Guided Surface Waves," which was filed on June 2, 2015 and assigned Application Number 14/728,507, and which is incorporated herein by reference in its entirety. This application is further related to co-pending U.S. Non-provisional Patent Application entitled "Excitation and Use of Guided Surface Waves," which was filed on June 2, 2015 and assigned Application Number 14/728,492, and which is incorporated herein by reference in its entirety.

BACKGROUND

[0003] For over a century, signals transmitted by radio waves involved radiation fields launched using conventional antenna structures. In contrast to radio science, electrical power distribution systems in the last century involved the transmission of energy guided along electrical conductors. This understanding of the distinction between radio frequency (RF) and power transmission has existed since the early 1900's.

SUMMARY

[0004] Embodiments of the present disclosure are related to remote surface sensing using guided surface waveguide modes on lossy media.

[0004a] According to a first aspect of the present invention, there is provided a system, comprising: a guided surface waveguide probe configured to launch a guided surface wave along a surface of a lossy conducting medium; and a receiver configured to receive backscatter reflected by a remotely located object illuminated by the guided surface wave.

[0004b] According to a second aspect of the present invention, there is provided a method, comprising: launching a guided surface wave along a surface of a lossy conducting medium by exciting a charge terminal of a guided surface waveguide probe; and receiving backscatter reflected by a remotely located object illuminated by the guided surface wave.

[0005] There is disclosed a system comprises a guided surface waveguide probe configured to launch a guided surface wave along a surface of a lossy conducting medium, and a receiver configured to receive backscatter reflected by a remotely located object illuminated by the guided surface wave. The guided surface waveguide probe can comprise a charge terminal elevated over a lossy conducting medium configured to generate at least one resultant field that synthesizes a wave front incident at a complex Brewster angle of incidence ($\theta_{i,B}$) of

the lossy conducting medium. The charge terminal can be one of a plurality of charge terminals.

[0006] The guided surface waveguide probe can comprise a feed network electrically coupled to a charge terminal, the feed network providing a phase delay (Φ) that matches a wave tilt angle (Ψ) associated with a complex Brewster angle of incidence ($\theta_{i,B}$) associated with the lossy conducting medium in the vicinity of the guided surface waveguide probe. The charge terminal can be one of a plurality of charge terminals. The feed network can be configured to impose a plurality of voltage magnitudes and a plurality of phases on the plurality of charge terminals to synthesize a plurality of fields that substantially match a guided surface-waveguide mode of the lossy conducting medium, thereby launching the guided surface wave.

[0007] The guided surface waveguide probe can be configured to launch a series of guided surface waves having a defined pulse duration at a defined repetition rate. The guided surface wave can be a frequency modulated continuous wave. The remotely located object can be on the surface of the lossy conducting medium or above the surface of the lossy conducting medium. The remotely located object can be a low flying aircraft or other vehicle on or over the lossy conducting medium. The lossy conducting medium can be a terrestrial medium.

[0008] A plurality of guided surface waveguide probes can be configured to launch guided surface waves along the surface of the lossy conducting medium. A plurality of receivers can be configured to receive backscatter reflected by the remotely located object illuminated by the guided surface wave. A mobile vehicle can include the receiver.

[0009] There is disclosed a method comprises launching a guided surface wave along a surface of a lossy conducting medium by exciting a charge terminal of a guided surface waveguide probe, and receiving backscatter reflected by a remotely located object illuminated by the guided surface wave. Excitation of the charge terminal can generate a resultant field that synthesizes a wave front incident at a complex Brewster angle of incidence ($\theta_{i,B}$) of the lossy conducting medium. A characteristic of the remotely located object can be determined based at least in part upon the backscatter.

[0010] The guided surface waveguide probe can comprise a feed network electrically coupled to the charge terminal, the feed network providing a phase delay (Φ) that matches a wave tilt angle (Ψ) associated with a complex Brewster angle of incidence ($\theta_{i,B}$) associated with the lossy conducting medium in the vicinity of the guided surface waveguide probe. The guided surface waveguide probe can be configured to launch a series of guided surface waves having a defined pulse duration at a defined repetition rate.

[0011] Other systems, methods, features, and advantages of the present disclosure will be or become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, methods, features, and advantages be included within this description, be within the scope of the present disclosure, and be protected by the accompanying claims.

[0012] In addition, all optional and preferred features and modifications of the described embodiments are usable in all aspects of the disclosure taught herein. Furthermore, the individual features of the dependent claims, as well as all

CLAIMS

1. A system, comprising:

a guided surface waveguide probe configured to launch a guided surface wave along a surface of a lossy conducting medium, where the guided surface waveguide probe generates at least one resultant field that synthesizes a wave front incident with the lossy conducting medium at a complex Brewster angle of incidence ($\theta_{i,B}$) of the lossy conducting medium; and

a receiver configured to receive backscatter reflected by a remotely located object illuminated by the guided surface wave.

2. The system of claim 1, wherein the guided surface waveguide probe comprises a charge terminal elevated over the lossy conducting medium configured to generate the at least one resultant field that synthesizes the wave front incident at the complex Brewster angle of incidence ($\theta_{i,B}$) of the lossy conducting medium.

3. The system of claim 2, wherein the charge terminal is one of a plurality of charge terminals elevated over the lossy conducting medium.

4. The system of claim 1, wherein the guided surface waveguide probe comprises a feed network electrically coupled to the charge terminal, the feed network providing a phase delay (Φ) that matches a wave tilt angle (Ψ) associated with the complex Brewster angle of incidence ($\theta_{i,B}$).

5. The system of claim 4, wherein the charge terminal is one of a plurality of charge terminals electrically coupled to the feed network.

6. The system of claim 5, wherein the feed network is configured to impose a plurality of voltage magnitudes and a plurality of phases on the plurality of charge terminals to synthesize a plurality of fields that substantially match a guided surface-waveguide mode of the lossy conducting medium, thereby launching the guided surface wave.

7. The system of claim 1, wherein the guided surface waveguide probe is configured to launch a series of guided surface waves having a defined pulse duration at a defined repetition rate.

8. The system of claim 1, wherein the guided surface wave is a frequency modulated continuous wave.

9. The system of claim 1, wherein the remotely located object is on the surface of the lossy conducting medium.

10. The system of claim 1, wherein the remotely located object is above the surface of the lossy conducting medium.

11. The system of claim 10, wherein the remotely located object is a low flying aircraft.

12. The system of claim 1, comprising a plurality of guided surface waveguide probes configured to launch guided surface waves along the surface of the lossy conducting medium.

13. The system of claim 1, comprising a plurality of receivers configured to receive the backscatter reflected by the remotely located object illuminated by the guided surface wave.

14. The system of claim 1, wherein the lossy conducting medium is a terrestrial medium.

15. The system of claim 1, comprising a mobile vehicle including the receiver.

16. A method, comprising:

launching a guided surface wave along a surface of a lossy conducting medium by exciting a charge terminal of a guided surface waveguide probe, the charge terminal elevated over the lossy conduction medium; and

receiving backscatter reflected by a remotely located object illuminated by the guided surface wave.

17. The method of claim 16, wherein excitation of the charge terminal generates a resultant field that synthesizes a wave front incident at a complex Brewster angle of incidence ($\theta_{i,B}$) of the lossy conducting medium.

18. The method of claim 16, wherein the guided surface waveguide probe comprises a feed network electrically coupled to the charge terminal, the feed network providing a phase delay (Φ) that matches a wave tilt angle (Ψ) associated with a complex Brewster angle of incidence ($\theta_{i,B}$) associated with the lossy conducting medium in a vicinity of the guided surface waveguide probe.

19. The method of claim 16, wherein the guided surface waveguide probe is configured to launch a series of guided surface waves having a defined pulse duration at a defined repetition rate.

20. The method of claim 16, comprising determining a characteristic of the remotely located object based at least in part upon the backscatter.