Applications of Backscatter Communication for Healthcare Networks
Jameel et al. IEEE Network 2017

3D Printing Wireless Connected Objects
Jeyn et al. ACM TOG 2016

Def. Ambient Backscatter (RF backscatter)
using existing radio frequency signals, such as radio, television, and mobile telephony, to transmit data without a battery or power grid connection.

Note: Backscatter is a method of communication. Can have different implementations.

Example 1: Passive RFID

Transmit and receive signal
store and modulate signal

How to modulate the signal: change the antenna impedance using a switch

Principle of reciprocity: any structure that receives a wave also transmits a wave
- small impedance → large current; large backscattered signal
- large impedance → small

Practical implementation
Read and Write with half-duplex

What if there are reflections from the ambient?

OOK (AM) might not be sufficient can also change phase (FSK)

However, with interference, cannot determine the absolute state, but can detect whether there is a change. Hence FSK

Put it together
Application in Healthcare

How does backscatter connect to 3D-print?

Example: Print WiFi

Print antenna: composite material that combines conductive material (graphene and copper) with plastic.

(a) Dipole
(b) Bowtie
(c) Patch

Print switch: modulate between reflective and non-reflective state.

(a) Cantilever (unpressed)
(b) Cantilever (pressed)
(c) Push button (unpressed)
(d) Push button (pressed)
Print control logic: encode data to switch

Print energy storage

How to extract it from Wi-Fi signal?

via...?

Demonstration

These Power-Free 3D Printed Objects Can Talk With WiFi

Variations

Acoustic Radar → Backscatter

nonVoice/THz Backscatter
\[ P_R = \frac{G_r G_t \lambda^2}{(4\pi d_1)^2} \]

\[ P_R = \frac{G_t G_r \lambda^2}{(4\pi d_2)^2} \]