(SD2021-225) Wireless Contact Force Sensing and Localization

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ABSTRACT

Contact force is a natural way for humans to interact with the physical world around us. However, most of our interactions with the digital world are largely based on a simple binary sense of touch (contact or no contact). Similarly, when interacting with robots to perform complex tasks, such as surgery, we need to acquire the rich force information and contact location, to aid in the task. To address these issues, researchers at UC San Diego have developed WiForce, which is a ‘wireless’ sensor that can be attached to an object or robot, like a sticker. WiForce’s sensor transduces force magnitude and location into phase changes of an incident RF signal, which is reflected back to enable measurement of force and contact location.

TECHNOLOGY DESCRIPTION

To address these issues, researchers at UC San Diego have developed WiForce, which is a ‘wireless’ sensor that can be attached to an object or robot, like a sticker. WiForce’s sensor transduces force magnitude and location into phase changes of an incident RF signal, which is reflected back to enable measurement of force and contact location. WiForce’s sensor is designed to support wide-band frequencies all the way up to 3 GHz. The inventors evaluated the force sensing wirelessly in different environments, including in-body like, and achieve force accuracy of 0.3 N and contact location accuracy of 0.6 mm.

The invention creates a new sensing modality to sense contact force and it's location of application, and communicate these wirelessly with ultra low power requirements

The uniqueness in this work lies in the extreme low power requirements for the sensing modalities, which allows the sensor to be powered via RF energy harvestors, and thus allows the sensor to be 'batteryless', a very big requirement for the force sensing applications to surgical robots

The invention essentially works by transducing contact force information into wireless signal phase changes, which are read by a wireless reader. To achieve this, the reader first transmits a wideband RF signal which the sensor backscatters with phase changes, and the reader receives back the phase changed signal. The phase change is then read at multiple frequencies using the wideband capabilities of the reader for a very robust phase change detection.

APPLICATIONS

OTHER INFORMATION

KEYWORDS

Robotics, signal processing, Networking and Internet Architecture (cs.NI);

CATEGORIZED AS

- **Communications**
  - Wireless
- **Medical**
  - Other
- **Sensors & Instrumentation**
  - Medical
- **Engineering**
  - Robotics and Automation

RELATED CASES

2021-Z08-1

Surgical Robots.

Many robots are remotely teleoperated, typically due to the need to operate in environments that are either hazardous or physically difficult for humans to access. Force sensing in these scenarios is critical, since teleoperation through a remote interface or tool causes the operator to lose their sense of touch, as they are no longer in direct contact with the physical environment. This lack of touch presents a particular challenge in the surgical setting, where robots can offer a number of potential benefits due to increased dexterity and precision compared to manual tools. In addition, the sensing challenge is further exacerbated by the small size of surgical tools, as well as the need for force information not just at the tool tip, but ideally along the length of the tool as well. This exacerbates the need for force sensing from not only requiring the location and magnitude of force, but the sensors should also be easy to attach, easy to read – no wires, low-form factor and batteryless.

ADVANTAGES

STATE OF DEVELOPMENT

INTELLECTUAL PROPERTY INFO

UC San Diego is looking for partners to develop commercial applications of this patent-pending technology.

RELATED MATERIALS

- Agrim Gupta, Cedric Girerd, Manideep Dunna, Qiming Zhang, Raghav Subbaraman, Tania Morimoto, Dinesh Bharadia. Wireless Sensing and Localization of Contact Forces on a Space Continuum. - 12/31/2020

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