Univerzitet u Beogradu, Građevinski fakultet

# Merenje nivoa vode i pritiska i obrada signala

Merenja u hidrotehnici

2. Vežba

2019/2020

# MERENJE OSNOVNIH VELIČINA U HIDROTEHNICI

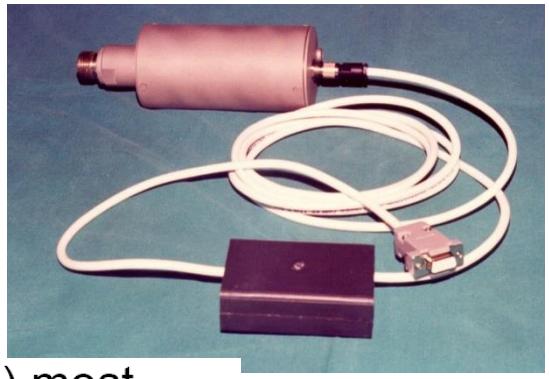
- **Merenje pritiska: pijezorezistivni, kapacitivni, induktivni senzori**
- **Merenje nivoa vode: ultrazvučni senzori, senzori pritiska + preračunavanje**
- **Merenje brzine: UZV, EM, hot-wire i hot-film, …**
- **Merenje protoka: volumetrijsko, UZV, EM, …**

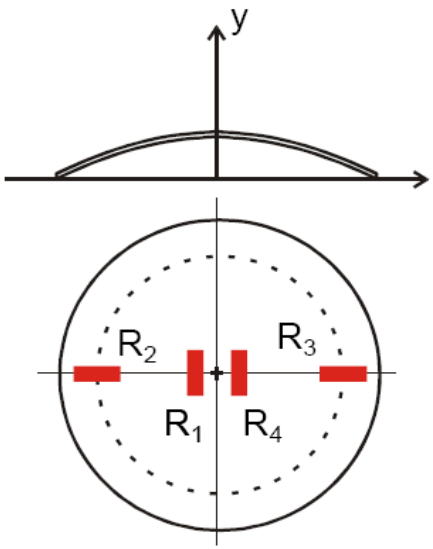
- **+ merenje kvaliteta vode: pH, mutnoća, elektroprovodnost**

# MERENJE PRITISKA

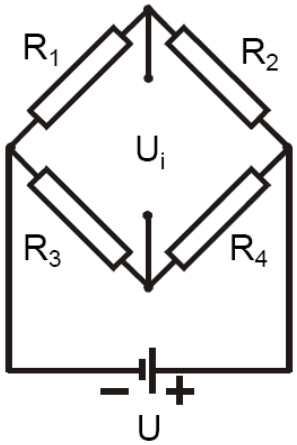
Pijezorezistivni senzor – AP02

$$p[bar] = f(U[V])$$






Vitstonov (Wheatstone) most




most je u ravnoteži kada je odnos otpornosti:

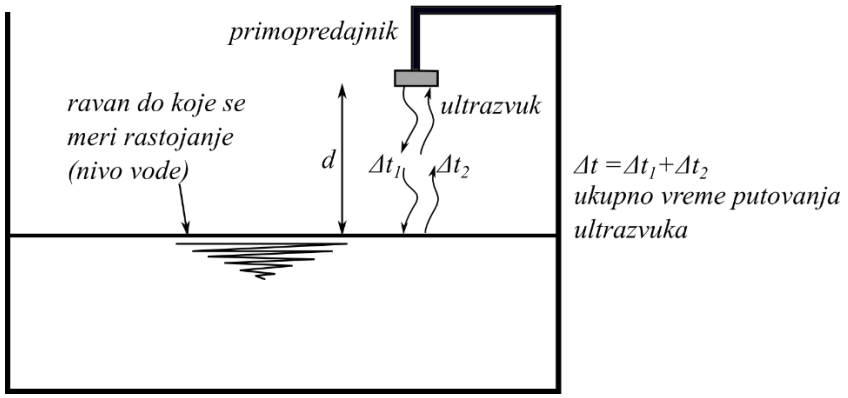
$$R_1 \cdot R_4 = R_2 \cdot R_3$$

$$U_{izl} = E \cdot \frac{R_1 \cdot R_4 - R_2 \cdot R_3}{(R_1 + R_2) \cdot (R_3 + R_4)} = 0$$

