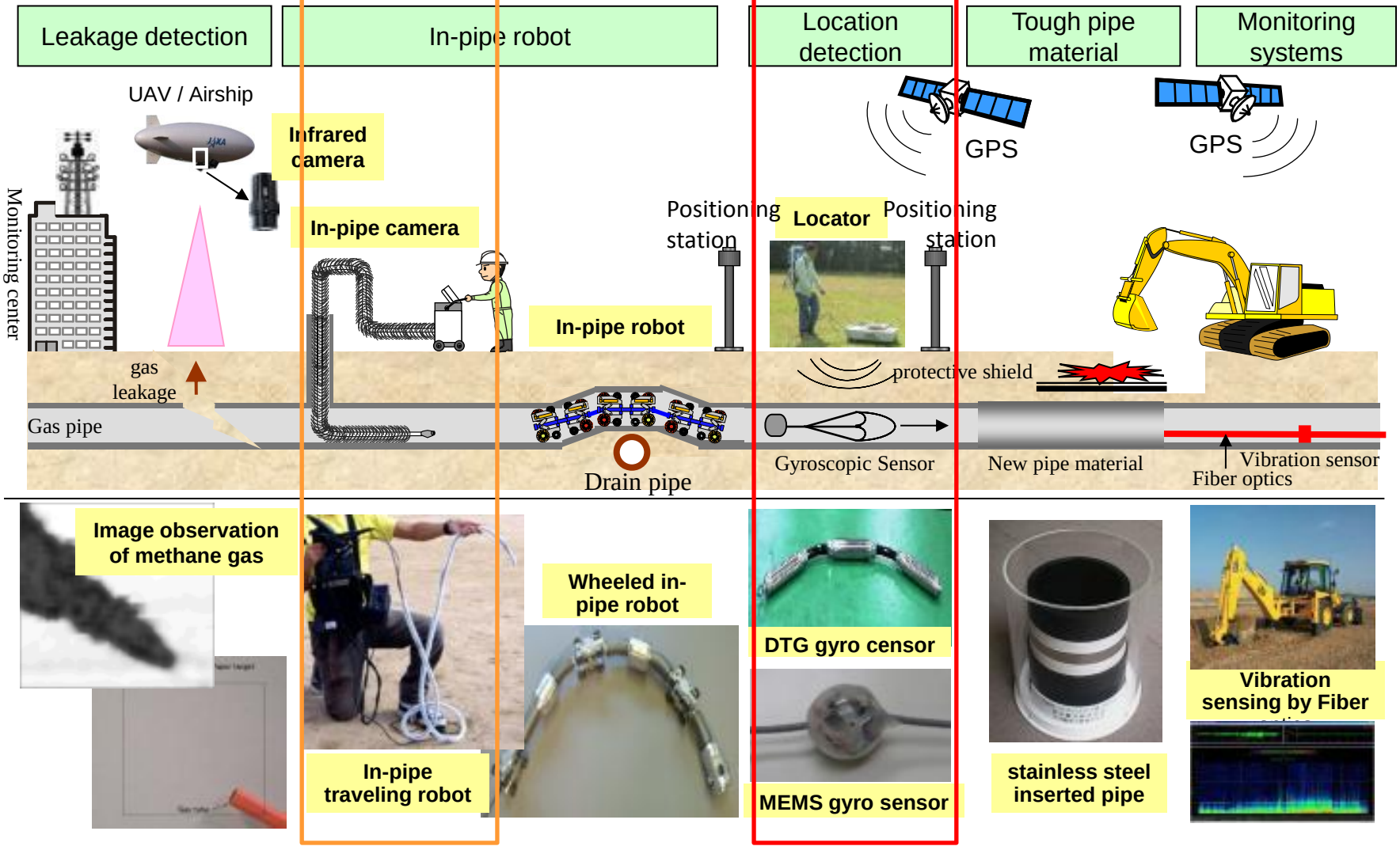
Technology Search - Two Promising Technologies

