Four-Dimensional Electron Density Mapping of the Ionosphere (#8349)

A novel technique for imaging electron density variations to support more efficient aerospace communications and space weather monitoring

This technique produces four-dimensional maps—specified by space and time—of electron density in the lower ionosphere, the ionized portion of Earth's upper atmosphere that is often used reflect and transmit radio waves over long distances. Developed at Georgia Tech, the technique uses natural lightning discharges as sources of very low frequency (VLF) radiation. A network of VLF receivers detect these emissions after they reflect between the ionosphere's D region (an altitude of 70 to 90 kilometers) and the Earth. This forms a spider web of paths from lightning locations to distant receivers, each providing information about one slice of the lower ionosphere. An innovative algorithm estimates the electron density for each path, and then assembles those many estimates into a three-dimensional image of electron density over a wide region, which evolves with time.

Benefits/Advantages

- **Innovative**: Produces the first four-dimensional image of electron density in the lower ionosphere
- **Far-reaching**: Leverages technology that can be used efficiently on a global scale
- **Pragmatic**: Yields a highly useful four-dimensional map to be used in military and commercial applications that rely on high-frequency communications

Potential Commercial Applications

An improved understanding of electron density variations and other patterns in the ionosphere has important applications for the military as well as government and commercial space agencies. Specifically, this technology has the potential to advance:

- Space instrument calibration
- Satellite navigation technologies
- Over-the-horizon radar systems
- High-frequency military and emergency communications

Background/Context for This Invention

The ionosphere contains plasma created by radiation from the sun and galactic cosmic rays. A robust understanding of the ionosphere is critical for many radio technologies, especially those used in the military and space agencies, as ionospheric variability affects the propagation of radio waves. This Georgia Tech

approach provides a practical, highly specific solution for mapping the ionosphere that will allow for more efficient aerospace communications systems.

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More Information

U.S. Number: 62/950,630

Publications

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/four-dimensional-electron-density-mapping-ionosphere

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot