

Implanted User Devices

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Outline

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- 2 History
 - Overview
 - Components
- 3 Communication and Security
 - Innovations
- 4 Implanted User Devices
 - Challenges
 - Interfaces
 - Power
- 5 Considerations
- 6 Conclusions

What are user devices?



Music players, cellular telephones, and other computing devices.

Implanted?



IMAGE: Artificial skin covering prototype device

(Credit: Holtz, et al.)

- Theoretically always-available interaction.
- Not visible.
- Never lost.

Early Implanted Devices

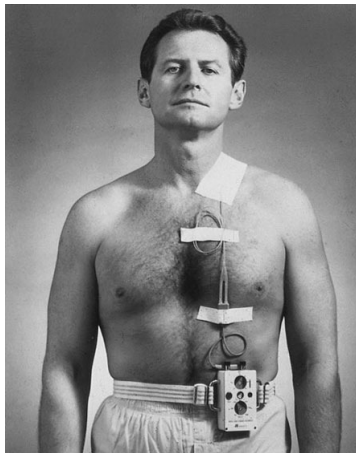
Pacemakers

Cochlear Implants

Implantable Cardioverter Defibrillators

Artificial Joints

Early Pacemaker



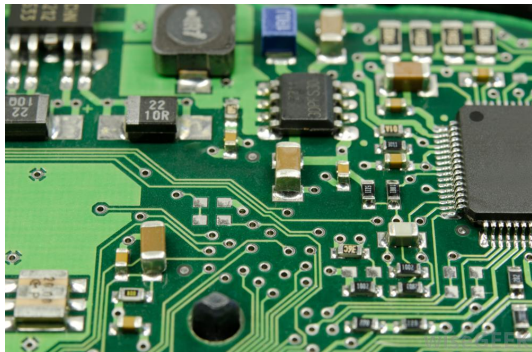
(Credit: Medtronic)

IMAGE: 1958 External Pacemaker

Essential Components:

What are they and how have they affected us?

Printed Circuit Board



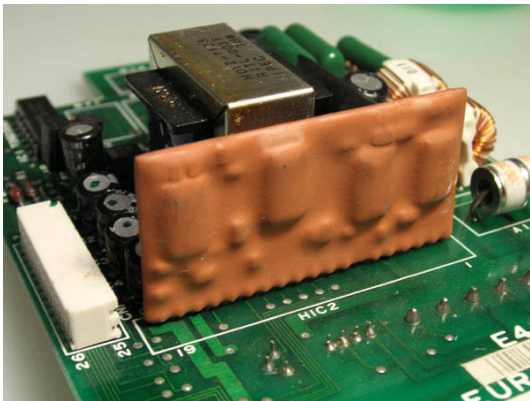
Development started in 1903

Patent filed in 1927

(Credit: Wisegeek.com)

IMAGE: Example of a printed circuit board

Hybrid Circuitry

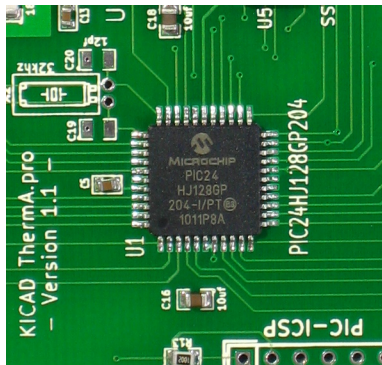


Developed in late 1950s.

Consists of one or more transistor chips and passive components mounted together.

IMAGE: Hybrid Circuit covered in orange epoxy

Integrated Circuit



(Credit: JGScraft.com)

IMAGE: Example of a microchip

Developed in 1958 by Jack Kilby of Texas Instruments.

Components and chip made out of same block of semiconductor material.

Communication and Security:

Why is it important?

Heart-to-Heart

Programmer - the device to interact with implanted device.

IMD - Implanted Medical Device

SECURE-CHANNEL SETUP PHASE

Secure but unauthenticated communication channel

Achieved through contact between Programmer and IMD patient.

AUTHENTICATION PHASE

1st: *Physiological Value (PV)* reading taken by both

2nd: PV readings used as "passwords"

3rd: If Programmer's PV = IMD's PV, access granted

4th: Authentication achieved

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Near-Field Communication (NFC)

Form of wireless communication
Smartphones have NFC capability

Differences between NFC and WiFi:

Utilizes electromagnetic radio fields – WiFi uses radio transmissions.

Operates in 13.56MHz frequency band

Average range \approx 1 meter – WiFi average range \approx 13 meters

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Implanted User Devices

Current State

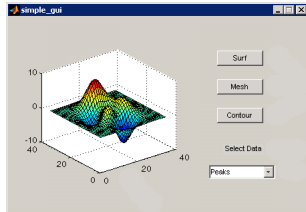
Two main challenges: Interface & Power

Interfaces

Definition: The point of interaction with computer software or hardware

Examples:

Touchscreen, mouse, microphone, GUI (graphical user interface)



Input

SOME SOLUTIONS:

EarPut

Magic Finger

Voice Interaction



EarPut



(Credit: Lisserman, et al.)

