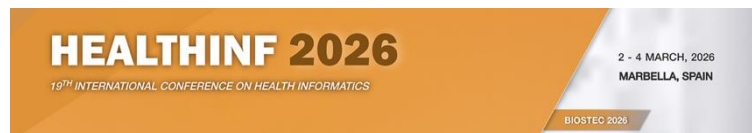


A Dataset for Benchmarking Machine Learning Models for Autonomous Deep Vein Thrombosis Detection Based on Compression Ultrasound Videos

S. Didaskalou, N. Portokallidis, K. Tzatzimaki, M. Liapi, N. Moustakidis, T. Moustakidis, N. Balciuniene, A. Macas, Rytis. Kijauskas, A. Aladaitis, A. Sotiriadou, F. Sarafis, G. Kynigopoulos, M. Potoupnis, E. Grandone, G. Mastrangelo, S. Maresca, M. Gautier, D. Chaiba, H. Boussaha, S. Goulvent, C. Stylianou, EN. Oglou, K. Chouchos, S. Deftereos, K. Papatheodorou, I. Drougka, P. Anagnostopoulou, HQ. Yu, E. Kaldoudi and the ThrombUS+ consortium.



presented by

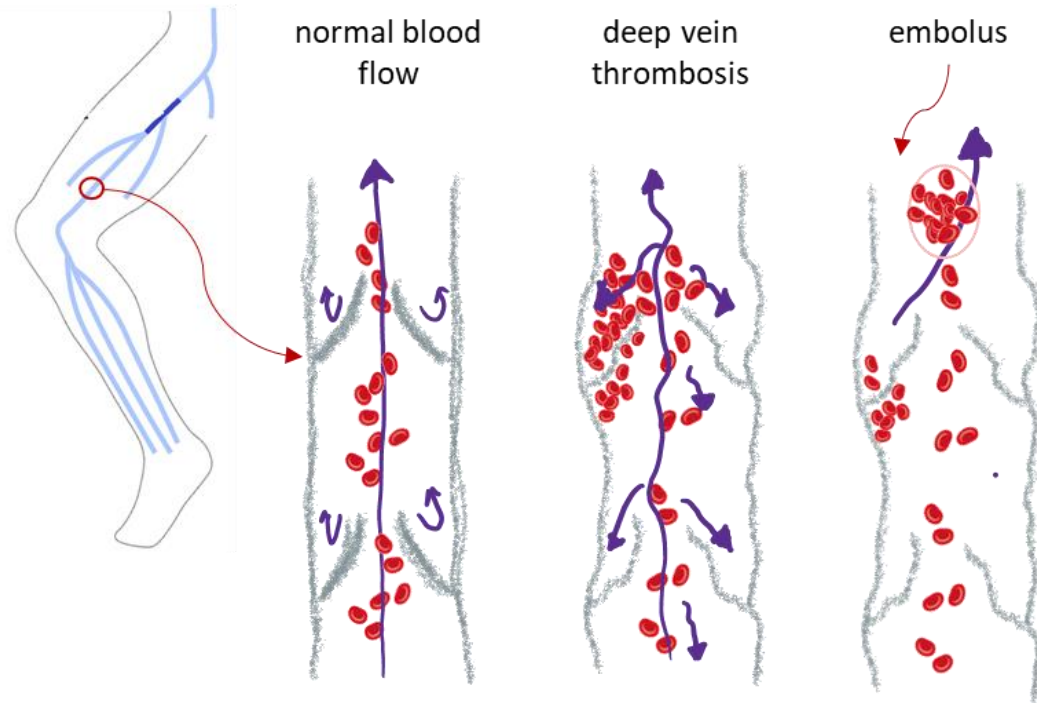
Stelios Didaskalou

Athena Research Center, Greece
Democritus University of Thrace, Greece
ThrombUS+ Horizon Project



ThrombUS+

Deep Vein Thrombosis (DVT) is the clotting of blood in a deep vein of the pelvis or an extremity (usually calf or thigh)



- A clot is mainly composed of fibrin and red blood cells and may contain platelets, leukocytes and other compounds
- A clot usually forms around the valves in the deep veins of the leg
- A clot forms in a matter of seconds or minutes depending on the individual
- When present, the clot disturbs the flow of blood and results in pain and swelling
- The clot might be pushed via the heart to the lungs where it can block an artery, what is known as Pulmonary Embolism, an acute, life-threatening condition