Five Needs for Gas Piping Safety

In-pipe Traveling Robot

MEMS Gyroscope

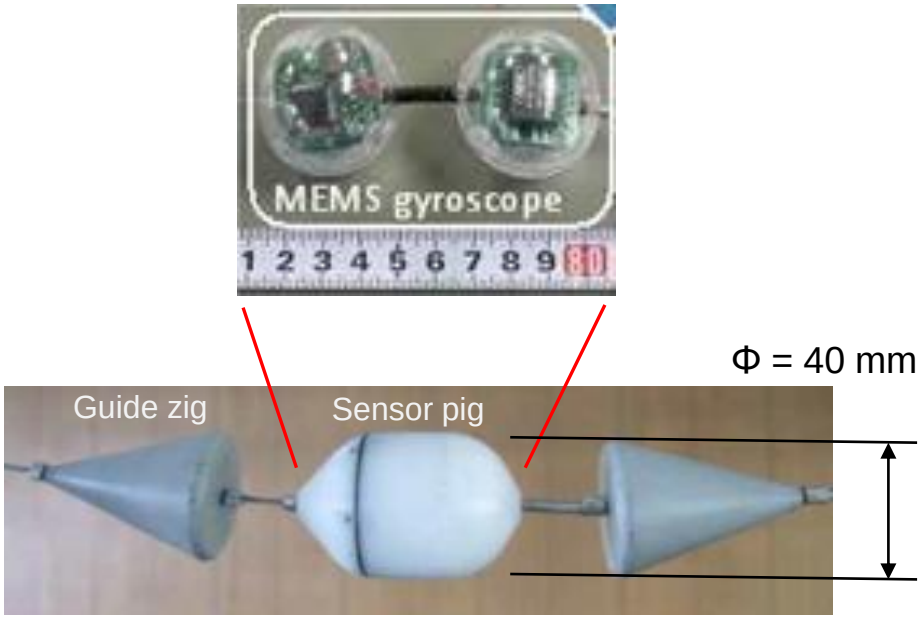
by JGA (2008 - 2010)



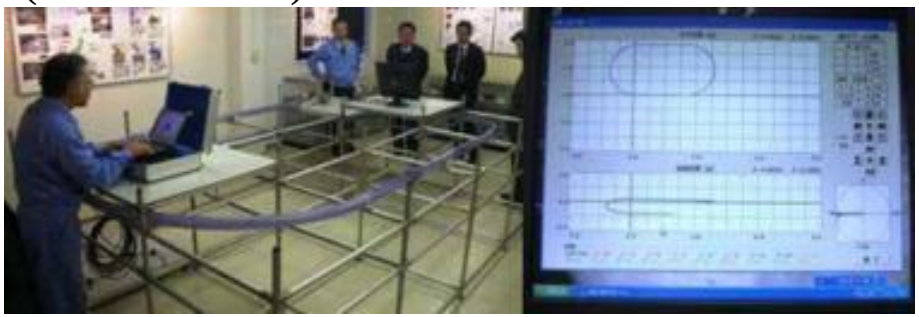
Gyroscope Technology - MEMS Gyro Sensor

by JGA (2008 - 2010)

Configurations of Gyro Sensor



(Demonstration)



(Specifications)

