

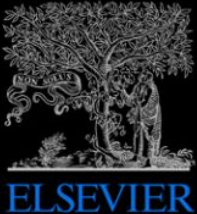
Calibração de FSR

Não tá em LaTeX :(

Framework for a Calibration-Less Operation of Force Sensing Resistors at Different Temperatures

Leonel Paredes-Madrid, Arnaldo Matute, and Angela Peña

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Short communication

A technique for conditioning and calibrating force-sensing resistors for repeatable and reliable measurement of compressive force

Rick S. Hall^{b,d}, Geoffrey T. Desmoulin^{c,d,1}, Theodore E. Milner^{a,d,*}

Framework for a Calibration-Less Operation of Force Sensing Resistors at Different Temperatures

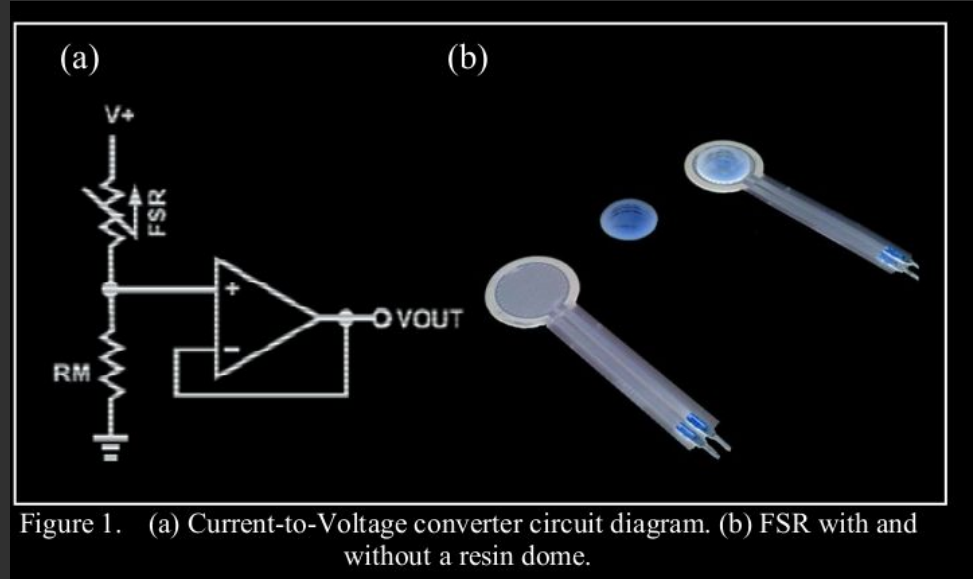
Leonel Paredes-Madrid, Arnaldo Matute, and Angela Peña

Por que calibrar?

- Creep (drift)
- Histerese
- Dependência da temperatura

Prejudicam:

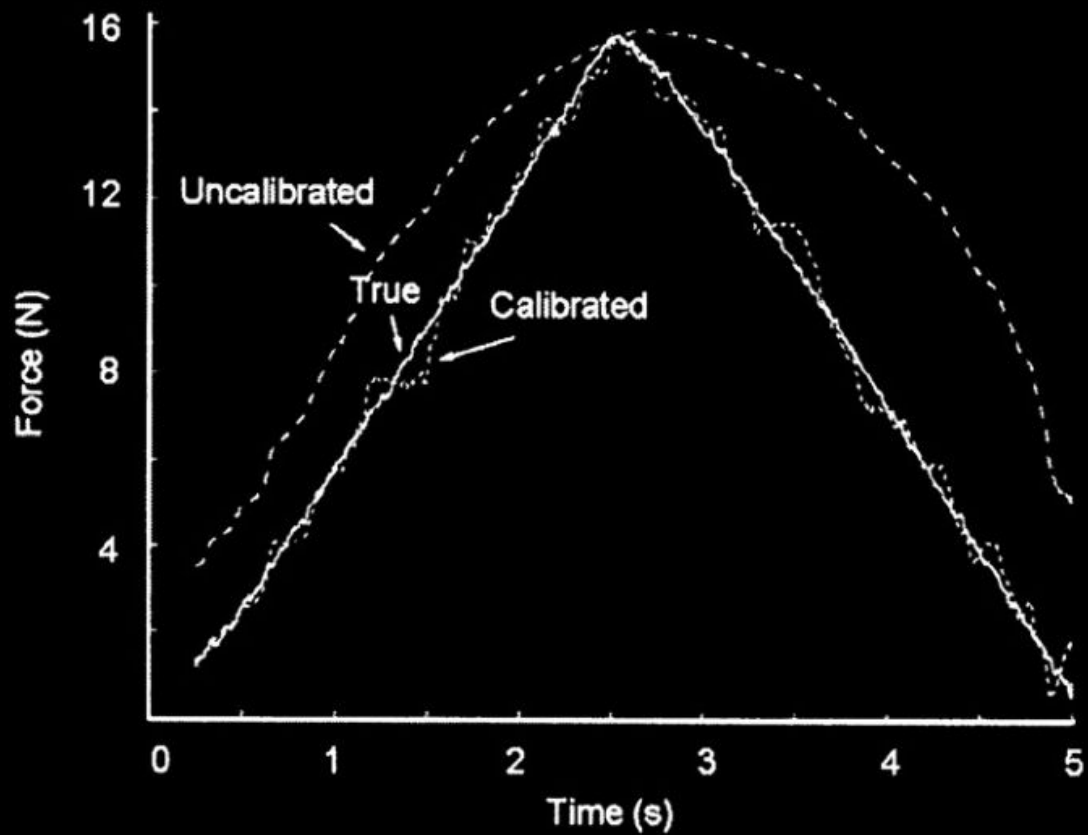
- Visualização
- Cria dependência temporal imprevisível



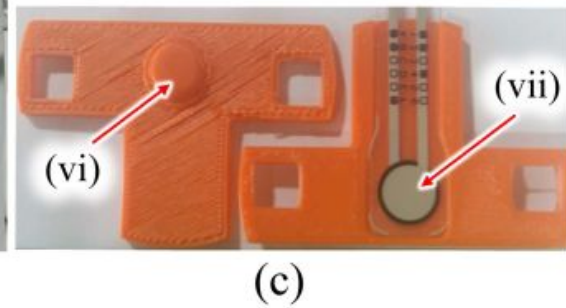
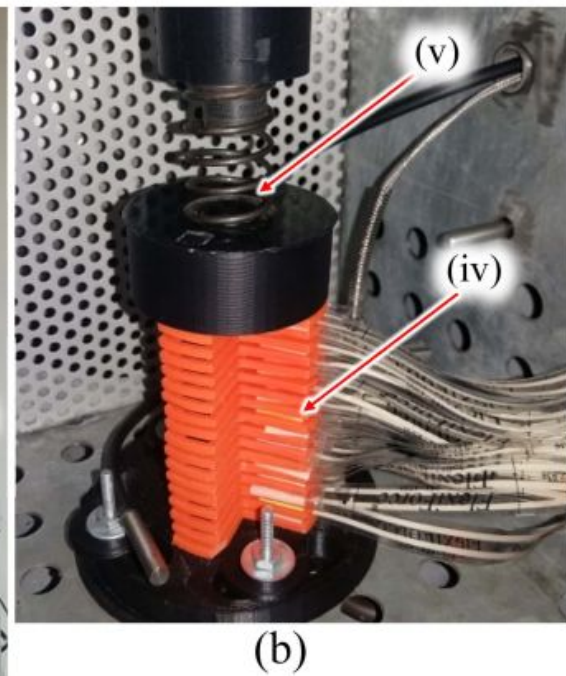
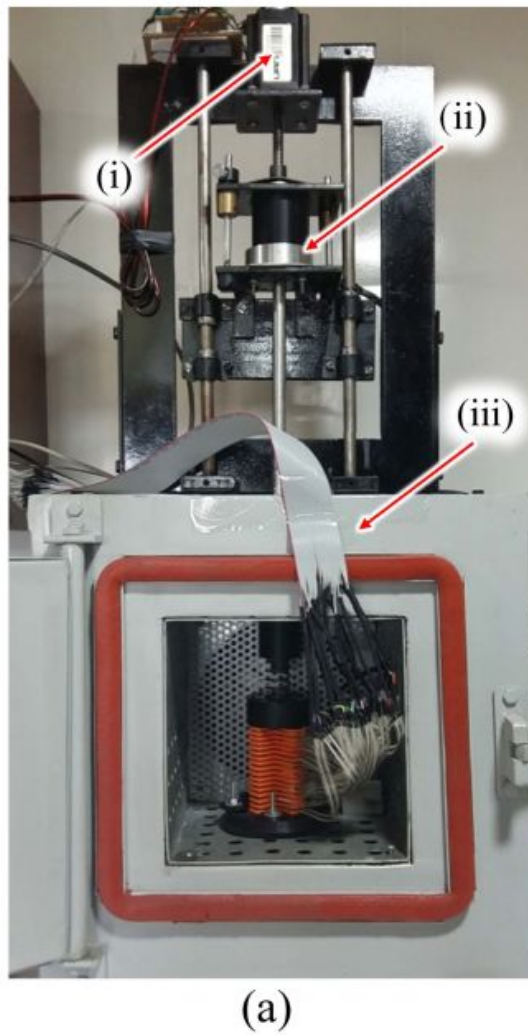
Force Repeatability³

(Part to Part)

$\pm 6\%$



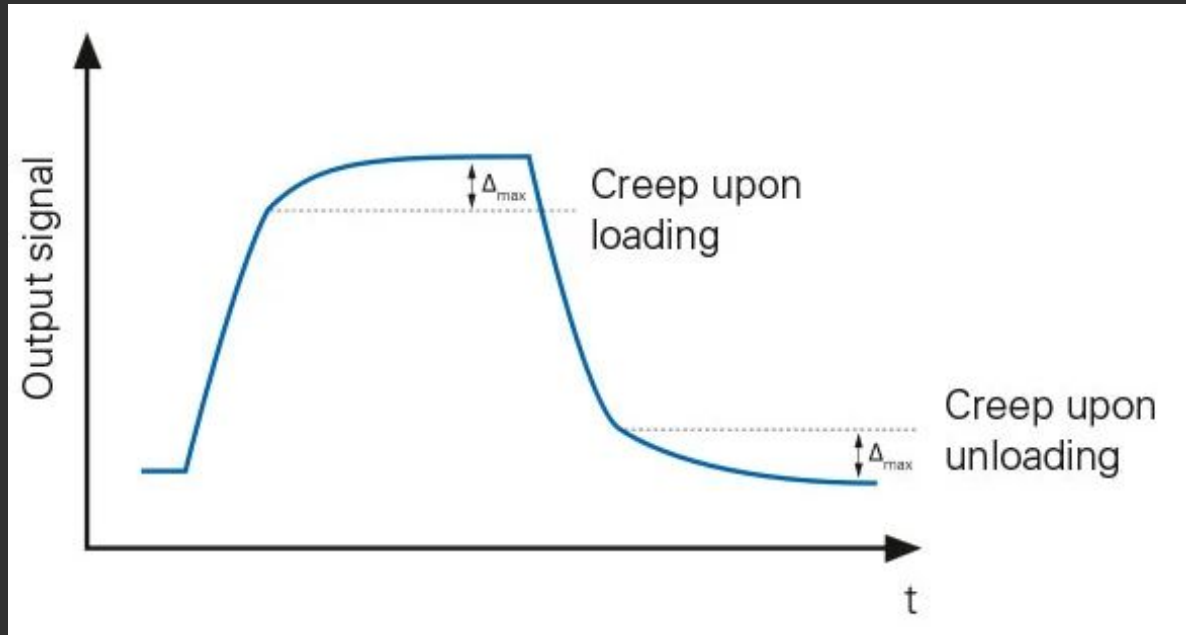
Coleta de dados



Temperatura relativamente desprezível / não tem solução

By theory it is considered that when a force is applied the change of the sensor's electric resistance is approximately linear in a logarithmic plot [1] although things get different when time plays around. Hence the objective of a proper calibration besides relating the electric resistance value of the sensor with the applied force is to compensate creep and hysteresis when a time constant and variable force respectively is applied.

Creep



Resolvido, mas precisa forçar a barra

Solução: alta taxa de amostragem, avalia derivada

numérica dos dados

```
if (derivada > delta) {
```

```
    não joga pro BD
```

```
}
```

```
else ...
```

→ Proposta: amostragem picada

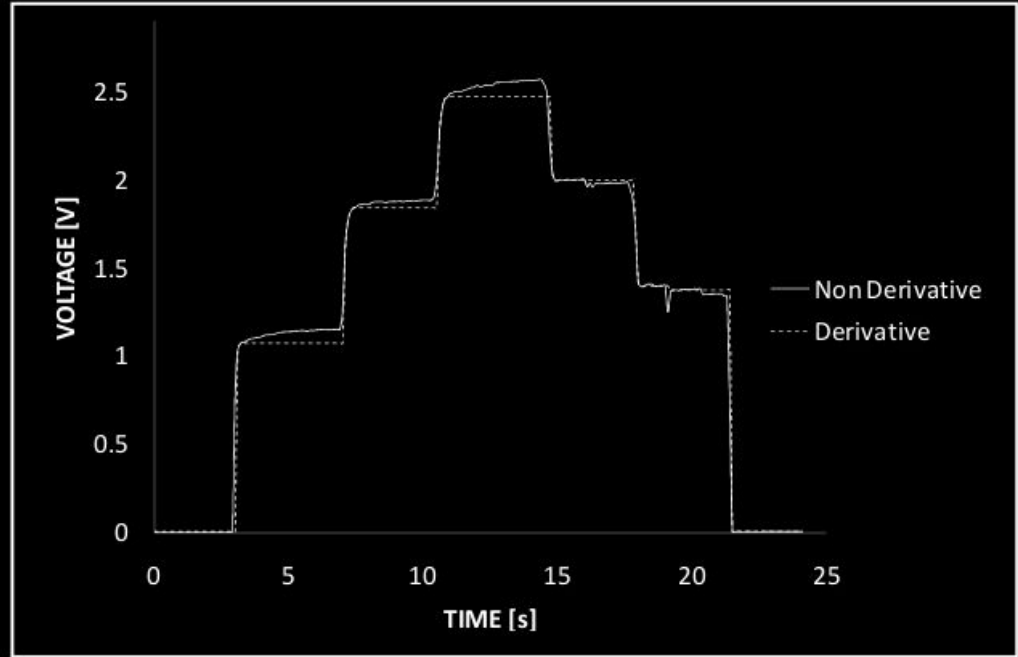


Figure 7. Result obtained when the derivate criteria was implemented to eliminate creep.

Histerese

- Induz dependência temporal nos dados!
- $1 \rightarrow 2 \neq 3 \rightarrow 2$
- CONTRIBUI PARA INCERTEZA DO MODELO ATEMPORAL

