

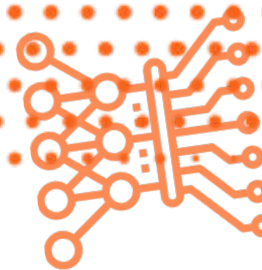
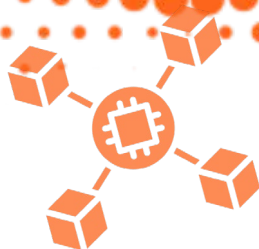
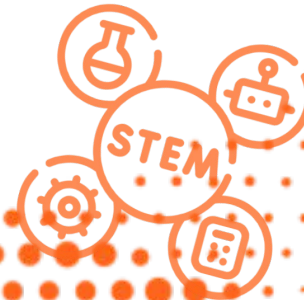
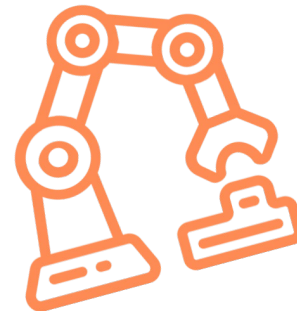


## Komunikacija za biomedicinske uređaje

Đurković Jovan, *MANT & MECOnet*

*jovan@meconet.me*







# Wire i wireless

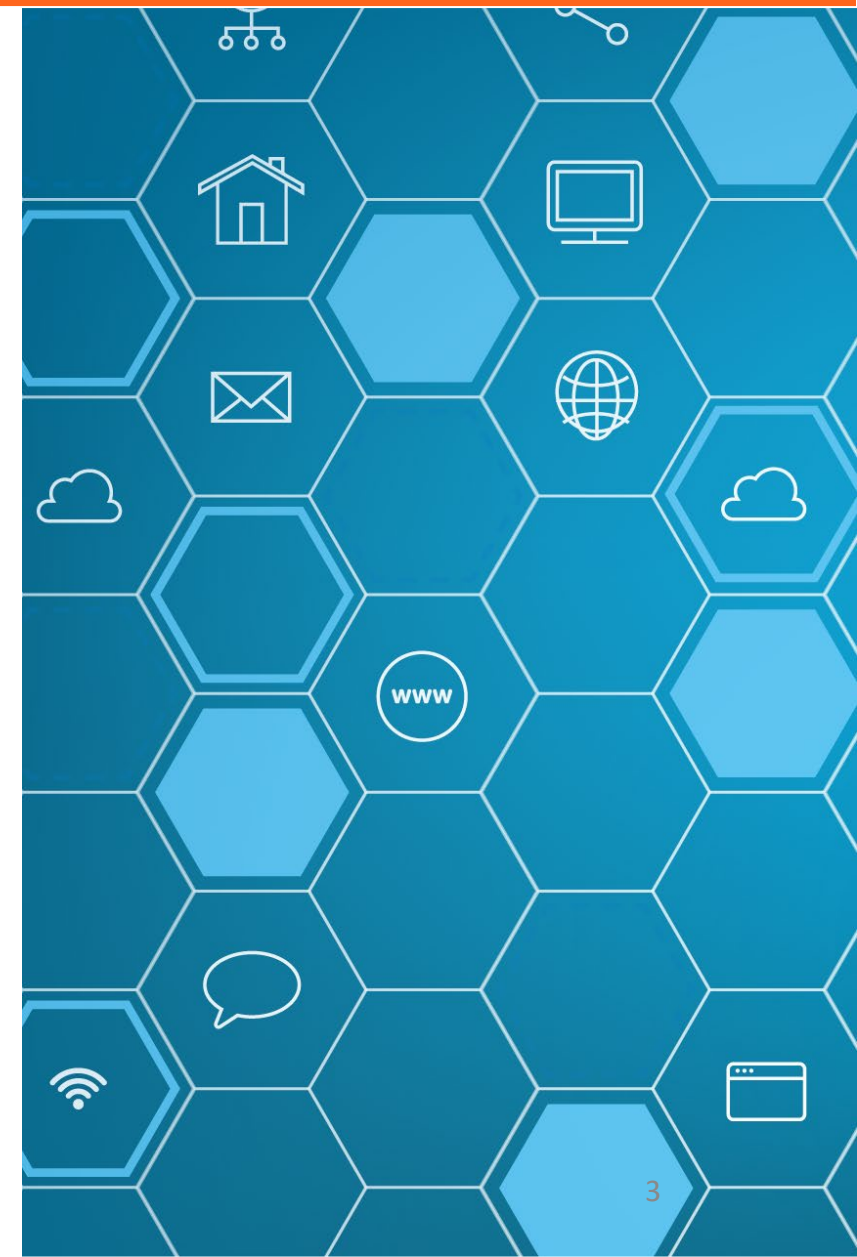
Aspekt komunikacije: wearable <-> local host (desktop ili gadget)

## Žičana komunikacija

- USB
- Audio (pomoću kabla)

## Bežična komunikacija

- RF
- BT / BLE
- WiFi
- Audio (pomoću mikrofona)





# Wire

## USB

- Primanje podataka sa medicinskog uređaja na računar ili telefon
- Brza komunikacija, naročito sa računarom
- Zahtijeva USB interfejs
- Potrebno je uskladiti podešavanja kod oba uređaja (brzinu komunikacije, veličinu znakova, parnost, broj stop bita)
- PC: SerialOscilloscope, SerialPlot, Arduino Serial Monitor, Matlab...
- Telefon: Serial USB Terminal, RobRemo, MIT App Inventor...