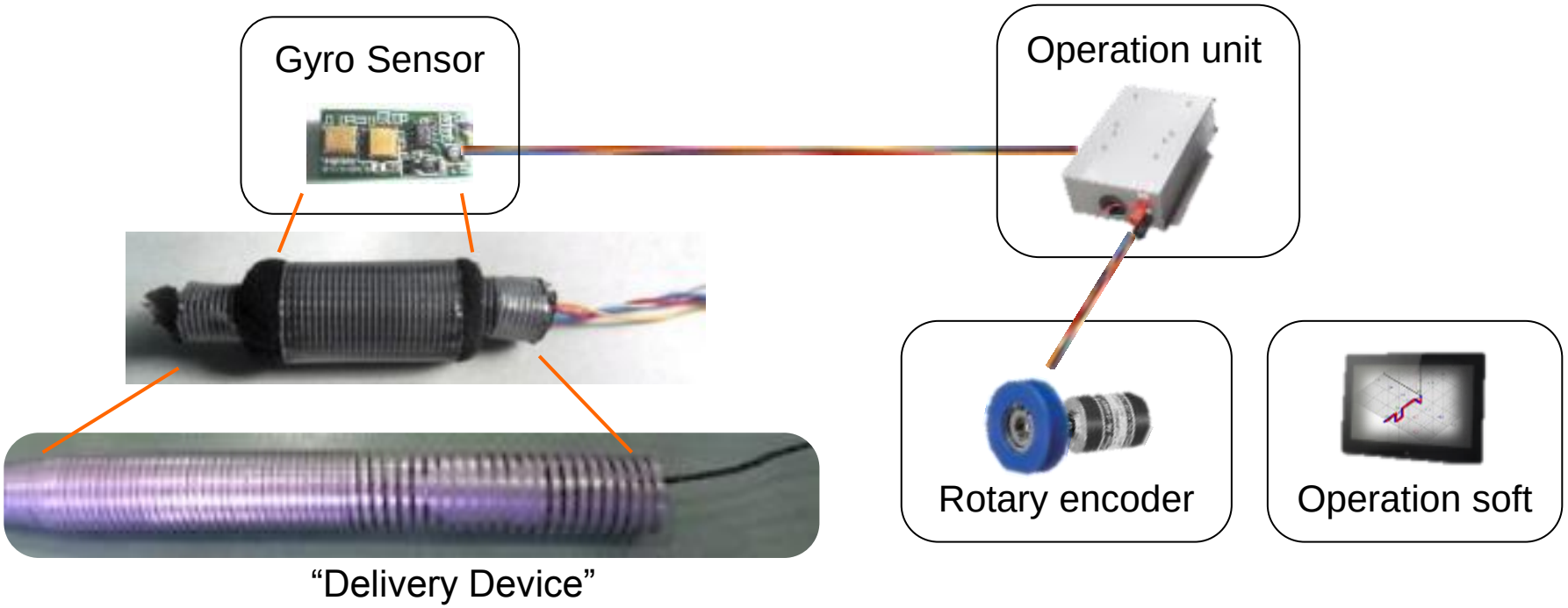
Purpose	Three-dimensional Pipeline Measurement
Principle	Gyro sensor carries through the pipeline, and gets the trace data.
Measurement Items	Gyro :Three axes Acceleration :Three axes Length :Encoder (ext.)
Dimensions	Diameter 40 mm × 61 mm
Quality	Prototype
Application	Construction field

Gyro-Locator - Development

Improvements

Gyro Sensor	Rotation Speed : From 300 to 900 degrees/sec Sensor Board : Compact in size 14 ×30 mm
Insertion & Collection	Adopting “Delivery Device” made of coiled metal wire
Software	Adopting a formula that calculates Attitude Angles