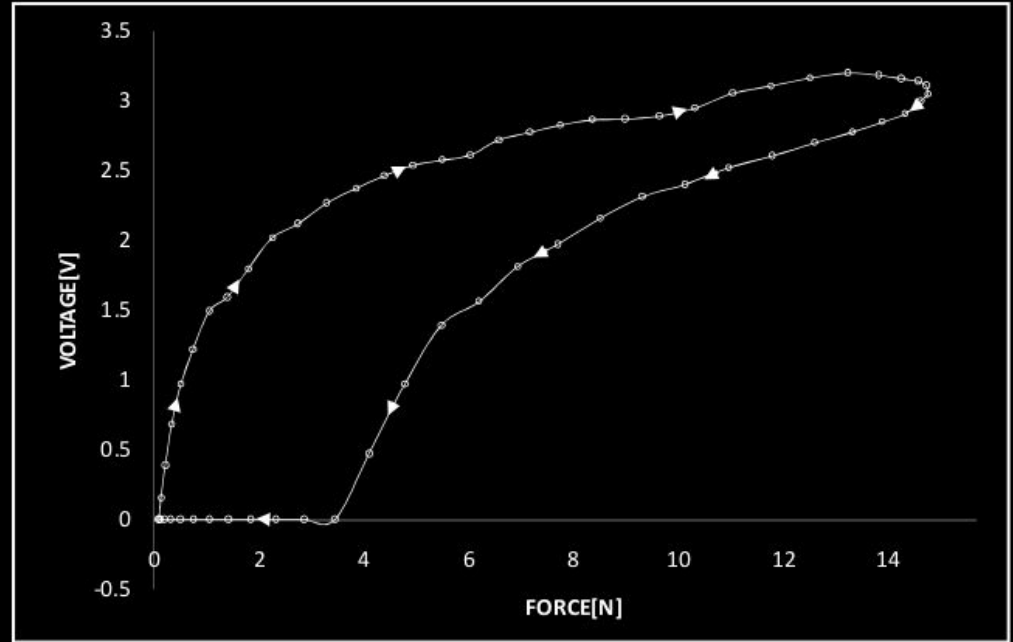
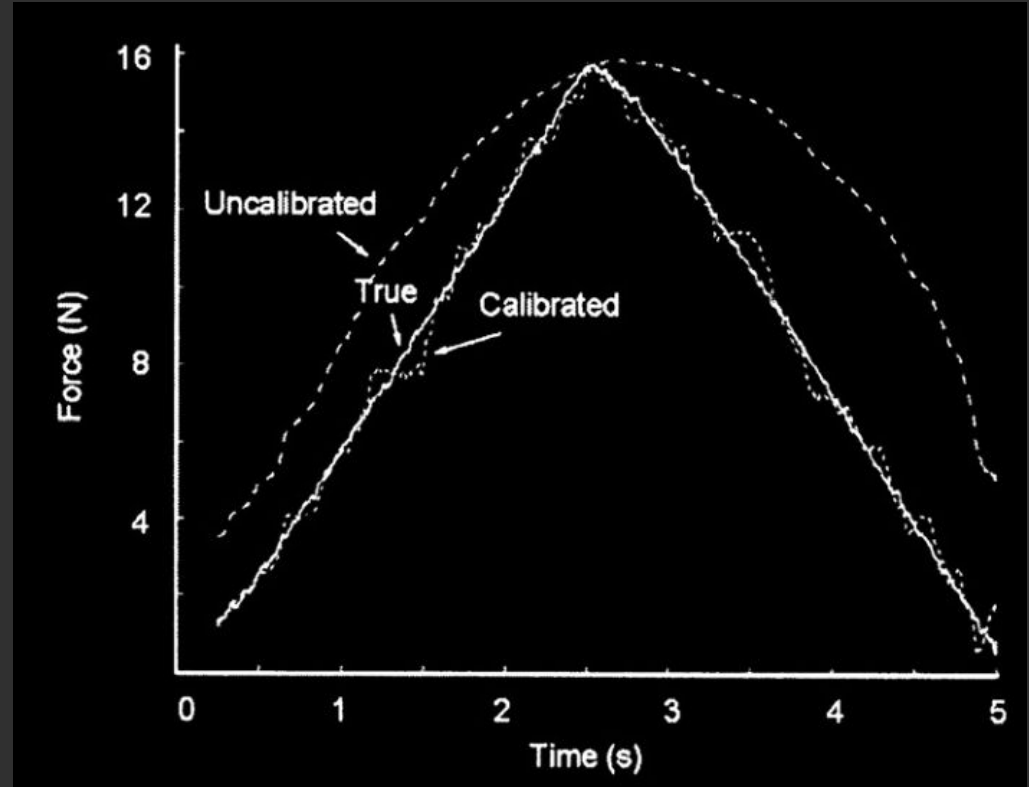


Figure 6. Hysteresis evidence.

Solução?

$$F(V,I)=a_0+a_1V+a_2V^2+a_3V^3+a_4V^4+a_5I+a_6I^2+a_7I^3+a_8I^4 \quad (1)$$

- Depende de alta taxa de amostragem
- Sem garantias teóricas (que eu conheça) (duvido que tenha)
- Baseado no princípio da indução MUITO forte (perderam a chance de usar Fourier ou qualquer coisa minimamente genérica)