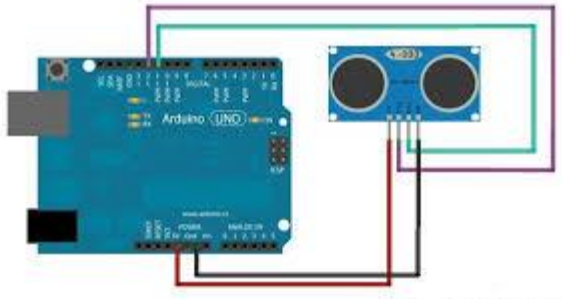
# MERENJE NIVOA VODE

Ultrazvučni senzor – Arduino

$$d[m] = c\left[\frac{m}{s}\right] \cdot \frac{\Delta t[s]}{2}$$

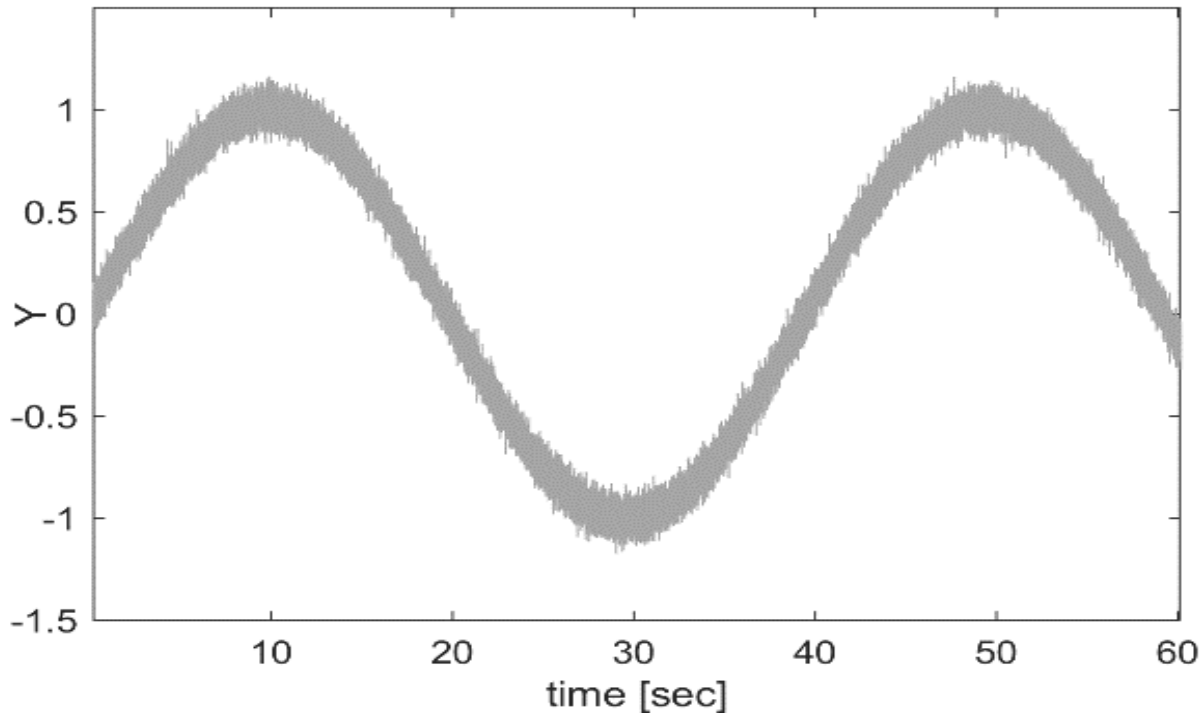



