# Project

## Summary & Proposal

Design And Development

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|---|---|
| Telephone | (910) 546-1707 |
| Web | www.theacutisproject.com |
| Email | matt@theacutisproject.com |
| Address | Trinity, Fl |

# THE ACUTIS PROJECT
## Brief Summary

The Air-Coupled Ultrasonic Transduction Inspection is a modern and efficient inspection system that utilizes non-destructive testing to identify defects in wooden utility poles. Its primary purpose is to provide an accurate, modern, and cost-effective solution for energy inspection companies.

The technology utilizes ultrasonic wave transmission to penetrate the woods interior to detect rot, holes, cracks, and other anomalies/defects without damaging/changing the integrity of the wood structure. The device will record a continuous readout of internal wood condition as the device travels in a vertical direction across the entire vertical profile of a utility pole.

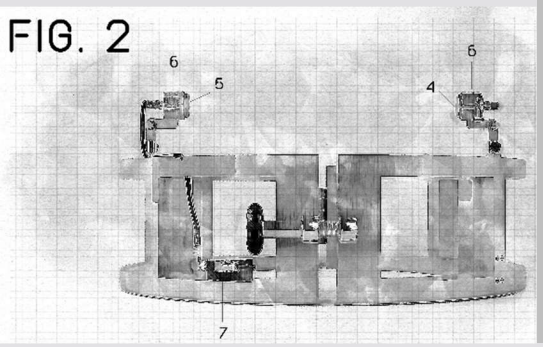
The system is launched through a UAS (Unmanned Aerial System) capable of supporting the electrical equipment necessary for operation. This includes the transducers, high-powered pulser and broadband receiver, batteries, and PSU (Power Supply Unit) for the high-powered pulser.

The system is currently in the proof-of-concept stage of development, awaiting the funding necessary to begin prototype development. Progress for the ACUTIS includes FEM (Finite Element Modeling) simulations, 3D model representations, promotional marketing structure, and a provisional patent.

The method uses two transducers, a transmitting unit, and a receiving unit that are placed on opposite sides of the pole in a colinear manner across the external diameter of the pole, which is attached to a UAS that moves in a vertical direction up the pole. An NCG50-D63 high-performance piezo-composite non-contact US transducer will be used as the transmitting transducer, and the NCG50-D50 high-performance piezo-composite non-contact US transducer will be used as the receiving transducer. The transducers have nominal frequencies of 50kHz and are 63mm and 50mm in diameter, respectively. The two transducers are fastened to the UAS using a holding mechanism which is constructed of thin, aluminum, cylindrical plates that wrap around the transducers to hold them in place. The plates are hinged, allowing them to be opened for insertion of the transducers. Neoprene inserts are placed inside of the plates to prevent abrasion between the transducers and the plates. The holder can swivel in a vertical direction/angle, allowing transducer installation in a range of positions. A RITEC Inc. RPR-4000 High Power Pulser/Receiver is used to excite/drive/receive signals from the transducers. The transmitting transducer is connected directly to the RPR-4000 unit through an RT-150 termination box, and the receiving transducer is connected to a broadband receiver. A mobile power supply will be used to power the ACUTIS unit and will be located on the UAS. As the unit travels vertically along the pole, the transmitting transducer emits a signal which is pulsed through the pole and is picked up by the receiving transducer for transmission to the broadband receiver (RPR-4000).

The design concept implements a UAS capable of lifting between 50 - 60 lbs. The broadband receiver sends its data to a module that has the bandwidth capabilities to transmit the data wirelessly to an external computer.

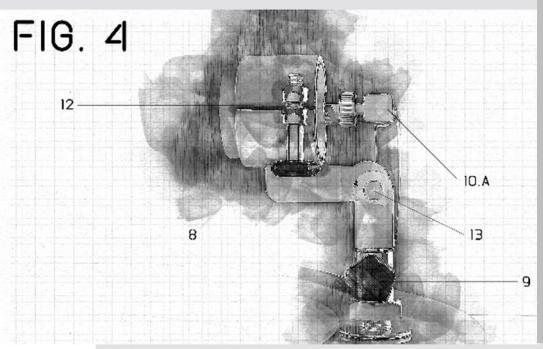
**FIG. 2** - This diagram illustrates a side view of the transducers placed co-linear across the diameter of the supporting structure and the receiving transducers connection to the resistor termination box.