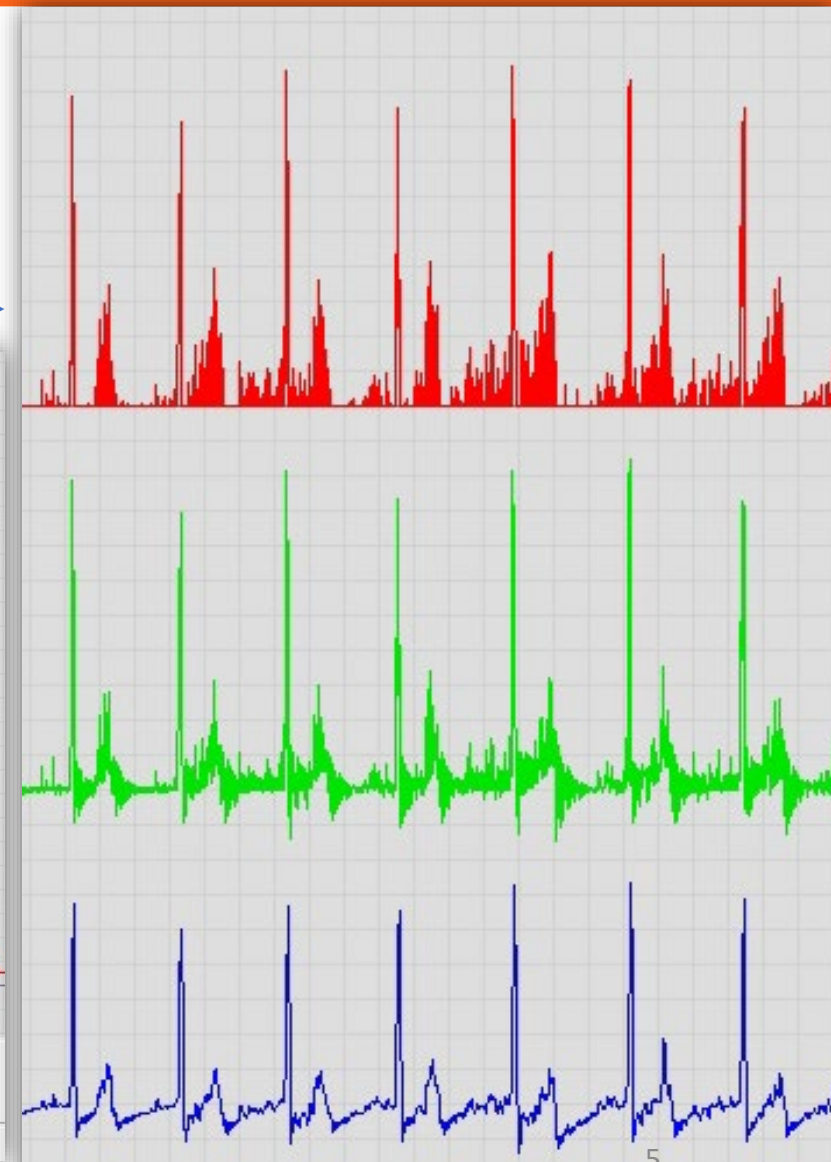
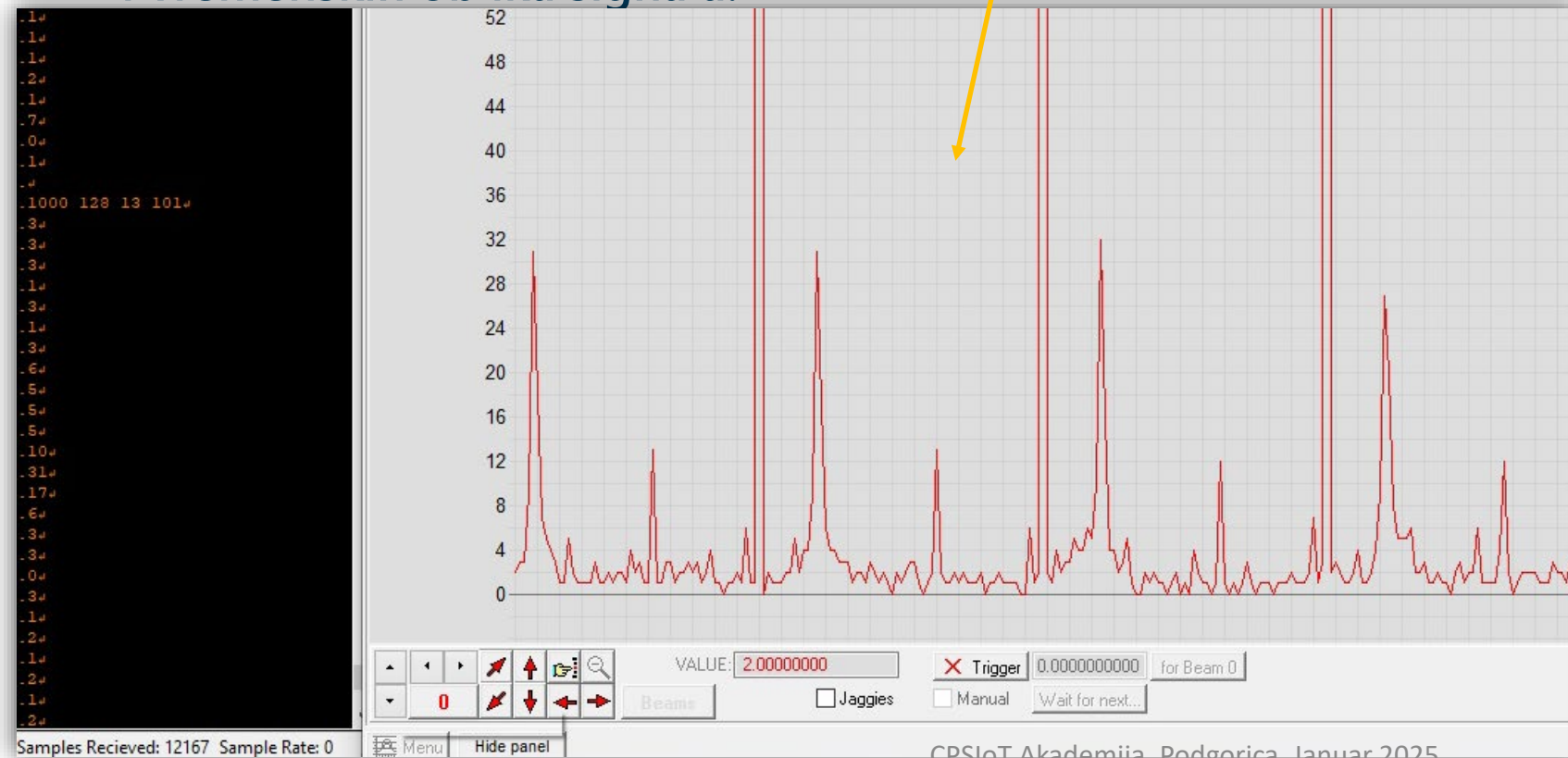
## Audio

- Bilo koji računar ili telefon sa audio priključkom i snimač zvuka



# Wire-serial over USB

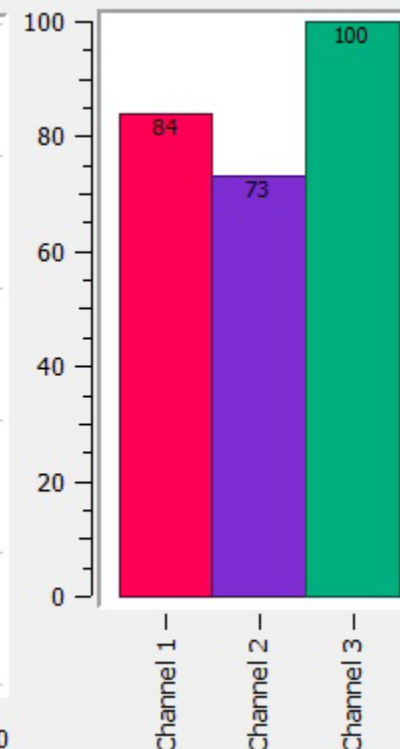
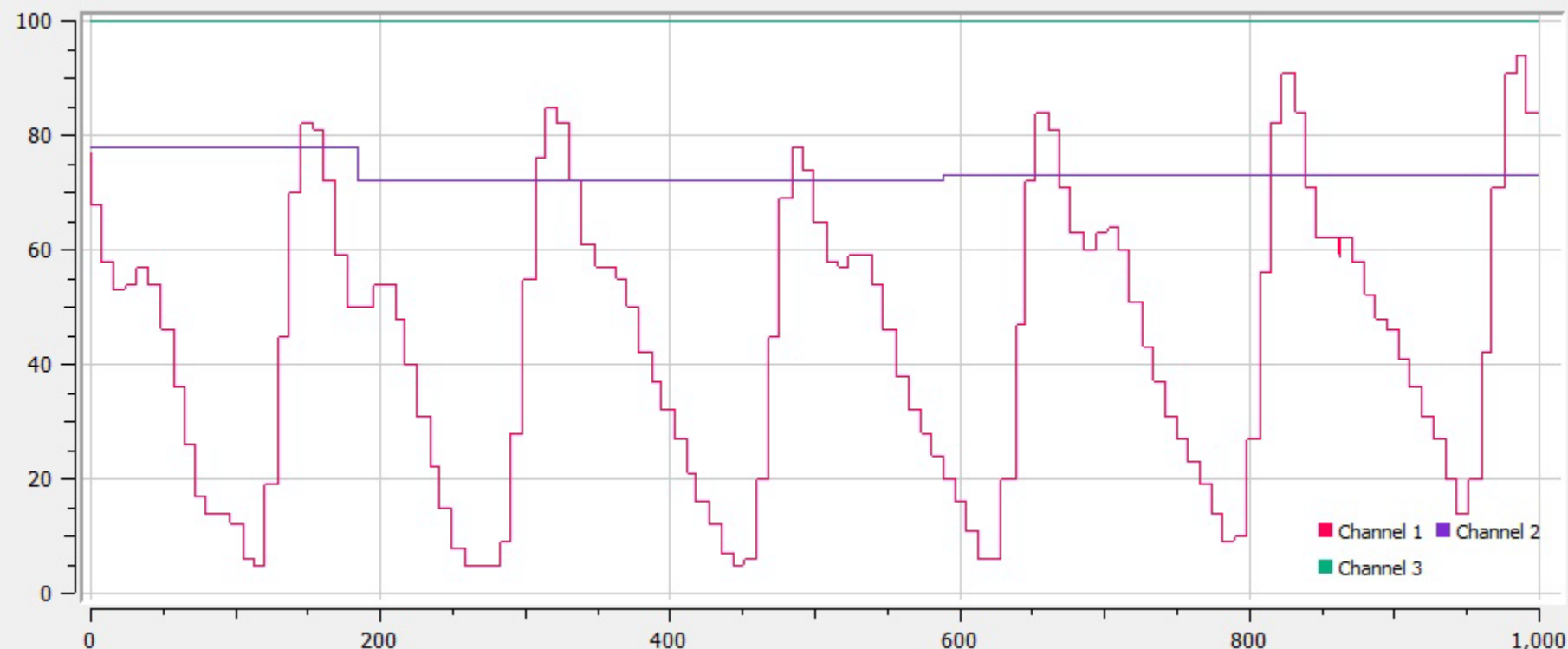
- Serial Oscilloscope, Primjer crtanja FFT spektra signala (Frekventni domen) kao i vremenskih oblika signala.





# Wire-serial over USB

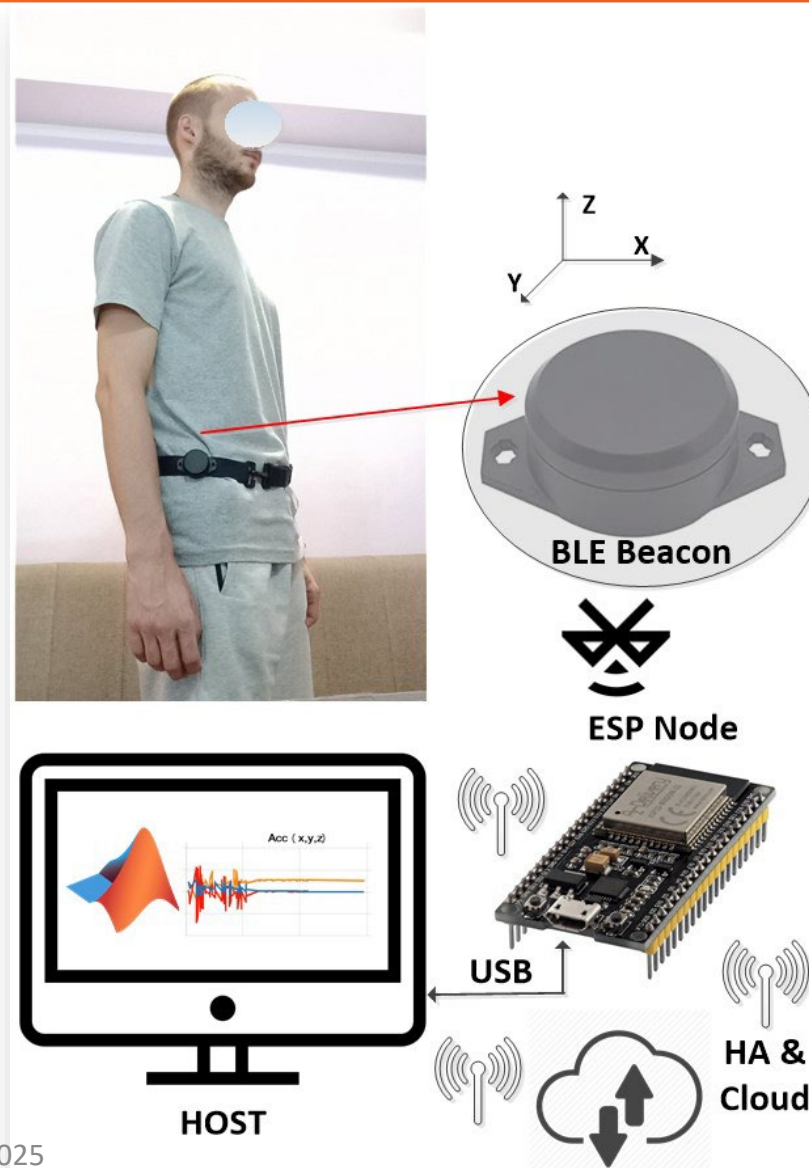
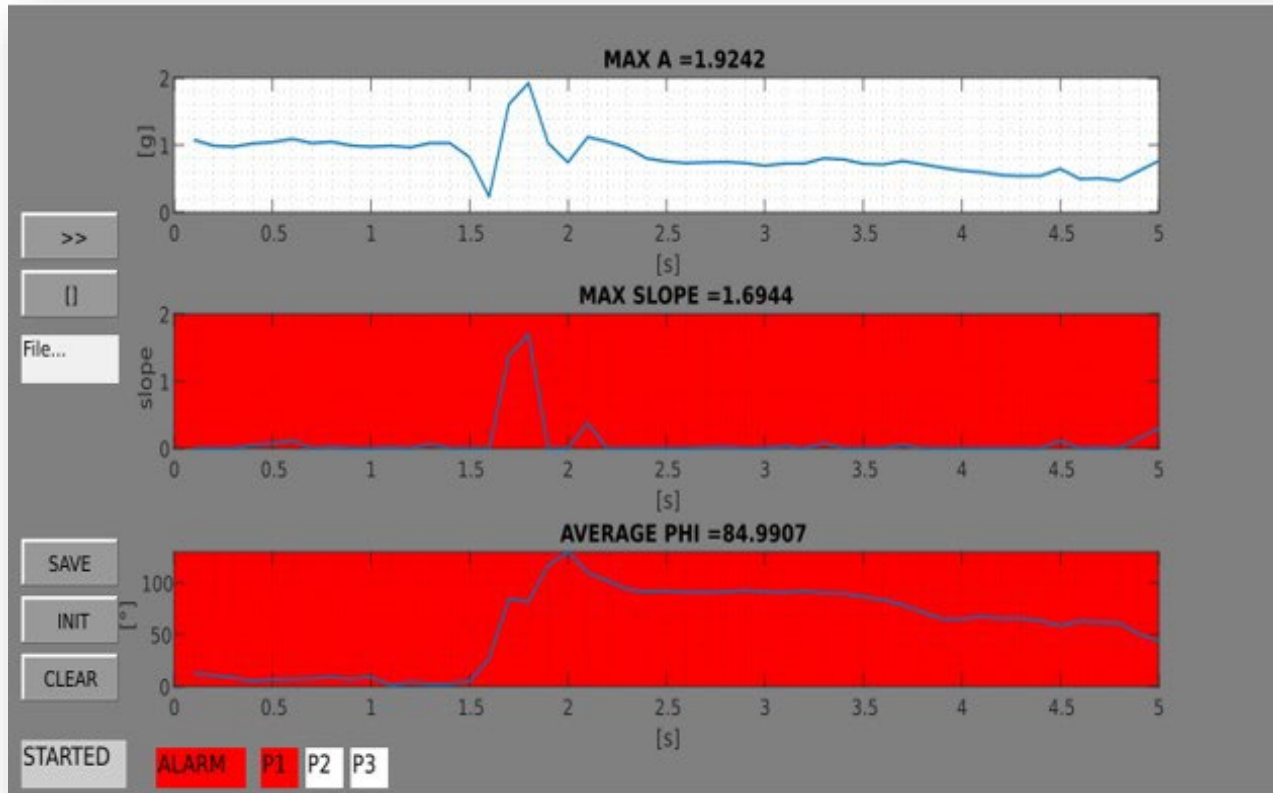
- SerialPlot, primjer korišćenja plotera za crtanje signala.





# Wire-serial over USB

- MATLAB, primjer detektora pada





# Wire-serial over USB

- Stress detector.  
Primjer aplikacije  
za vizualizaciju  
podataka  
primljenih preko  
USB.







# In audio

## Audio - modulacija / demodulacija

- Razmjena podataka između dva ili više uređaja
- Jednosmjerna komunikacija
  - Domet zavisi od amplitude zvuka
  - Analogni signal
- Frekvencijski opseg je ograničen karakteristikama mikrofona
  - 20Hz-20KHz za obične mikrofone
  - Do 96KHz i više za zvučne kartice, putem kablova
  - Frekvencija odabiranja mora da bude najmanje dva puta veća od najveće frekvencije signala





# In audio

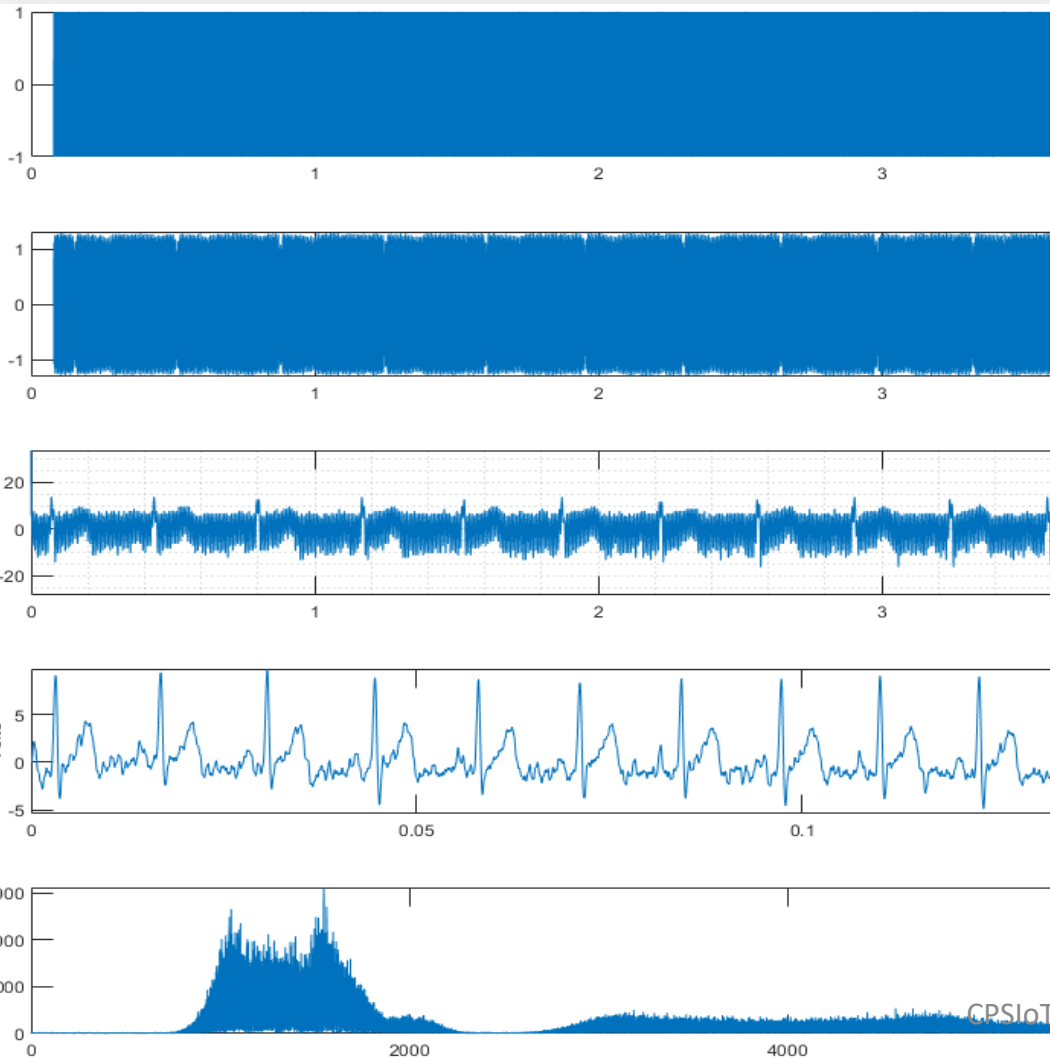
- Snimanje putem kabela:
- Snimanje putem mikrofona:



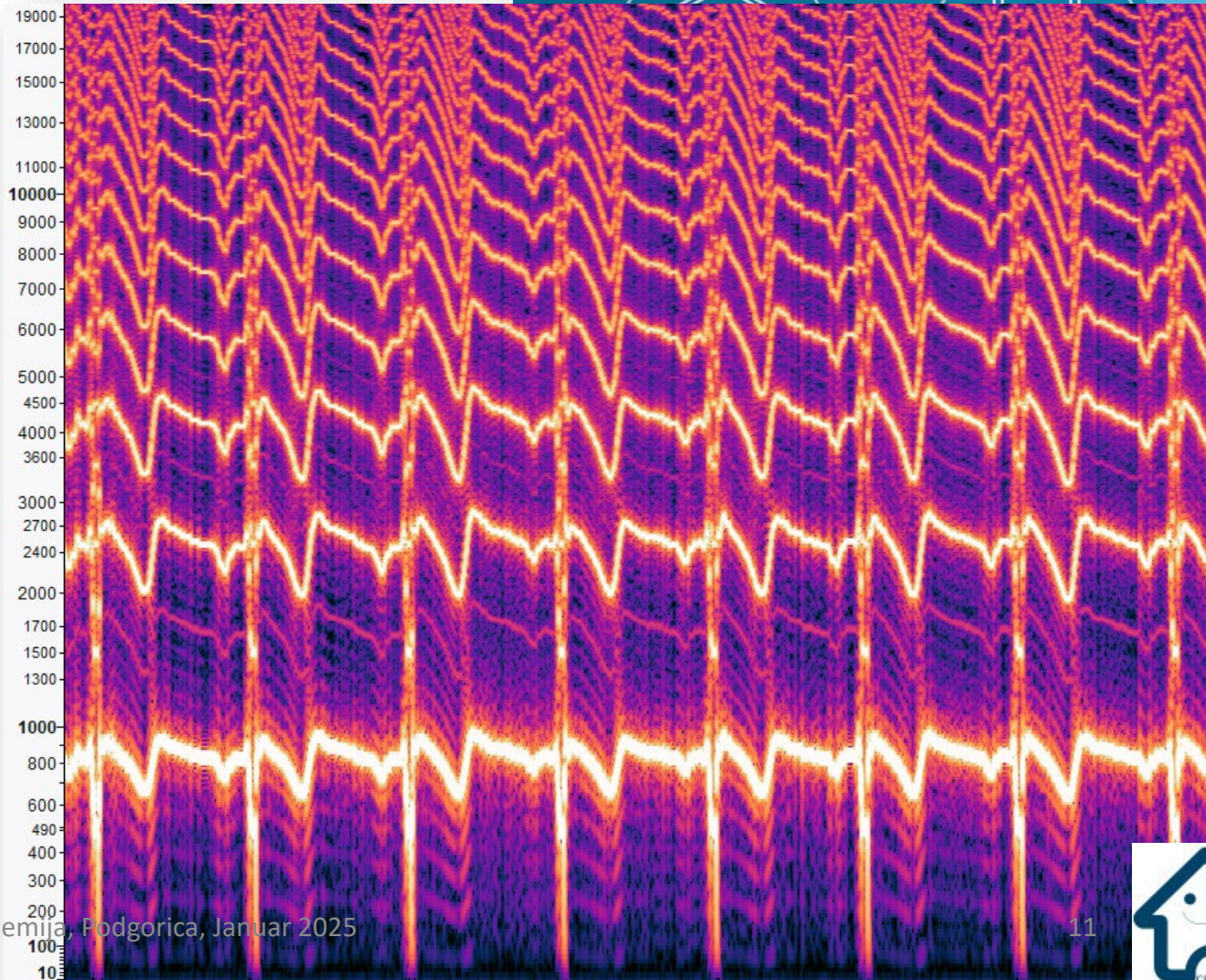


# In audio

- Obrada u matlabu



- Audacity, spektrogram





# RF

## RF

- Razmjena podataka između više uređaja
- Jednosmjerna ili dvosmjerna komunikacija
- 433MHz, 868MHz, 2.4GHz...
- Domet i brzina zavise od RF modula koji se koristi
  - 10m-1000m
  - 1-10kbps, 250kbps-2Mbps
- Moduli: FS1000A + XY-MK-5V, SYN115 + SYN480R, NRF24L01...





# BT

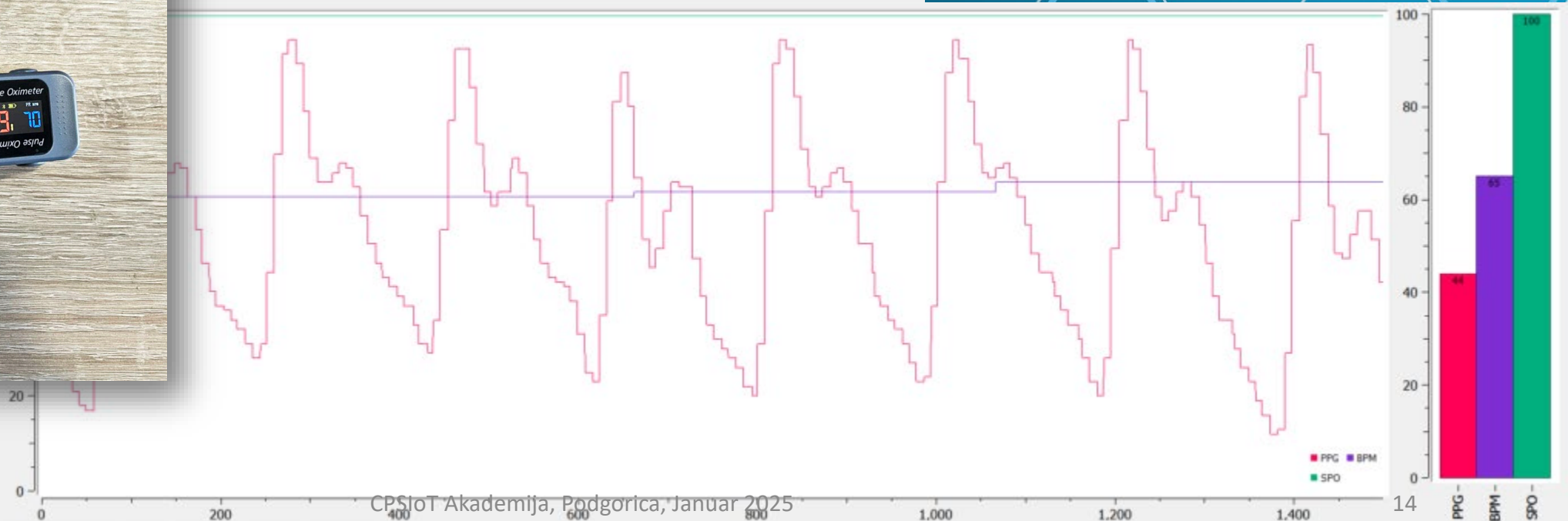
## Bluetooth / BLE

- Razmjena podataka između dva uređaja
- Dvosmjerna komunikacija
  - BT: 10m, 1Mbps
  - BLE: 30m, 1-2Mbps
- Moduli BT 2.0: HC-05, HC-06, JDY-08...
- Moduli BLE: HM-10, HM-11, nRF8001
  - Arduino Nano 33 BLE
  - ESP32, ESP32-S2, ESP32-C3, ESP32-C6, ESP32-S3
- Android: Bluetooth LE Scanner, Serial Bluetooth Terminal, BLE Scanner, LightBlue, nRF Connect



# BT

## Bluetooth / BLE





# WiFi

## WiFi

- Web socket metod
- Razmjena podataka između dva ili više uređaja
- Dvosmjerna komunikacija
  - 50-100m
  - 70-150Mbps
- Moduli: Wi-Fi Shield 101, ESP01, Wemos D1 Mini
- Arduino Nano 33 IoT
- ESP32, ESP32-S2, ESP32-C3, ESP32-S3
- Web browser
- Android: RoboRemo, MIT App Inventor...