$\Delta t = \Delta t_1 + \Delta t_2$
*ukupno vreme putovanja ultrazvuka*



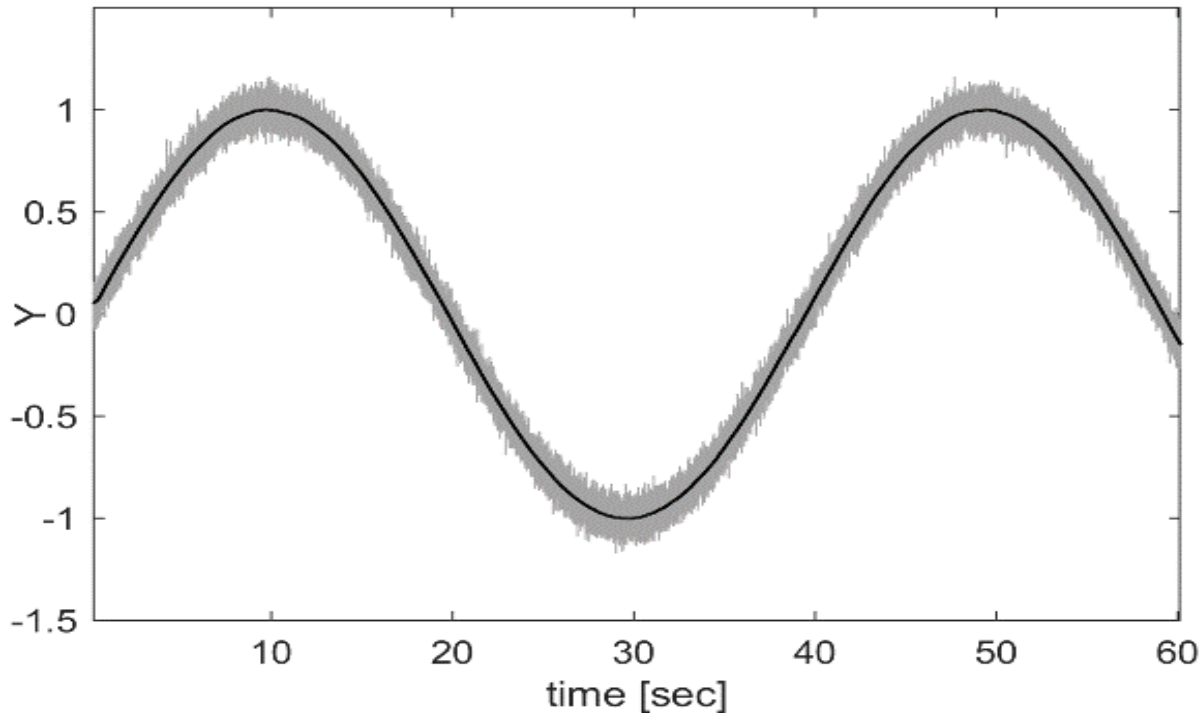
# OBRADA SIGNALA

Šum



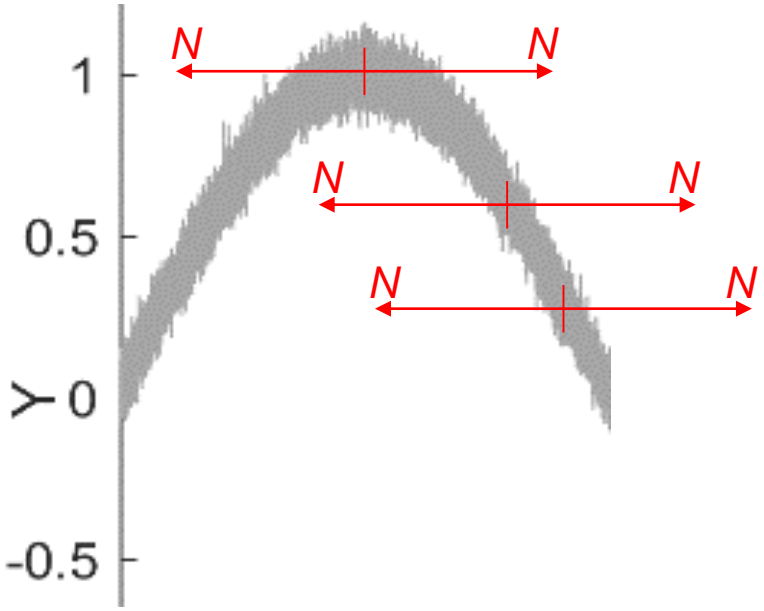
# OBRADA SIGNALA

Filter



