Wearable Wireless Biosensors for Spatiotemporal Grip Force Profiling in Real Time

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Plan

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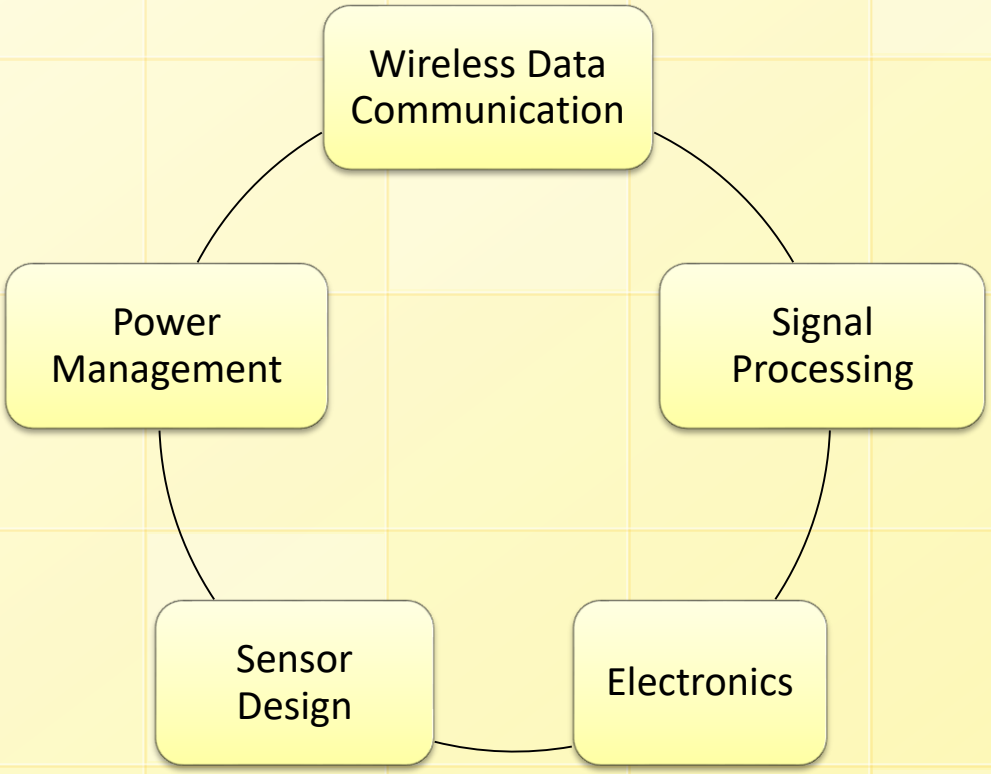
Introduction