# WiFi

## Web socket

Sampling Frequency: 200 Hz   Received: 64 samples   Status: WebSocket connection opened

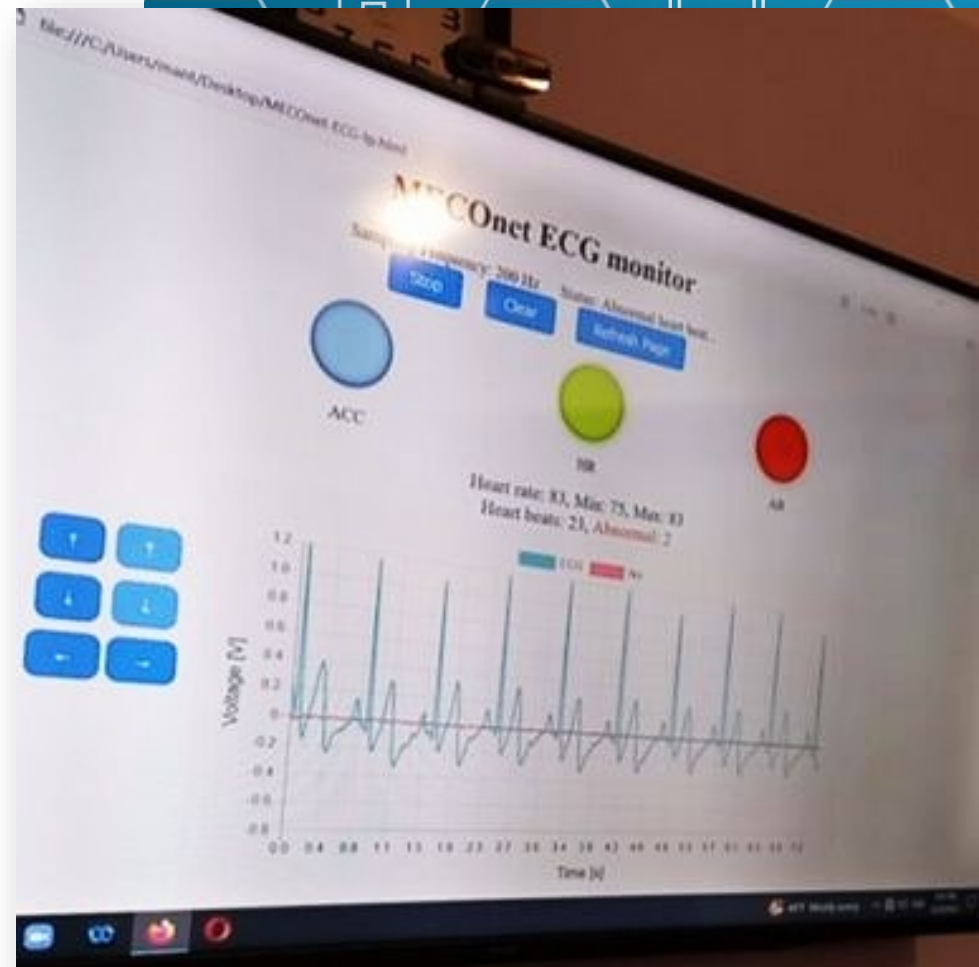
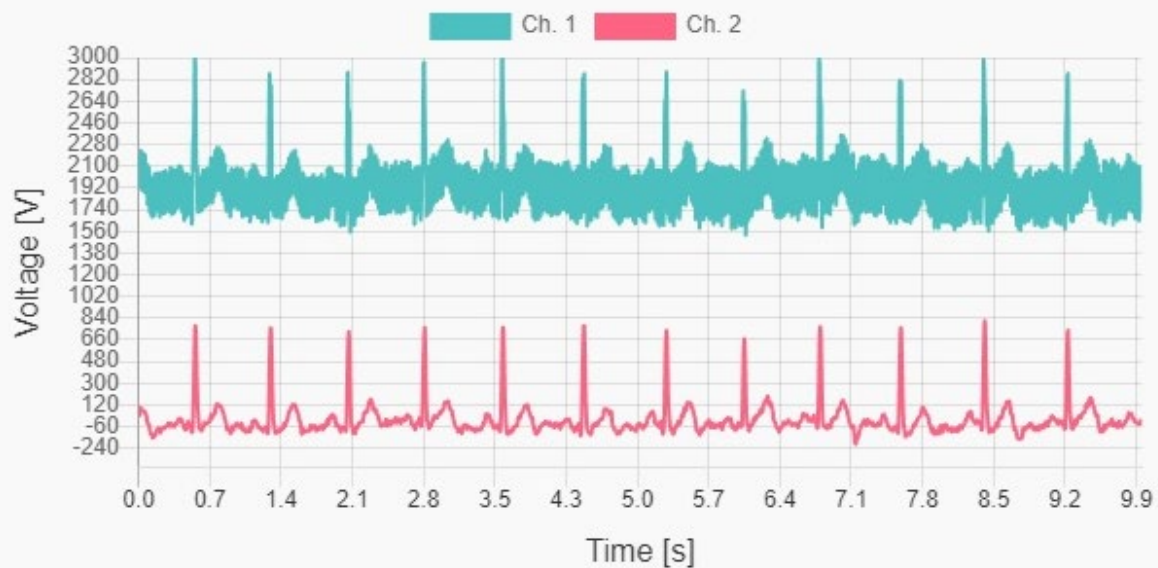
Stop

Clear

loggedData.csv

Save Data

Refresh Page







# Vizualizacija

## Mobilne aplikacije

- MIT App Inventor
  - Onlajn razvojno okruženje, besplatna



```

initialize global canvasHeight to 150
initialize global minValue to 0 initialize global maxValue to 101
initialize global Graph_maxPos to 0
initialize global Graph_Current_X_Pos to 0
initialize global Graph_Y_Val_List to create empty list
initialize global VALUE to 0 initialize global Resolution to 5

when Screen1.Initialize do call Initialize
when btn_Reset.Click do call Initialize
when btn_closeapp.Click do close application

to Initialize
do call Canvas1.Clear
set global Graph_Y_Val_List to create empty list
for each i from 1 to 1000 by 1
do add items to list list get global Graph_Y_Val_List
item 0
set Clock1.TimerEnabled to false
set btn_Start.Text to START
set Canvas1.Height to get global canvasHeight
set Canvas1.BackgroundImage to Grid_330x120_10_OL.png
set global Graph_Current_X_Pos to 0
set global Graph_maxPos to round Canvas1.Width / get global Resolution

```

```

when btn_initialize.Click
do call SerialOTG1.Initialize

when btn_open.Click
do set Label1.Text to call SerialOTG1.Open
set Clock1.TimerEnabled to true

when btn_Start.Click
do if compare texts btn_Start.Text = PAUSE
then set Clock1.TimerEnabled to false
set btn_Start.Text to START
else set Clock1.TimerEnabled to true
set btn_Start.Text to PAUSE

when Clock1.Timer
do set global VALUE to call SerialOTG1.ReadLn
if compare texts get global VALUE ≠ 0
then set value_Val_lbl.Text to get global VALUE
call UpdateGraph