# OBRADA SIGNALA

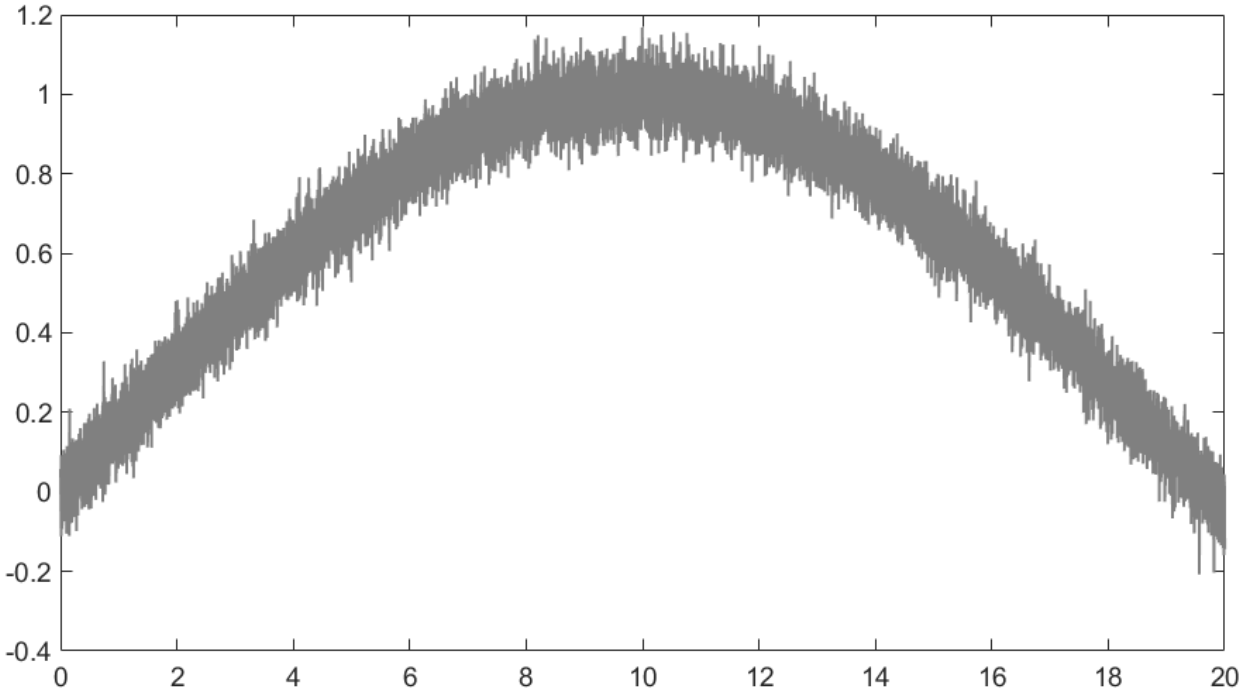
(Central) Moving Average filter – Putujuća srednja vrednost




$$\overline{p_i} = \frac{p_{i-N} + p_{i-N+1} + \cdots + p_i + \cdots + p_{i+N-1} + p_{i+N}}{2N}$$