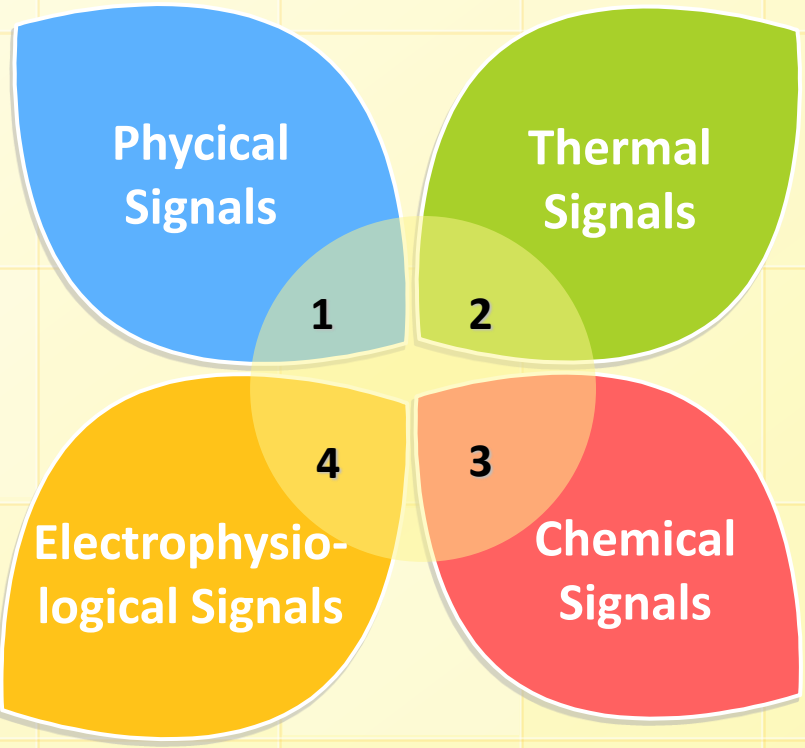
Wearable wireless biosensors

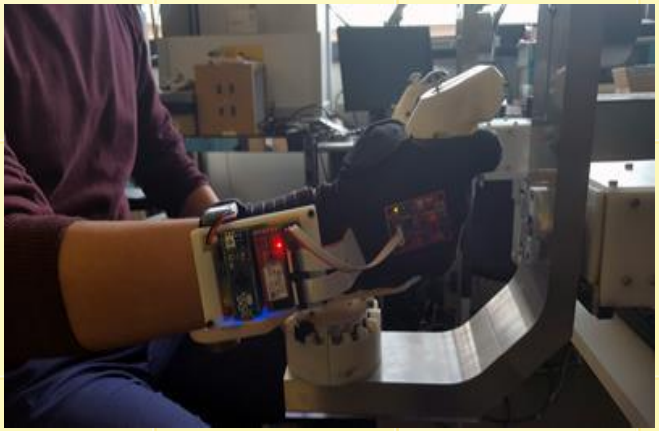


Introduction

Wearable wireless biosensor signals

Convenient
Continuous
Unobtrusive





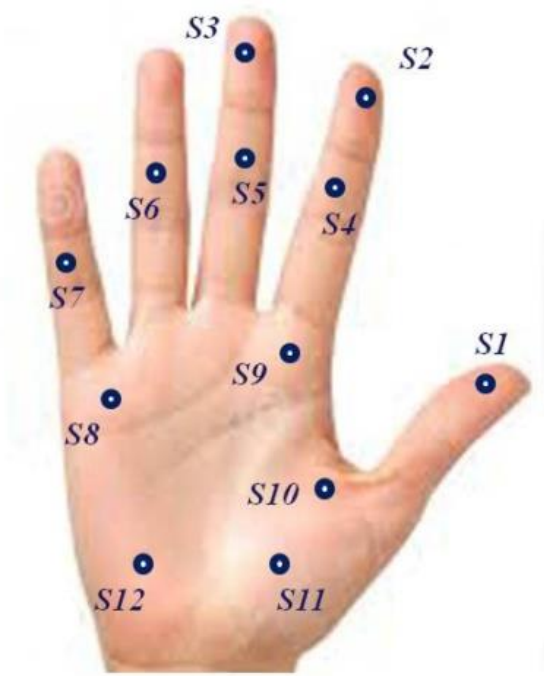
Grip Force Signals

Introduction

Wearable wireless sensor glove system

Materials and Methods

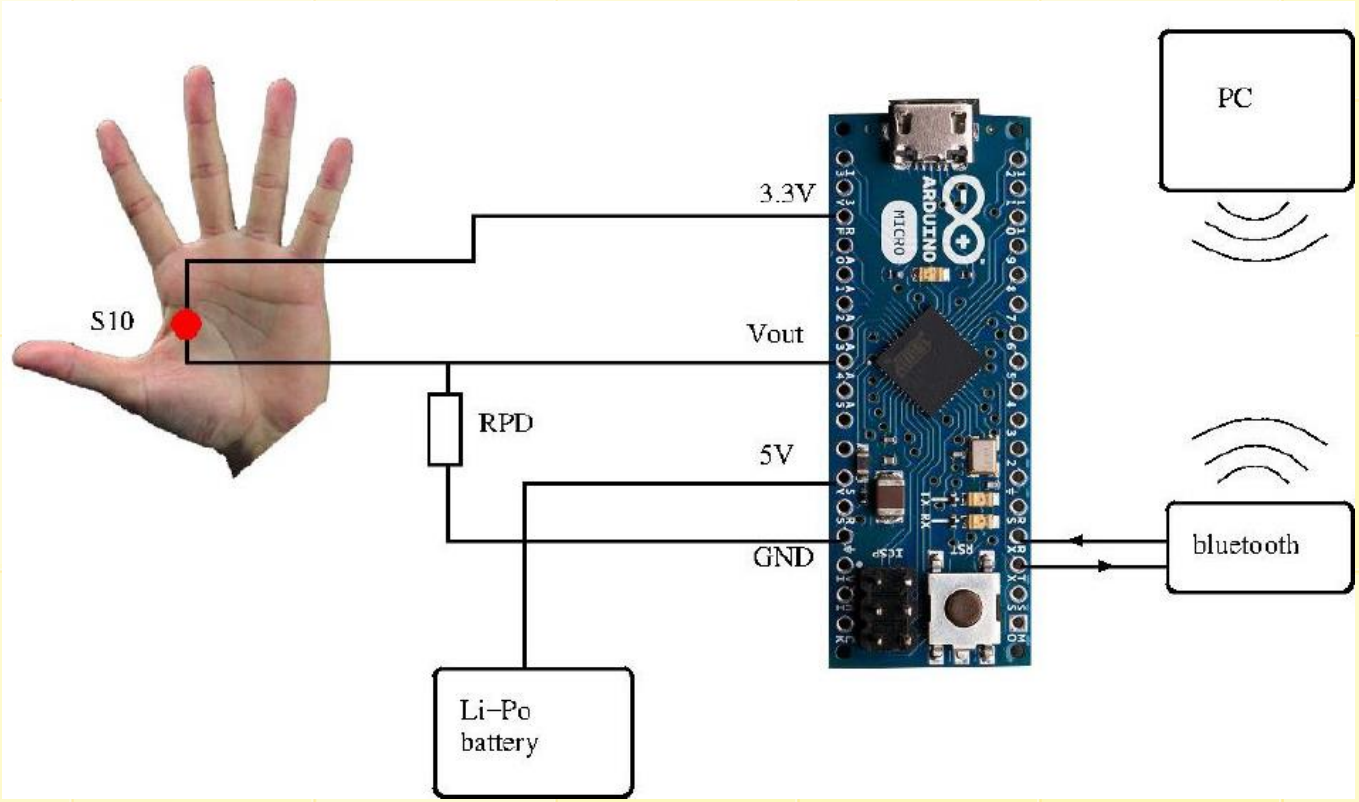
Force sensor locations



Sensor	*Hand region*	*Anatomical reference*
S1	Thumb	Distal Phalanx
S2	Index	Distal Phalanx
S3	Middle	Distal Phalanx
S4	Index	Middle Phalanx
S5	Middle	Middle Phalanx
S6	Ring	Middle Phalanx
S7	Pinky	Middle Phalanx
S8	Palm	Head Metacarpal
S9	Palm	Head Metacarpal
