COMBAT-VT:

Digital Twin to Predict Ventricular Tachycardias using Hybrid Modelling

C.M.A. Buck[1], M. van 't Veer[2], W. Huberts[1], F.N. van de Vosse[1], L.R.C. Dekker[1,2]

[1]Department of Biomedical Engineering, University of Technology Eindhoven
[2]Cardiology, Catharina Hospital Eindhoven

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CLINICAL BACKGROUND

Post-myocardial infarct patients have an increased risk for scar-based **ventricular tachycardia** (VT), an abnormal heart rhythm, which may lead to **sudden cardiac death** (SCD). An implanted cardioverter defibrillators (ICD) can help prevent SCD. However, the **current indicator** for this treatment based on left ventricular ejection fraction (LVEF) proves to be **insufficient** in identifying patients with a high risk of SCD.[1]

AIM

To develop a **Digital Twin** to ultimately **predict VT development** as early as possible and guide decision support by creating a **hybrid model** based on existing **physical models** and **data models** capturing **time evolution**.

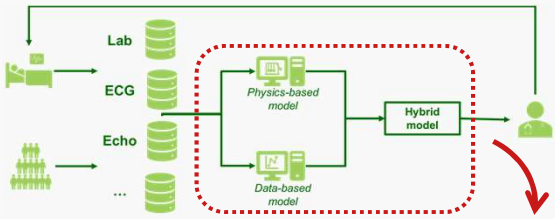
CONCLUSION

A **hybrid model** consisting of a **neural network constraint with physics** of the 0D one-fiber model, makes **training** more **efficient** with **sparse data**.

DIGITAL TWIN

A **Health Digital twin** is a **predictive computer model** (data plus algorithms) which **dynamically pairs** the **physical** and **digital** worlds to represent (part of) a patient. It is **continuously** updated with new data.

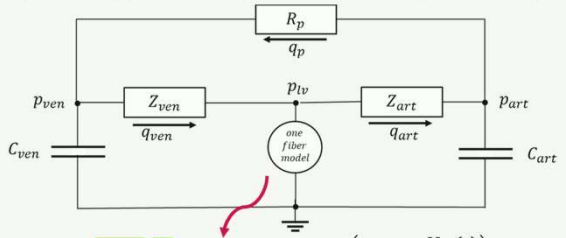
The **VT Digital Twin** combines different data types (e.g., lab, ECG, echo, vital functions) and data-based and physics-based models in a hybrid way.



PHYSICS-BASED MODEL

0D one-fiber model

Input: time (t) **Output**: left ventricular pressure (p_{lv})



$$p_{lv}(t) = \sigma_f(t) * \left(1 + 3 * \frac{V_{lv}(t)}{V_w}\right)$$

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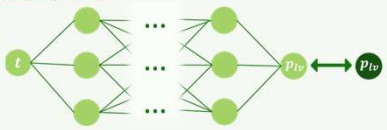
DATA-BASED MODEL

Neural Network

Input: time (t) **Output**: left ventricular pressure (p_{lv})
Hidden layers: 8 **Nodes per layer:** 20

Loss = MSE of labeled data



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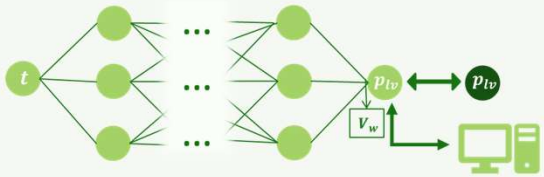
HYBRID MODEL

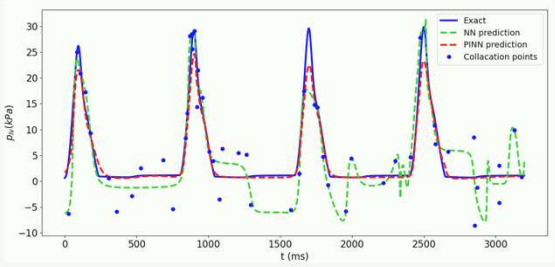
Physics Informed Neural Network (PINN)

Input: time (t) **Output**: left ventricular pressure (p_{lv}) and wall volume (V_w)
Hidden layers: 8 **Nodes per layer:** 20

Loss = MSE of labeled data + MSE of physics



RESULT



Contact details: c.m.a.buck@tue.nl

[1] Dagres, N., & Hindricks, G. (2013). Risk stratification after myocardial infarction: is left ventricular ejection fraction enough to prevent sudden cardiac death?. *European heart journal*, *34*(26), 1964–1971.