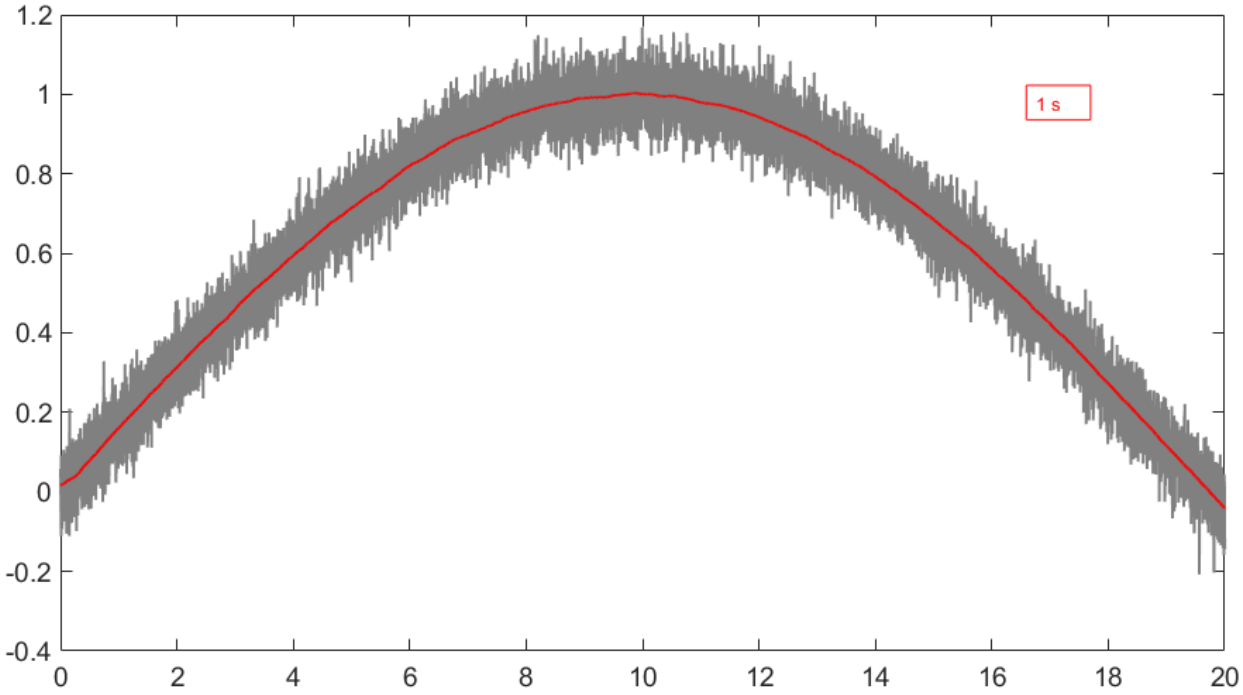
# OBRADA SIGNALA

Moving Average filter – Primer



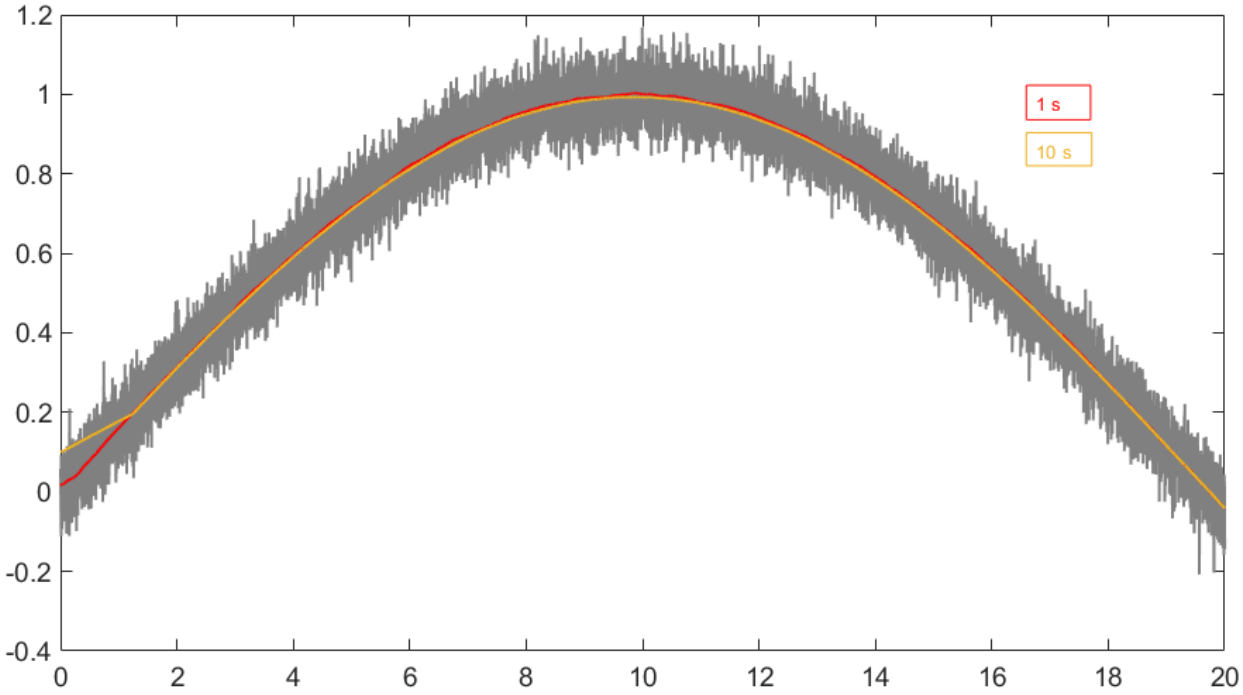
# OBRADA SIGNALA

Moving Average filter – Primer



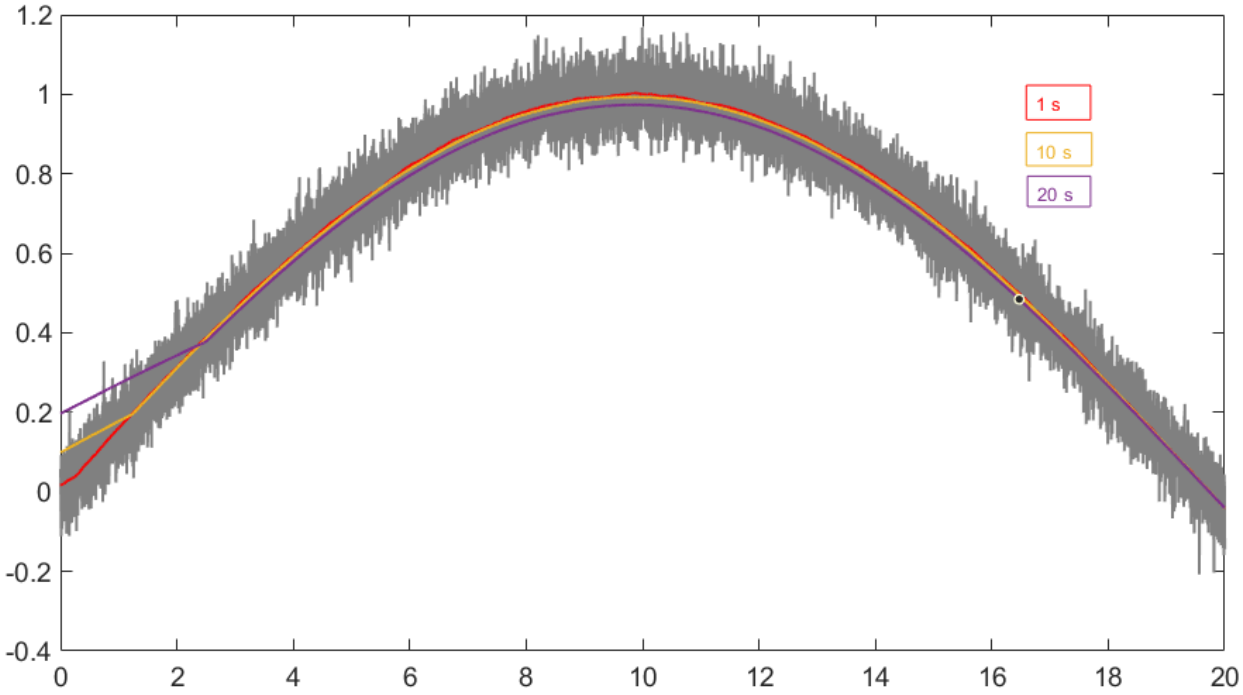