S10	Palm	Shaft Metacarpal
S11	Palm	Base Metacarpal
S12	Palm	Base Metacarpal

Materials and Methods

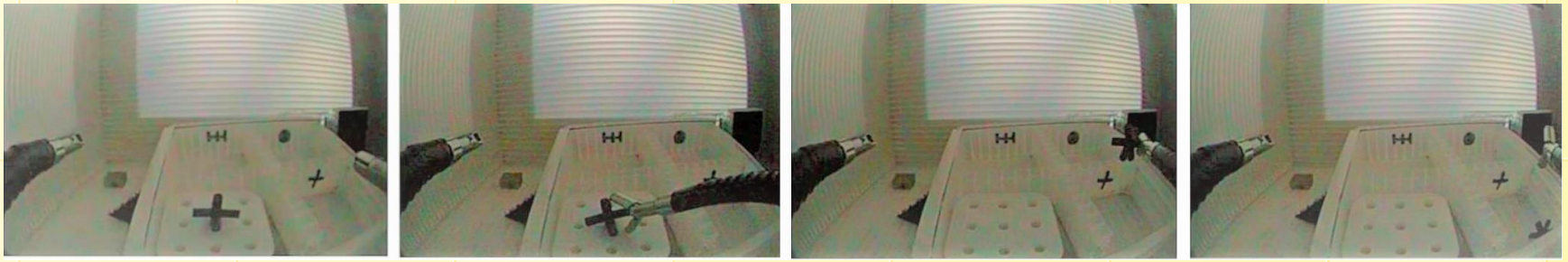
Data acquisition system



Materials and Methods

Four-step pick-and-drop task

Step	Description
1	Activate and move tool towards object location
2	Open and close grippers to grasp and lift object
3	Move tool with object to target location
4	Open grippers to drop object in box



Snapshot views of the four successive steps

Results

Three sensors on middle phalanx chosen

Sensor	Finger	Role in grip force control
S5	Middle	Gross grip force deployment
S6	Ring	No meaningful role in grip force control
S7	Pinky	Precision grip force control

