# EMBEDDED PASSIVE TAGS TOWARDS INTRINSICALLY LOCATABLE BURIED PLASTIC MATERIALS

Saikat MONDAL[1], Deepak KUMAR[1], Prem CHAHAL[1] , Dan CONNORS[2] and Yiming DENG[1*]
[1]Department of Electrical and Computer Engineering, Michigan State University, East Lansing
[2]Department of Electrical Engineering, University of Colorado, Denver
*Office: 517-432-0492, Email: dengyimi@egr.msu.edu

## MAIN OBJECTIVE

Pipeline is considered as one of the safest means of transportation. However, there are still risks of incident that can occur due to natural and man made events especially for plastic pipes.
Accurate and reliable locating, identifying and characterizing the buried plastic pipes from ground surface can reduce the likelihood of happening such event.

- Design and development of passive harmonic radar RF tags.
- Investigate on-tag sensing capabilities and efficient data transmission.
- RF tag must be able to withstand high temperature processing of plastic and stress involved with horizontal tunneling/drilling of buried pipes.

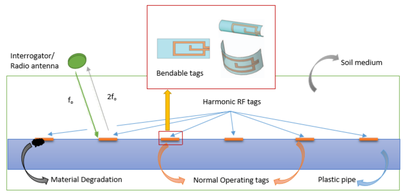



Fig.1 RF tags embedded on plastic pipe

## PROJECT APPROACH/ SCOPE

- A new harmonic radar (frequency doubling) RF tags can be embedded on the buried plastic pipes.
- The low-cost, small and efficient passive RF tags are highly sensitive to their surroundings as well as detectable from ground surface.
- The tag response can be translated into location, identification and characterization of the buried plastic pipe.

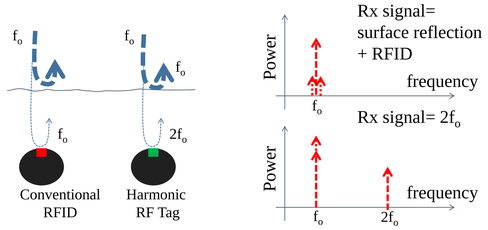



Fig.2 Harmonic radar frequency doubling

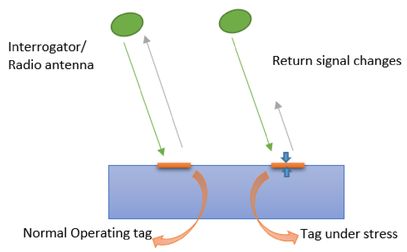



Fig.3 On-tag sensing capabilities

## Design and Setup

- A Non-linear Transmission Line (NLTL) based harmonic tag with antenna was fabricated with different components.
- The harmonic generator circuit consists of 1) A NLTL, 2) A power splitter, and 2) An energy harvesting Circuit.
- The NLTL was fabricated with discrete component inductor and varactor diodes.
- A voltage regulator was designed for regulated DC.