# OBRADA SIGNALA

Moving Average filter – Primer



# OBRADA SIGNALA

Moving Average filter – Primer

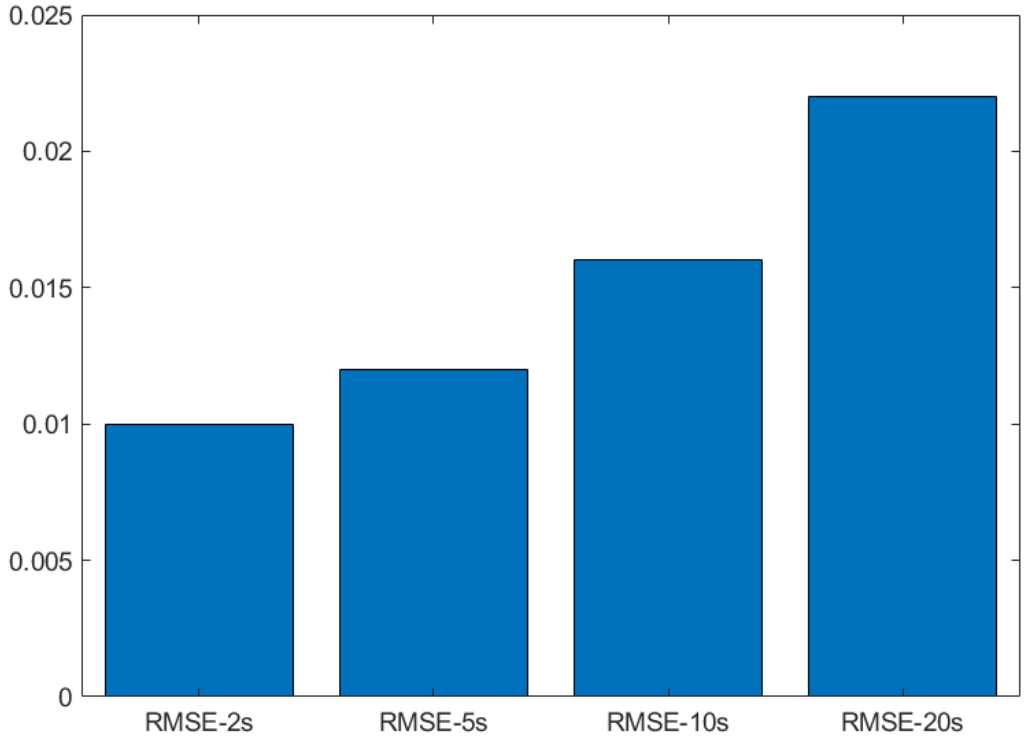


# OBRADA SIGNALA

Poredjenje vremenskih serija – Root Mean Square Error *RMSE*

*Osrednjavanje na 1s se usvaja kao referentno*

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} \left(X_{ref,i} - X_i\right)^2}{N}}$$



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