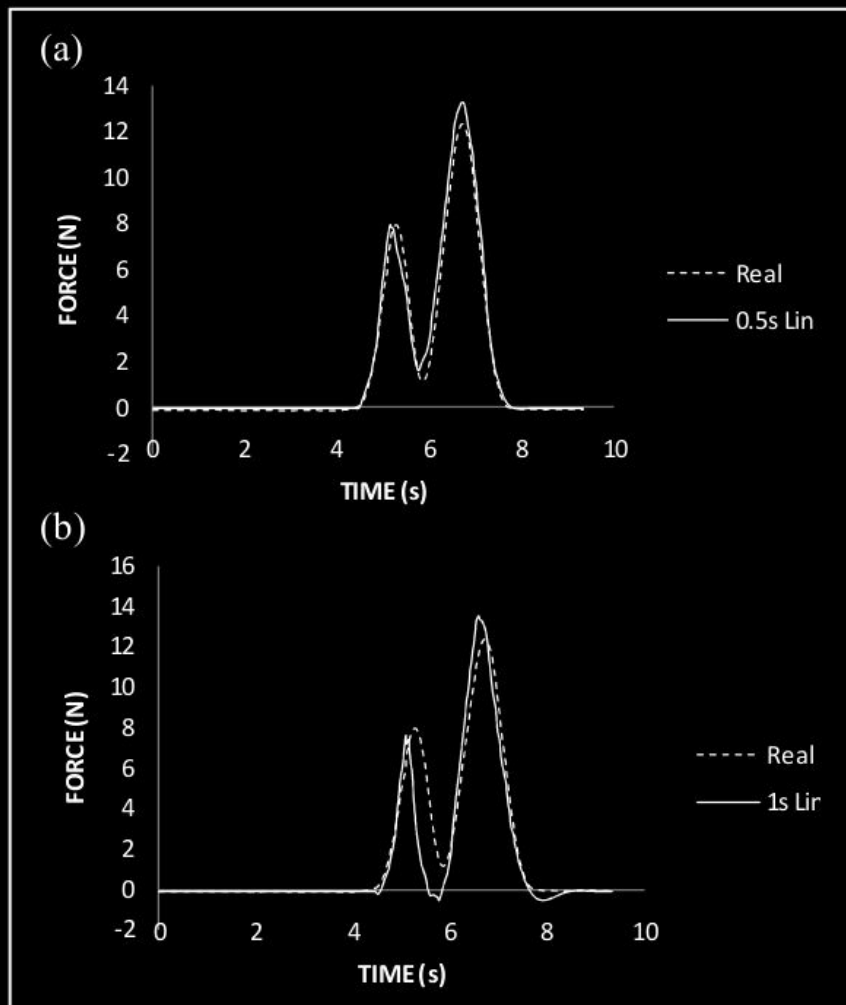


Figure 9. Linear Interpolation.

