normally placed at each end of the rope. Therefore the resolution of this system is limited by the distance between the transducer and receiver. If only a small part of the rope is damaged, the system would not be able to indicate the specific location of the damage and the entire rope would have to be considered suspect. Another limitation to this method is that it cannot be used in situations where a portion of the rope is inaccessible, such as a rope used in conjunction with an offshore crane where one end could be under thousands of feet of water.

[0009] Therefore, there is a need for a system that enables structural health monitoring of synthetic fiber ropes in a way that does not need to have direct contact with the rope, access to two distinct points along the rope, or the use of secondary materials, with greater resolution, and furthermore, is able to be used on a fast moving rope, and with a variety of rope fibers and construction methods.

SUMMARY OF THE INVENTION

[0010] ~~According to one aspect of the present invention, a non-contact acoustic signal propagation property evaluation system for synthetic ropes includes a first non-contact transducer spaced from a side of a rope to be evaluated. A first electrical signal is generated by a signal generator. The first transducer converts the first electrical signal from the signal generator into an acoustic signal directed towards the rope. A first portion of the acoustic signal propagates through the rope in a transverse direction and a second portion of the acoustic signal passes around the perimeter of the rope. A second transducer is spaced from an opposite side of the rope and is radially aligned with the first transducer. The second transducer receives and converts the first and second portions of the acoustic signal into a second electrical signal. A signal processing circuit receives and converts the second electrical signal into a digital signal. A processor connected to the signal processing circuit and executing computer readable code attributes properties of the digital signal to the acoustic propagation properties of the rope which can then be used to determine the physical properties of the rope.~~In one aspect, there is provided a non-contact acoustic signal propagation property evaluation system for synthetic ropes, the system comprising: a first transducer spaced from a side of a rope to be evaluated, configured to convert a first electrical signal into an acoustic signal directed towards the rope, wherein a first portion of the acoustic signal propagates through the rope in a transverse direction and a second portion of the acoustic signal passes around the perimeter of the rope; a second transducer spaced from an opposite side of the rope and radially aligned with the first transducer, configured to receive and convert the first and second portions of the acoustic signal into a second electrical signal; a signal processing circuit configured to receive and convert the second electrical signal into a digital signal; a processor connected to the signal processing circuit and executing

computer readable code configured to attribute properties of the digital signal to acoustic propagation properties of the rope and provide a structural health measure of the rope based in part on the acoustic propagation properties of the rope.

[0011] The acoustic signal may be an ultrasonic waveform and the first portion of the acoustic signal may be a longitudinal ultrasonic wave. The first and second transducers may be fixed in place while the rope moves relative to the first and second transducers. Additional transducers may be used in the system, such as a third transducer spaced from the rope and the first transducer and a fourth transducer spaced from the rope and the second transducer. The first transducer and the second transducer may be positioned at a first longitudinal location of the rope, and the third transducer and the fourth transducer may be positioned at a second longitudinal location of the rope. In some embodiments, the first

electrical signal is either a pulse, square, or a sinusoidal waveform. The code may further provide a structural health measure of the rope based in part on the acoustic propagation properties of the rope. The first transducer and the second transducer may be piezoelectric-based transducers. A first air gap may be disposed between the first transducer and the rope, and a second air gap may be disposed between the second transducer and the rope.

[0012] ~~According to another aspect of the present invention, a method of evaluating acoustic signal propagation properties through a rope comprises the steps of: generating, at a first location spaced apart from the rope, an acoustic signal; directing the acoustic signal in a transverse direction towards a first longitudinal location of the rope, wherein upon impinging the rope, a first portion of the acoustic signal propagates through the rope and a second portion of the acoustic signal passes around the perimeter of the rope; receiving, at a second location spaced from the rope, the first portion and the second portion of the acoustic signal; and analyzing the first portion and the second portion of the acoustic signal.~~In another aspect, there is provided a method of evaluating acoustic signal propagation properties through a rope as the rope is used over time to monitor the structural health of the rope, comprising the steps of: generating, at a first location spaced apart from the rope, an acoustic signal; directing the acoustic signal in a transverse direction towards a first longitudinal location of the rope, wherein upon impinging the rope, a first portion of the acoustic signal propagates through the rope and a second portion of the acoustic signal passes around the perimeter of the rope; receiving, at a second location spaced from the rope, the first portion and the second portion of the acoustic signal; analyzing the first portion and the second portion of the acoustic signal; and repeating the generating, directing, receiving, and analyzing steps over time as the rope wears to monitor changes in the first portion and the second portion of the acoustic signal and thereby determine structural health changes of the rope.

[0013] The steps of generating, directing, receiving, and analyzing may be repeated at each of a plurality of longitudinal locations along the rope. The steps of generating, directing, receiving, and analyzing may be repeated at the first longitudinal location of the rope and the step of analyzing may include analyzing changes in the first portion and the second portion of the acoustic signal over time. The step of analyzing may include determining a rate of change of the first portion and the second portion of the acoustic signal. The step of analyzing may include comparing the first portion and the second portion of the acoustic signal to reference data. The step of generating the acoustic signal may include generating the acoustic signal using a first transducer spaced from the rope. The step of receiving the first portion and the second portion of the acoustic signal may include receiving the first portion and the second portion of the acoustic signal using a second transducer spaced from the rope

opposite the first transducer. The method may further comprise the step of moving the first transducer and the second transducer while the rope remains stationary. The method may further comprise the step of determining a structural health measure of the rope based, at least in part, on the first portion and the second portion of the acoustic signal. The step of directing may include directing the acoustic signal through a water gap between the first location and the rope.

[0014] The foregoing and other aspects~~objects~~ and advantages of the invention will appear in the detailed description that follows. In the description, reference is made to the accompanying drawings that illustrate a preferred embodiment of the invention.