## Figure 2 Diagram Details

**FIG. 2** illustrates a diagram of the transducers, transducer holders (**6**), and resistor-termination box (**7**). The figure illustrates the arrangement of the transducers and their co-linear locations towards one another. This arrangement is necessary to initiate in "through-transmission propagation" in which the wave propagated from the transmitting unit is sent across the diameter of the pole to be captured by the receiving unit. The UAS will be able to rotate the transducers in a perimeter around the pole to send ultrasonic waves at multiple diameter points, which enables the capture of data from various locations. Vital parameters from the capture of the through-transmission waves are time-of-flight, acoustic impedance, frequency, attenuation coefficient, and modulus of elasticity. This data is interpreted and analysed on the oscilloscope by a skilled technician who will identify and determine the defect and subsequently, if the pole is serviceable given the defect severity. These parameters are essential to identifying the defects that may be in the pole's internal structure. Time-of-flight will be the main data point in which to capture and is defined as the time required by the wave to travel from the transmitter to the receiver. The standard baseline and establishment for a non-defective pole will be measured first by observing the earliest peak of the cross-correlation between the two units. This measurement will then be compared to the readings from an initial inspection and any deviations in the peak amplitude will be cause for further identification to receive more information about the defect. The resister-termination box is specific to the system operation and reduces the reflections caused by the toneburst as well as providing more control of the voltage amplitude.

**FIG. 4** - This diagram illustrates the side view of the transducer that highlights the components of the transducer holder.




## Figure 4 Diagram Details

**FIG. 4** The transducer holder plays an important role in allowing placement of the transducer unit and providing a stable non-motion platform for which the transducers can conduct their main functions. The main holding structure of the holder, the cylindrical plate mechanism (**12**) is the focus point of the holder and allows for a specific and secure placement of the transducer. The clamp screw mechanism (**8**) secures the two cylindrical aluminium plates in place by containing two matching, threaded, and extended screw inserts at opposite sides along the cylindrical plate separation. The screw is inserted rotationally inside the screw holders by a knob at the bottom of the screw. The action of "unscrewing" the screw will allow the cylindrical plates to rotate in an outward angle. This action is described in detail in **FIG. 6**. The rotational axis point mechanism (**13**) incorporates three circular and threaded "rings" with a fitted screw to provide a full 180° of the transducer holder (except for the base) allowing the holder to be placed at any angle along the 180° for access or pitch-echo transmission. The base mechanism (**9**) is complete with a cylindrical copper base with a threaded insert to provide another 180° horizontal rotation point for the holder. The screw is placed in the threaded insert in the cylindrical base by a rotational knob that secures and un-secures the holder from horizontal rotation.

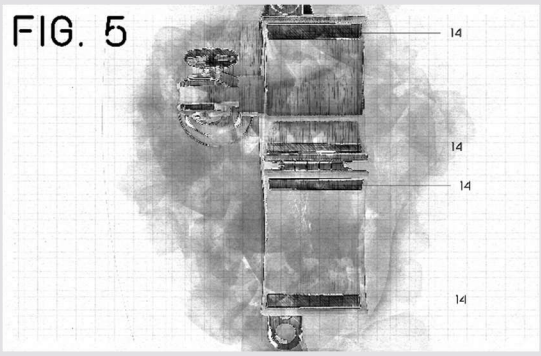



**FIG. 5** - This diagram illustrates the top-down view of the transducer holder with the cylindrical plates extended 180°.

## Figure 5 Diagram Details

**FIG. 5** The neoprene inserts (**14**) negate the aluminium-to-aluminium contact between the transducer and the cylindrical plate mechanism. This eliminates any scratches or abrasion that may occur from the above-mentioned contact.

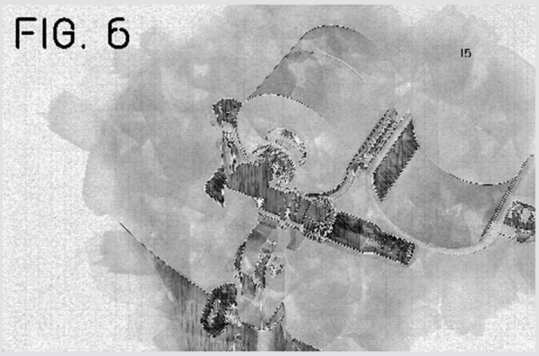



**FIG. 6** – This diagram illustrates the transducer holder with the cylindrical plates extended 180° with the transducer placed inside the holder.

## Figure 6 Diagram Details

**FIG. 6** The rotational hinge mechanism (**15**) describes the action of rotating the cylindrical plates in an outward angle to provide an access point for the transducer to be placed. This mechanism is of copper material and functions like a common door hinge.