```

```

to UpdateGraph
do initialize local mappedValue to 0
in set mappedValue to do initialize local inRange to get global maxValue - get global minValue
initialize local outRange to get global canvasHeight - 0
initialize local temp1 to 0
initialize local temp2 to 0
in set global VALUE to get global VALUE - get global minValue
set temp1 to get outRange / get inRange
set temp2 to get temp1 + 0
set global VALUE to round get global VALUE * get temp2
result get global VALUE
set mappedValue to get global canvasHeight - get mappedValue
if get global Graph_Current_X_Pos < get global Graph_maxPos
then set global Graph_Current_X_Pos to get global Graph_Current_X_Pos + 1
replace list item list get global Graph_Y_Val_List
index get global Graph_Current_X_Pos
replacement get mappedValue
else for each i from 1 to get global Graph_maxPos - 1
by 1
do replace list item list get global Graph_Y_Val_List
index get i
replacement select list item list get global Graph_Y_Val_List
index get i + 1
replace list item list get global Graph_Y_Val_List
index get global Graph_maxPos
replacement get mappedValue
call Canvas1.Clear
for each i from 1 to get global Graph_Current_X_Pos - 1
by 1
do call Canvas1.DrawLine
x1 get i * get global Resolution - get global Resolution
y1 select list item list get global Graph_Y_Val_List
index get i
x2 get i * get global Resolution
y2 select list item list get global Graph_Y_Val_List
index get i + 1

```



# Vizualizacija

## Mobilne aplikacije

- MIT App Inventor
- Bluetooth, Serial, Web
- Testiranje uživo
- Preuzimanje .apk fajla

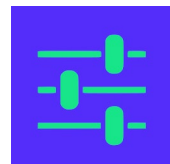
**User Interface**

- Button
- CheckBox
- CircularProgress
- DatePicker
- Image
- Label
- LinearProgress
- ListPicker
- ListView
- Notifier
- PasswordTextBox
- Slider
- Spinner
- Switch
- TextBox
- TimePicker
- WebView



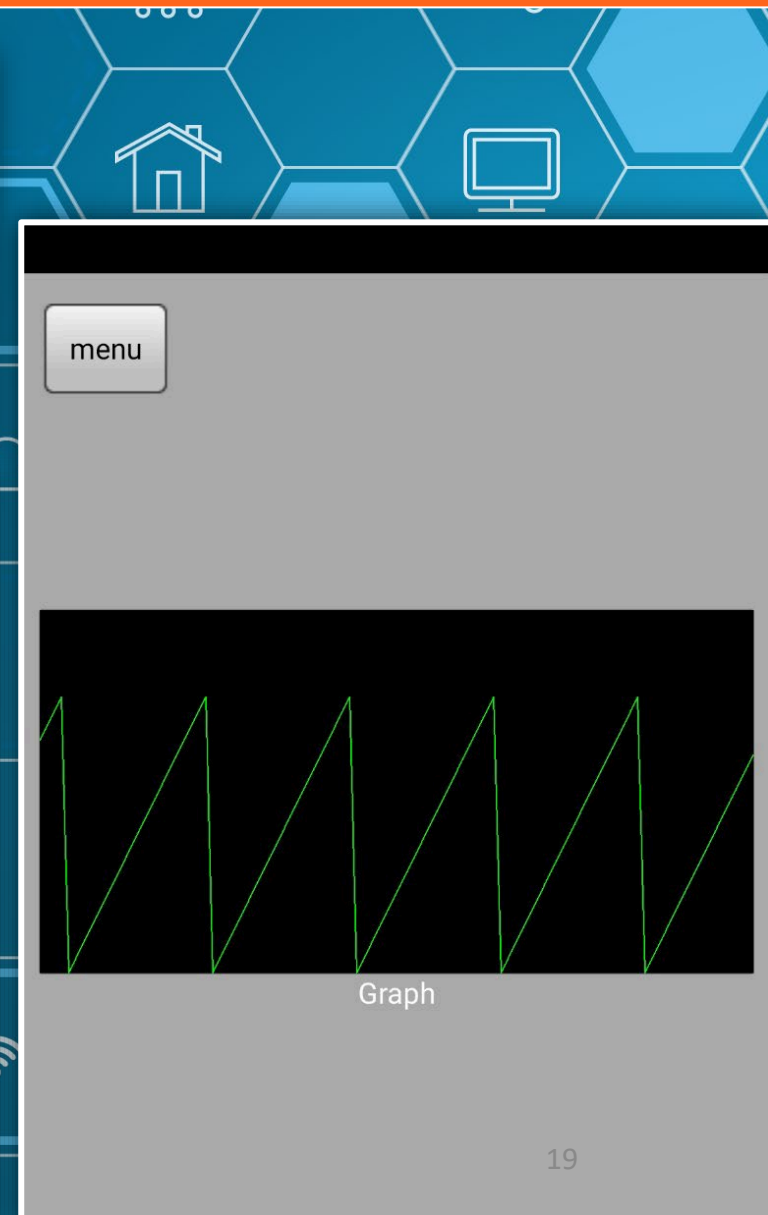
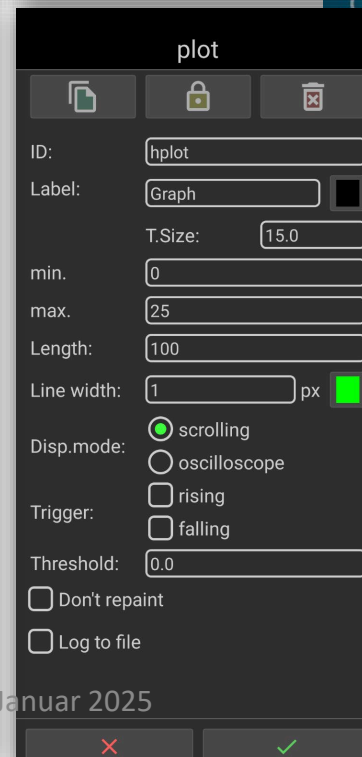
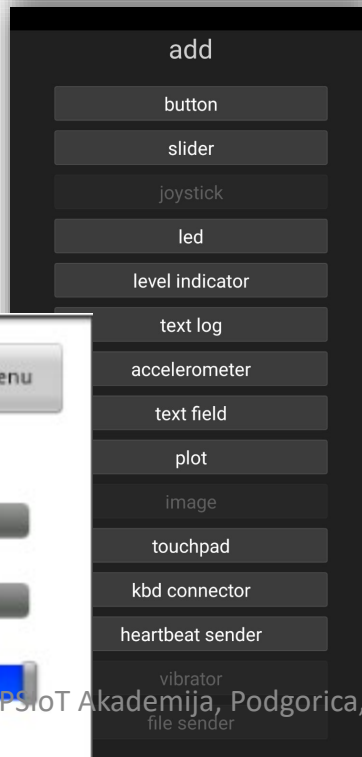
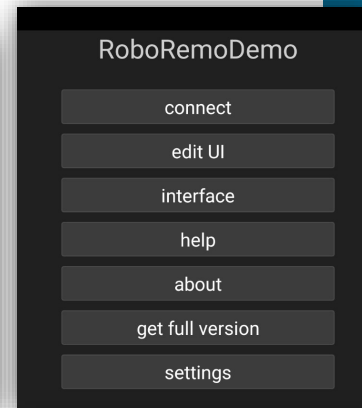
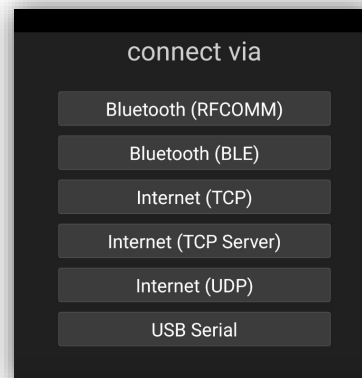
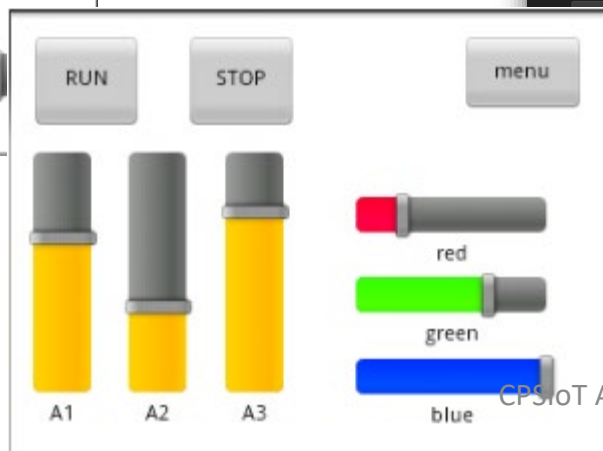
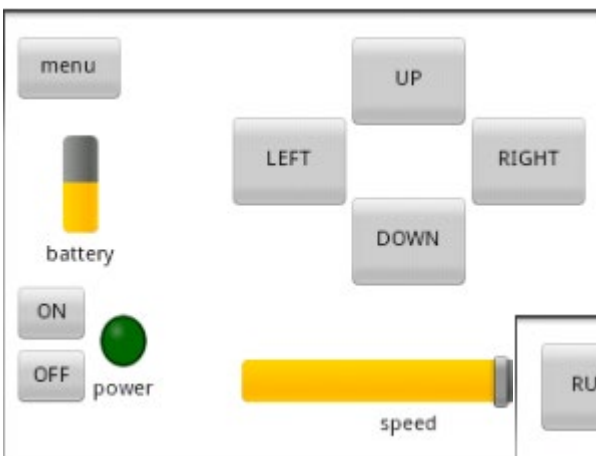
# Vizualizacija