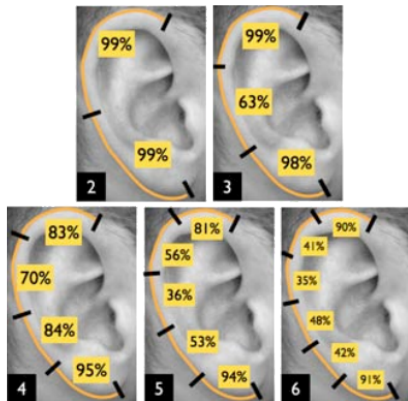
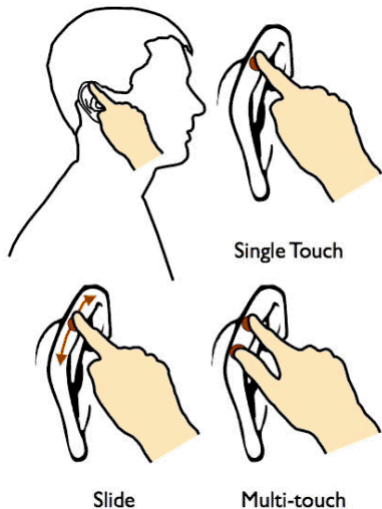
IMAGE: 2013 prototype device

Touch-based interaction

12 touch areas

Registers touches and swipes

EarPut

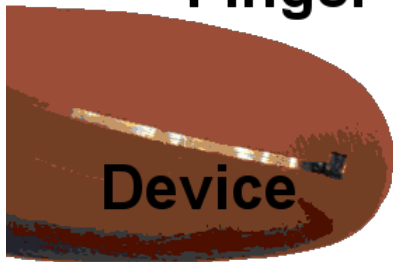


(Credit: Lisserman, et al.)

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Magic Finger

Finger



Uses optical mouse sensor and micro RGB camera.

Tap input (sensing contact) or gesture input (positional movement).

IMAGE: 2012 prototype MagicFinger device.

Voice Interaction



IMAGE: Apple's Siri

Technology exists:
Dragon Dictate, Siri, Cortana...

Limitations:
Languages, accents, privacy.

Output

CONSTRAINTS:

No screen

POSSIBLE ALTERNATIVES:

LED-indicators

Vibration

Audio

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Devices

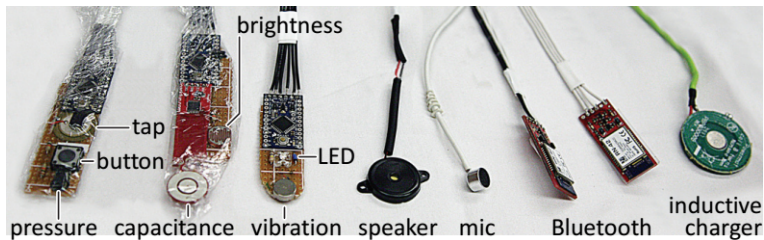
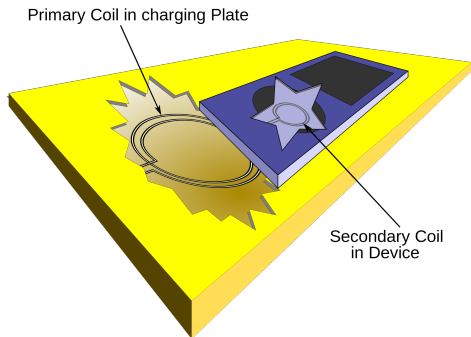


IMAGE: Devices used by Holtz, et al. 2012.

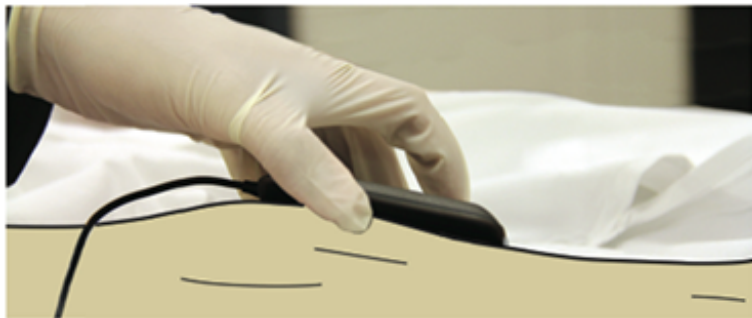
Power

INDUCTIVE CHARGING:

- 1st Magnetic field induced in transmitter coil by alternating current (AC)
- 2nd Sends energy from transmitter to receiver coil via magnetic coupling
- 3rd Receiver converts energy received into a direct current (DC)
- 4th DC used to charge battery



Power



(credit: Holtz, et al.)

Holtz, et al. using inductive charging on test subject.
Minimal loss of power through skin.

Considerations

PHYSICAL CONCERNS:

- Repercussions of radio waves
- Repercussions of inductive charging
- Allergic reactions
- Infections

ETHICAL CONCERNS:

- Affordable to all?
- Devices for entertainment vs. for improvement of life

Conclusions

- ◇ Implanted user devices are becoming a reality.
- ◇ They may not replace hand held devices
- ◇ Decisions need to be made in ethical concerns

QUESTIONS?