Two–Dimensional Communication

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1 Introduction

Two–Dimensional Communication is an alternative technology for conventional wired or wireless networks especially for ubiquitous computing and sensor networks. This novel communication technology provides both 54 Mbps communication and a 10 W power supply via a thin, soft and flexible sheet without wiring.

For high-density sensor networks, it is quite difficult to connect all the nodes with wires, and the networks can become highly complex. Wireless connection has been the only simple way to distribute sensor nodes to a large area. Supplying power to each node, however, is a critical problem.

We have proposed an innovative communication device, the Two–Dimensional Communication sheet (2DC sheet). The nodes touching to the 2DC sheet can communicate with each other with 54 Mbps of bandwidth and can acquire 10 W of electricity. The 2DC sheet requires no direct electrical contact between the nodes and the sheet. Therefore nodes can be moved freely on the sheet. Wireless and batteryless ubiquitous infrastructure is possible through these features of the Two–Dimensional Communication sheet.

The idea of communication via a two dimensional medium was also proposed by several other groups ([Lifton et al. 2002] [Laerhoven et al. 2003] [Scott et al. 2002]). These projects, however, did not achieve both high speed communication and power supply simultaneously with a simple sheet.

2 Principle

The 2DC sheet has three layers. Two conductive layers sandwich a dielectric layer. When the high frequency voltage between two conductive layers is supplied, microwaves propagate two dimensionally in the dielectric layer. The upwards-facing side of the conductive layer has a meshed structure. When microwaves propagate in the 2DC sheet, the meshed pattern creates an evanescent wave immediately above the surface of the sheet. The evanescent waves make it possible for the nodes to communicate with each other and to receive electricity. Since the coupling to the evanescent field requires no electrical contact, the nodes can be connected anywhere on the sheet. This makes the technology both safer and rustproof.

The 2DC sheet corresponds to the physical layer of the OSI reference model. Any existing protocols including the wireless LAN protocols, Bluetooth, ZigBee, etc. are available. The Two–Dimensional Communication networks can be simply applied by replacing the existing antennas of wireless devices with a special surface connector for the 2DC sheet.

3 Applications

The 2DC technology can be applied to a room. Based on our 2DC scheme, walls, floors and ceilings can become both wireless and

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Figure 1: The demonstration of both data transmission and power supply through the Two–Dimensional Communication sheet. The right PC displays the movie data sent by the left one. The LEDs and the small fans receive electricity from the power source shown in the upper–left of the picture via the 2DC sheet.

batteryless communication infrastructures. As no wires and no batteries are required for the nodes, installation and maintenance becomes easier.

When the 2DC sheet fixed to a desktop surface, the desk itself provides the ubiquitous environment. Wireless devices can be connected to networks via the desk as well as recharged. Since the microwaves propagate only within the sheet, the communication becomes safer than a conventional wireless scheme.

Soft materials such as fabrics and rubbers can also be used for the conductive layers. This makes the sheet both flexible and stretchable. Such soft 2DC sheets can be used for artificial skins or wearable computing devices.

Acknowledgements

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