## Mobilne aplikacije



- RoboRemo

- Razvoj na telefonu
- Besplatna + platna verzija



# Zaključak

- Komunikacija wearable <-> local host (desktop ili gadget) je veoma važna kako sa stanovišta razvoja sistema i aplikacija, tako i za vizualizaciju i daljnje umrežavanje.
- Njeno projektovanje i realizacija je uslovljena cijenom koštanja, brzinom, količinom podataka, potrošnjom itd.
- Dati su neki primjeri korišćenja žičane i bežične komunikacije.

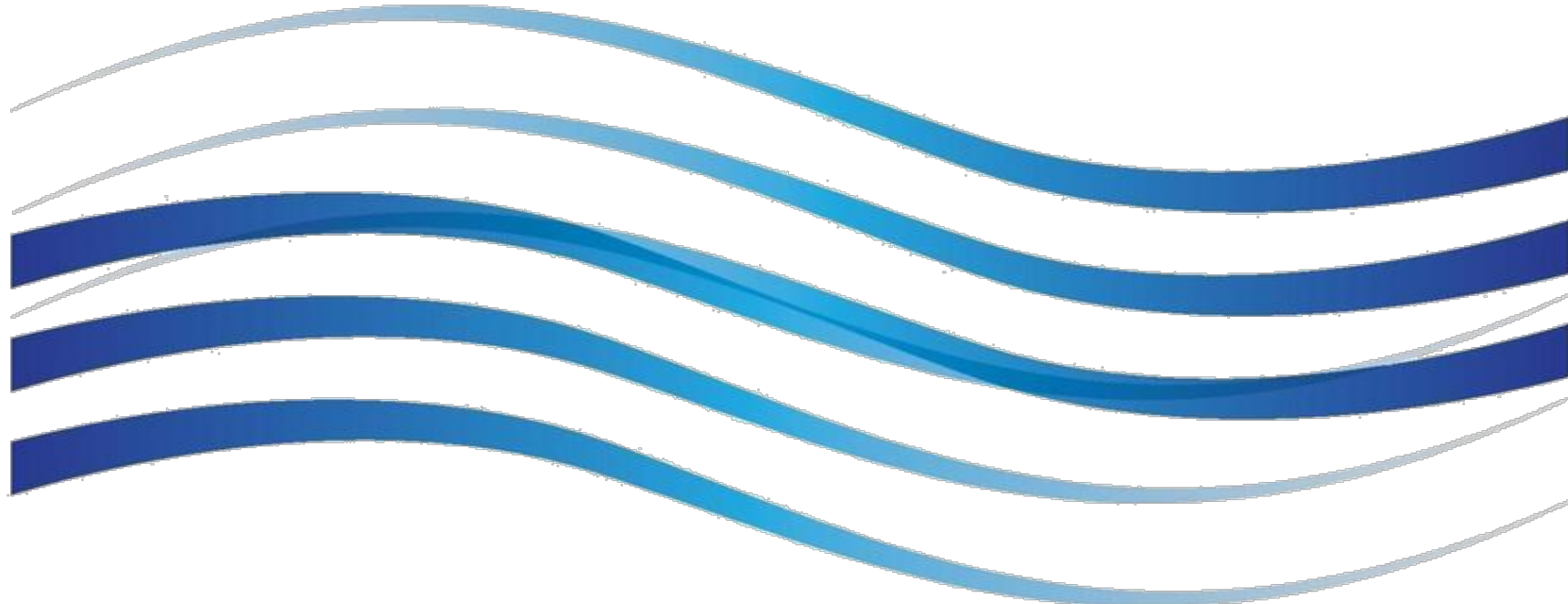


# Reference

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11. Radovan Stojanović, Design of performance and energy efficient nodes for smart systems, in Lech Jóźwiak, Radovan Stojanovic, & Christos Antonopoulos. (2023). Proceedings of the 4th Summer School on Cyber-Physical Systems and Internet-of-Things, Vol. IV, 2023 (1.0) [Computer software]. 4th Summer School on Cyber-Physical Systems and Internet-of-Things (SS-CPSIoT2023), Budva, Montenegro. Zenodo. <https://doi.org/10.5281/zenodo.8113313>



**Hvala na pažnji, pitanja, komentari?**



**Zahvalni Fondu za inovacije CG na sufinansiranju  
CPSIoT Academy**