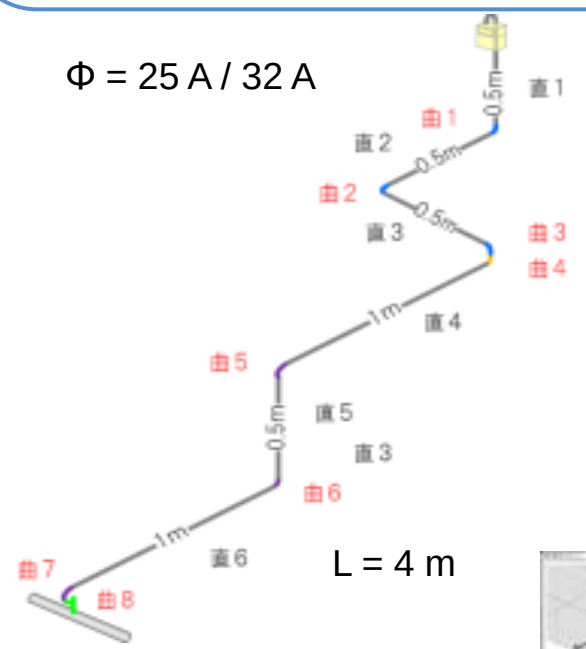
Configurations of Gyro-Locator



Gyro-Locator - Test Assessment

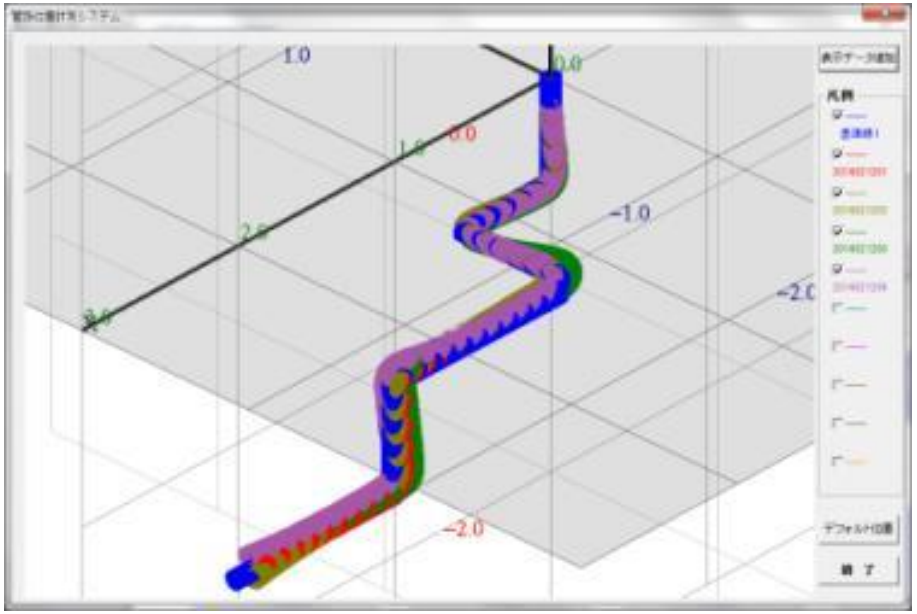
Simulation Pipes

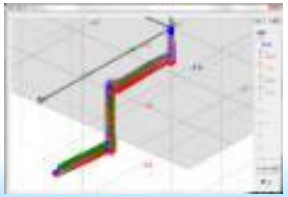
(Specification)
- Total Length = 4 m (13 feet)
- Bend Pipe = Eight curves
- Diameter (2)
  = 1 inch & 1·1/4 inch
- Shapes (5)
  = Five different patterns

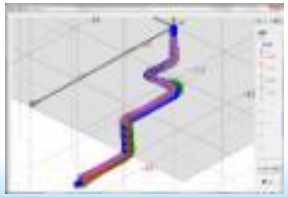


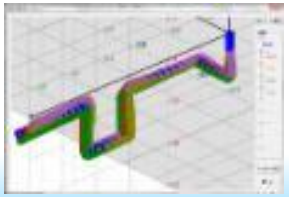
Assessment

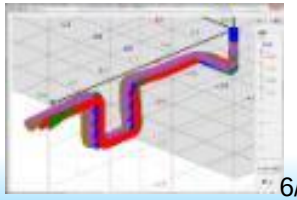
Number of Tests	2 ×5 × 3 times = 30 tests
Three-dimensional Measurement	All tests passed within a 10-cm (4-inch) margin of error.











Conclusion - Buried Pipe Detection Technology

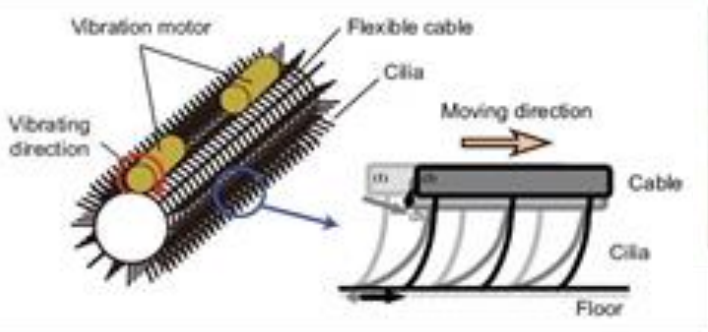
MEMS Gyro Locator

- Development
  - A super-compact MEMS Gyro Sensor (14 ×30 mm)
  - “Delivery Device” installs the super-compact sensor.
- Test Assessment
  - Gyro-Locator can carry through pipe joints and pipe bends.
    (1 inch & 1·1/4 inch)
  - Accuracy of measurement is within 2.5 % margin of error.
- Future Issues
  - Reducing the amount of shock when passing through pipe joints
  - Correcting any margin of error in pipe measuring