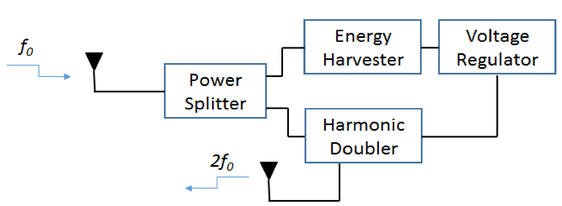



Fig.4 Block Diagram of the designed Harmonic RF Tag

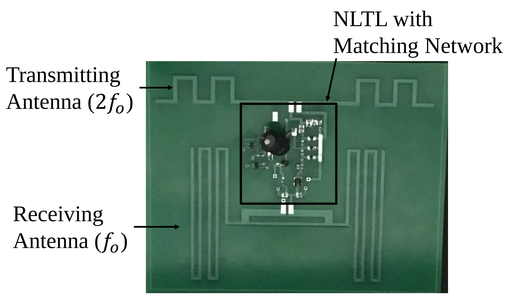



Fig.5 Image of the designed Harmonic RF Tag

## RESULTS

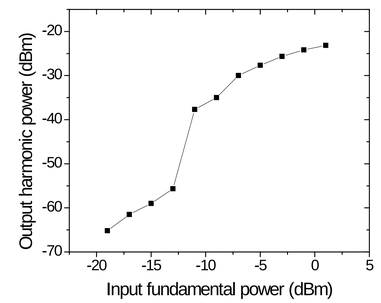



Fig.6 Input power at $f_o$ vs Output power at $2f_o$

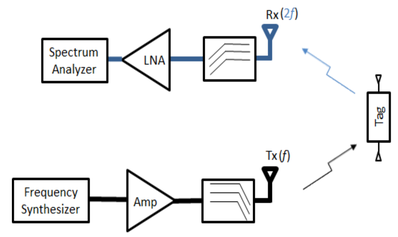



Fig.7 Harmonic Interrogator setup

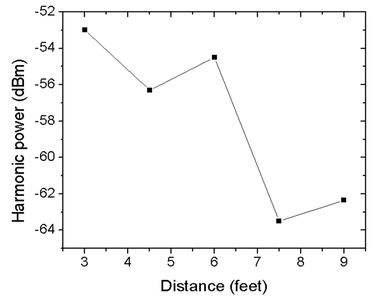



Fig.8 Received Harmonic Power vs Tag Distance

- The RFID tags can also have the sensing capabilities required for SHM of pipeline infrastructure. For example: Pressure, Temperature, Humidity, etc.
- A passive wireless pressure sensor is presented that can be installed on surface of the pipeline with RF tags, which reflects back the pressure information by changing phase of the signal

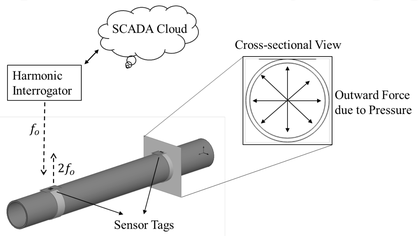



Fig.9 Wireless Pressure Sensing mechanism using passive RF sensor Tags

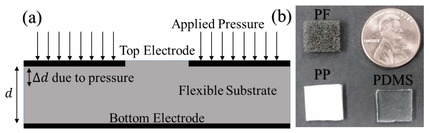



Fig.10 Capacitive Pressure Sensor with three different substrates: (1) Polyurethane Foam (PF), (2) Polypropylene (PP), and (3) Polydimethylsiloxane (PDMS)


Fig.11 Field Experiment

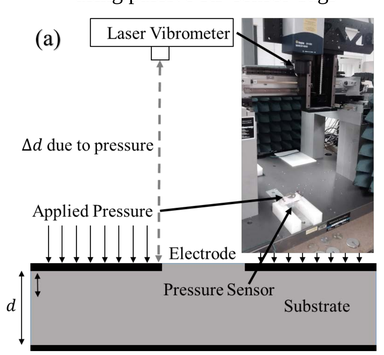
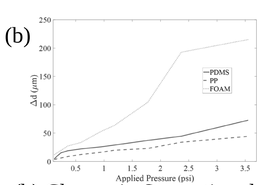



Fig.12 Capacitive Electrode Separation (a) Measurement Setup using laser vibrometer,




(b) Change in Separation due to very small applied pressure

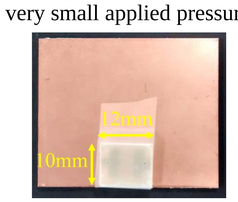



Fig.13 Designed Sensor Tag

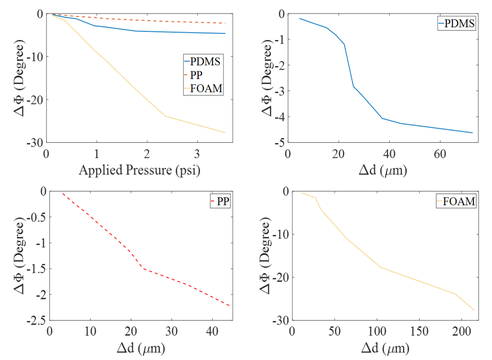



Fig.14 Wireless phase measurement due to applied pressure and change in phase due to electrode separation

## Acknowledgements

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## Public Project Page

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