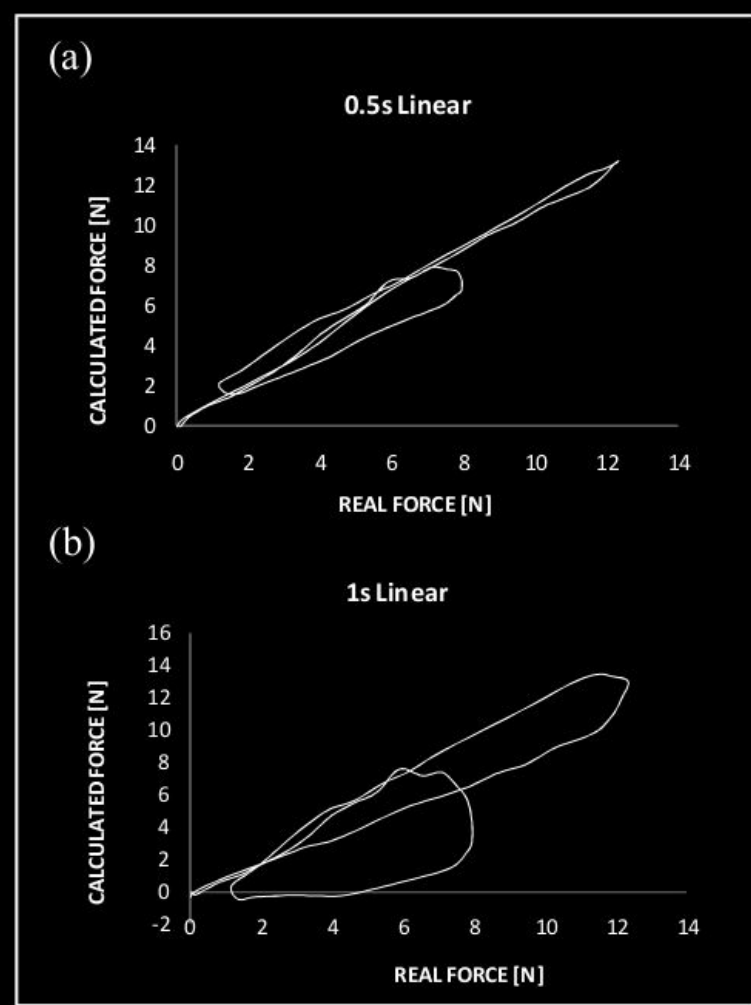


Figure 12. Hysteresis with linear interpolation.

Pontos fracos e impeditivos do método

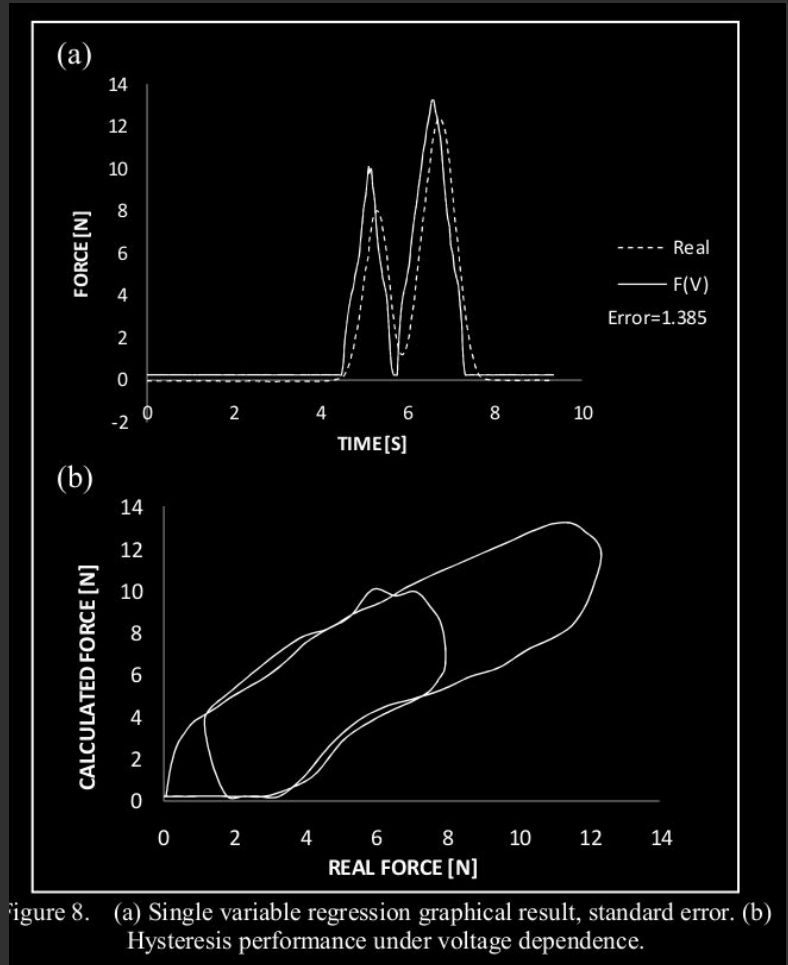
- Precisa de alta velocidade de amostragem
- Alto custo computacional (pra um controlador)
- Depende de uma máquina de calibração
 - Custosa
 - Difícil de operar

Sem componente temporal

$$F(V)=b_0+b_1V+b_2V^2+b_3V^3+b_4V^4$$

Ideias brutas:

- Modelar histerese com estatística
- Descolar curva de previsão



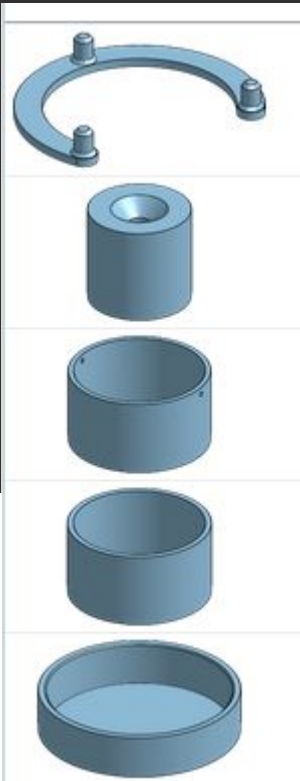
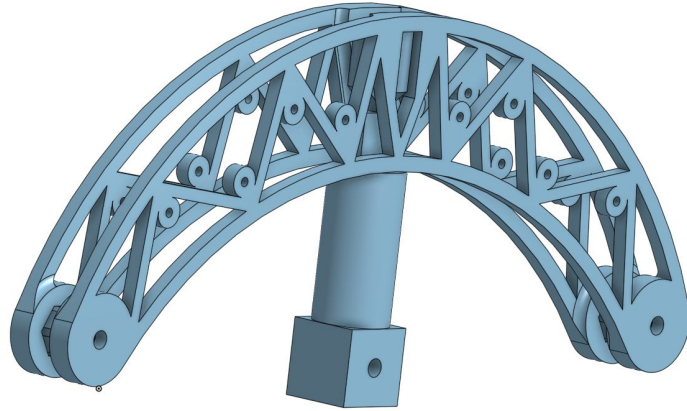
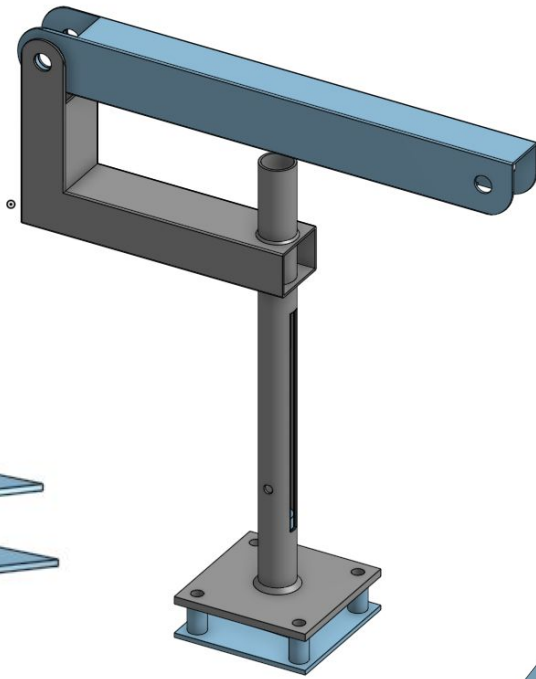
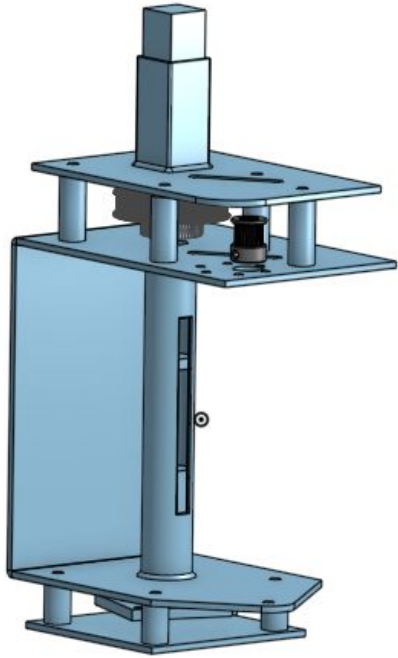
Resumo da solução para amostragem estática e baixa amostragem

- Retira influência da histerese dos dados
- Regressão polinomial \rightarrow interpolação polinomial sem histerese (nas raízes do polinômio de chebychev)

$$|f(x) - P_{n-1}(x)| \leq \frac{1}{2^{n-1}n!} \max_{\xi \in [-1,1]} |f^{(n)}(\xi)|$$

- Resolver o problema e ser feliz :)

O que já
tenho



Feriadão: fazer a gambiarra funcionar