In-pipe Traveling Robot– Active Scope Camera

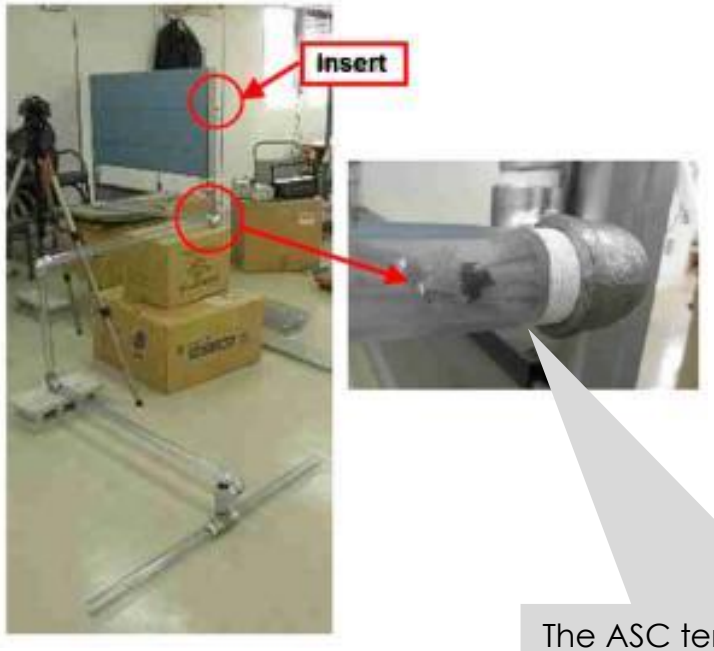
by JGA (2008 - 2010)

Configurations of Active Scope Camera (ASC)



ASC cannot insert 1-inch pipe.

(Demonstration)



(Specifications)

Purpose	Search robot for narrow space
Principle	ASC moves forward autonomously when the fibers attached to the surface of the camera cable respond to vibrations caused by a motor.
Dimensions	Diameter 30mm
Quality	Prototype
Application	Construction field

The ASC tends to get stuck at the curves of continuous fitting.

Active Scope Camera - Development

Improvements

Fundamental Structure	Fixed body part (including vibration motor inside) and flexible Tube
Tip Rotation Mechanism	Installing a tire with screw-like grooves
Easy to Retract Design	Tapering the metal in t Taking full advantage

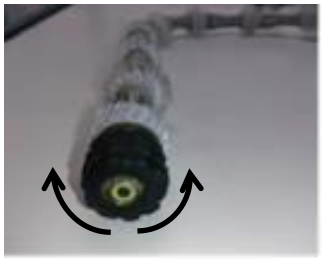
＜Specifications＞
- **Total length：7m**
- **Diameter of the fixed body part without including the fibers ：12mm**
- **Diameter of the tube：10mm**
- **Fiber length：5mm**