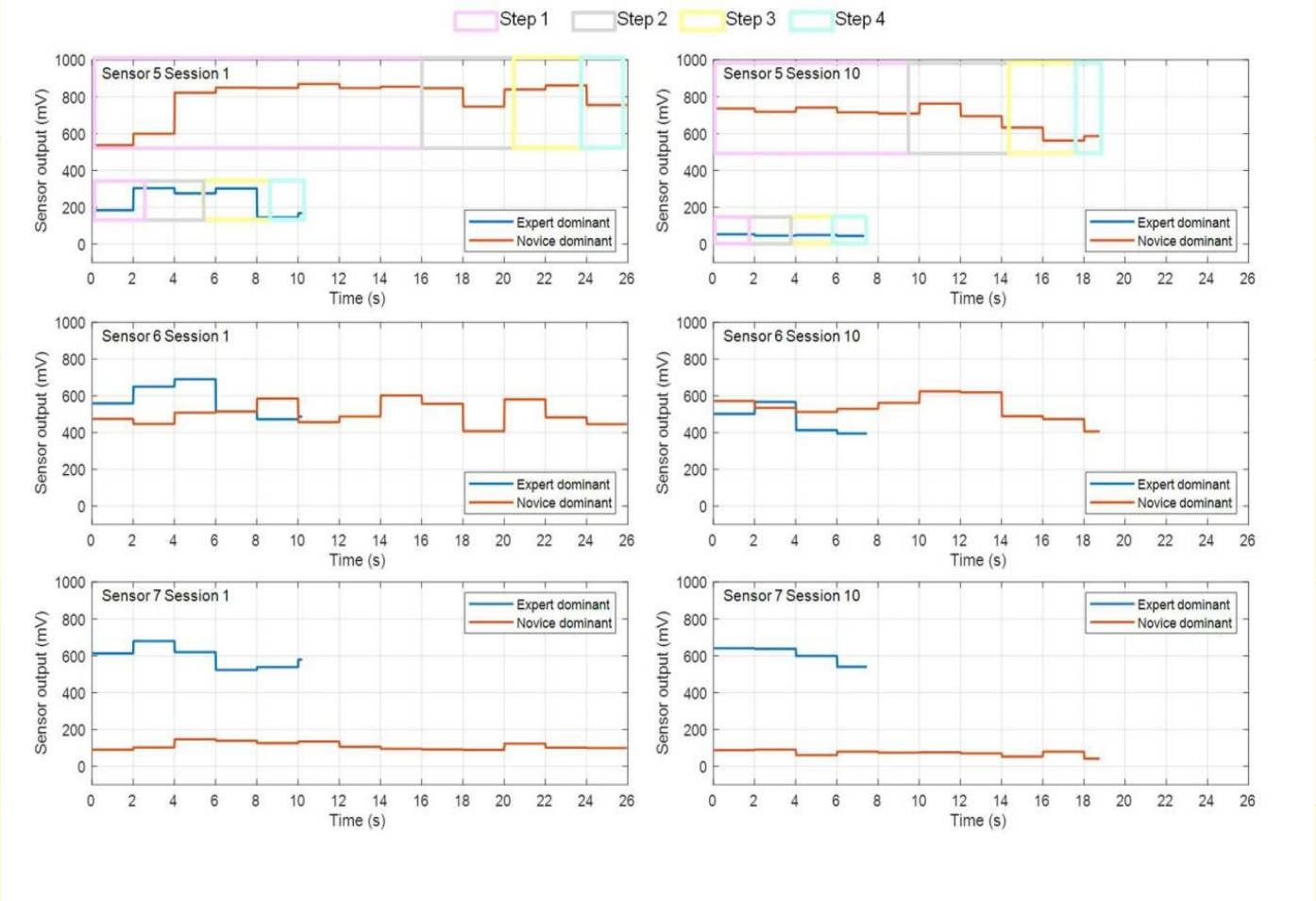
Results

Statistical comparison (2-Way ANOVA)

Sensor	Session	Mean (m)/ Standard errors (sem)		Interaction significance
		Expert	Novice	
S5	first	m=241mV /sem=4.3	m=790mV /sem=2.7	F(1,2880)=28.65; p<0.001
	last	m = 78mV /sem=4.9	m=640mV /sem=3.6	
S6	first	m=576mV /sem=3.8	m=504mV /sem=2.4	F(1,2880)=35.86; p<0.001
	last	m=474mV /sem=4.5	m=445mV /sem=3.3	
S7	first	m=594mV /sem=1.8	m= 98mV /sem=1.2	F(1,2880)=188.53 p<0.001
	last	m=609mV /sem=2.2	m= 78mV /sem=1.6	

Results

Average peak amplitudes



Discussion

Expertise-specific difference in task time

- A considerable temporal training effect

User	First session	Last session
Expert	10.20	7.48
Novice	24.56	18.78

- Largest time training gain for first step

Discussion

Expertise-specific difference in force deployment

Finger	Force deployment strategy
Middle	Too much unnecessary grip force for the novice
Ring	Little difference, both decrease across sessions
Pinky	Insufficient force for the novice, no major evolution

Conclusions

- Spatiotemporal grip force profile analyzed for wearable wireless biosensor in real time
- Grip force profile revealing task skill level and expertise
- To deliver insight to monitor manual precision tasks, control performance quality, or prevent risks in robot assisted surgery systems

Thanks for your attention