Fixed body part including vibration motor

Flexible Tube

For passing thr
in continuou

Fundamental Structure



Tip Rotation Mechanism

Configurations of ASC

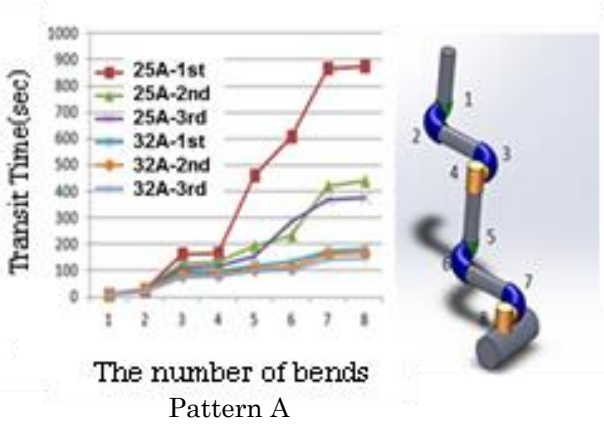
Easy to Retract Design

Active Scope Camera - Test Assessment

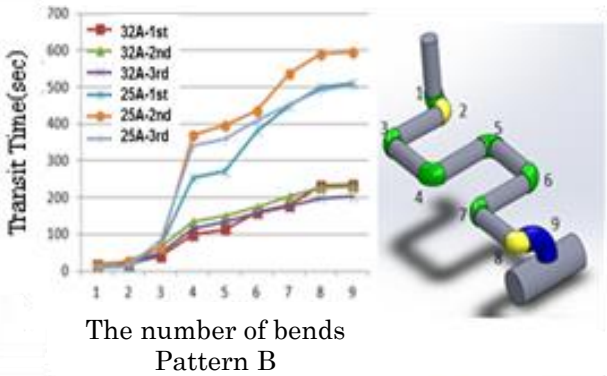
Simulation Pipes

(Specification) Pattern A
- Total Length = 5.5 m (18 feet)
- Bend Pipe = Eight curves
- Diameter (2)
  = 1 inch & 1·1/4 inch

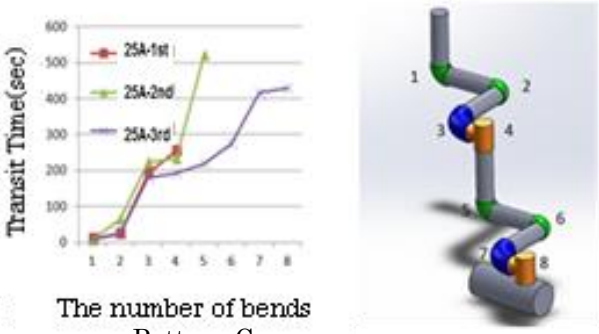
(Shapes (4))
  = Four different patterns



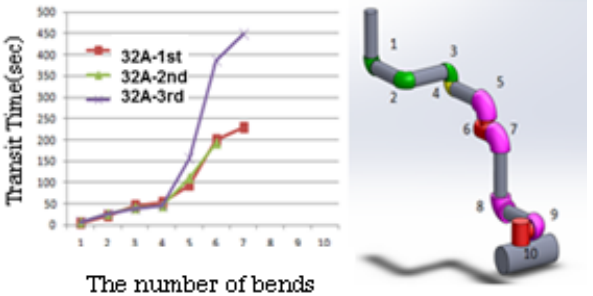
Pattern A



Pattern B



Pattern C



Pattern D

Assessment

	Insertion	Retraction
Pattern A	All bends passed.	Up to four bends retracted.
Pattern B	All bends passed.	Up to five bends retracted.
Pattern C	All bends passed. (25A-3rd)	Up to four bends retracted.
Pattern D	Up to six bends passed.	Up to four bends retracted.

Conclusion – In-pipe Traveling Robot Technology

Active Scope Camera

- Development (for 1 inch & 1-1/4 inch diameter pipe)
  - Structural improvement of the body part and the tube
  - Installing a tip rotating mechanism
  - Easy-to-Retract design
- Test Assessment
  - Insertion: All bends passed（Pattern A,B,C）.
    Up to six bends passed（Pattern D）.
  - Retraction: Up to four bends retracted.
- Future Issues
  - Improving the retraction method
  - Improving the mobility through pipes with various twists and turns

Conclusion including Future Issues

We developed these two technologies.

Gyro-Locator

For detecting three-dimensional pipe locations

Active Scope Camera

For in-pipe delivery inspection

We will develop a new technologies by combining these two technologies.

In the future,

We no longer have to dig out buried pipes to detect their location and shape.

It also allows extensive survey of the interior of the pipe.

This, in turn, contributes to safer gas pipeline maintenance.