Deep Vein Thrombosis (DVT) is a major preventable cause of morbidity and mortality worldwide

- 3rd most frequent vascular diagnosis after heart attack and stroke
- affects more than 1,000,000 Americans per year
affects more than 700,000 Europeans per year
- 1/2 of people with DVT experience a sudden pulmonary embolism
- about 1/4 of those who have a pulmonary embolism die from it
- annual health expenditure related to DVT is €8.5 billion in EU
- DVT and PE related DALYs lost are more than nosocomial pneumonia

Olaf M et al. Deep Venous Thrombosis. Emerg Med Clin North Am. 2017. <https://doi.org/10.1016/j.emc.2017.06.003>

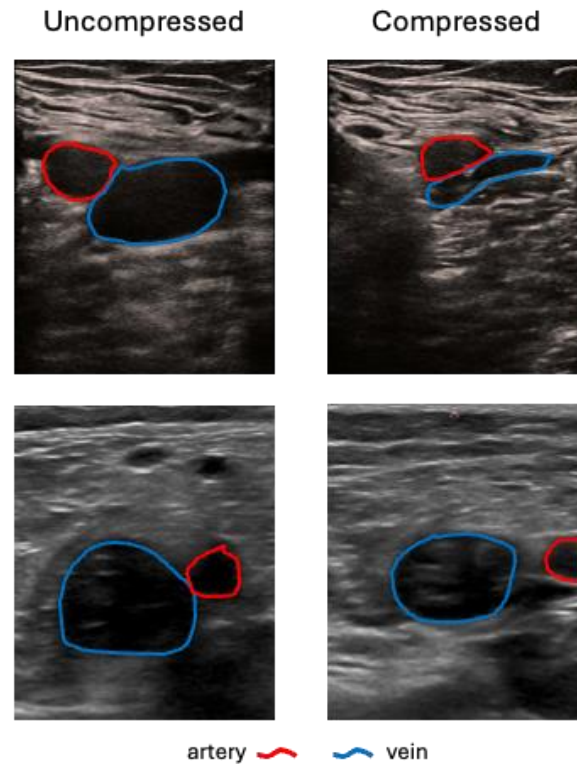
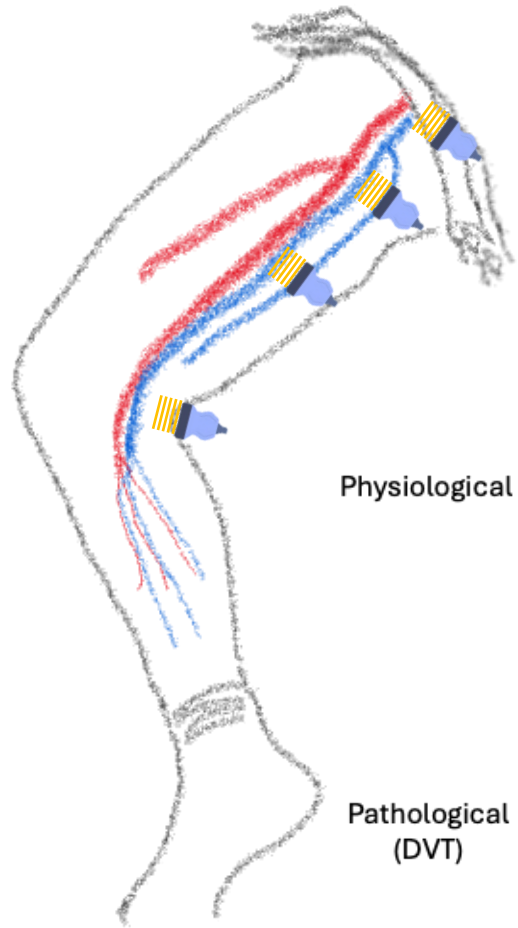
Cohen AT et al. Thromb Haemost. 2007 Oct, <https://doi.org/10.1160/TH07-03-0212>

Barco S et al. Thromb Haemost. 2016. <https://doi.org/10.1160/TH15-08-0670>

Jha AK, et al. The global burden of unsafe medical care: analytic modelling of observational studies. BMJ <https://doi.org/10.1136/bmjqs-2012-001748>

currently, **ultrasonography** is the method of choice for DVT diagnosis

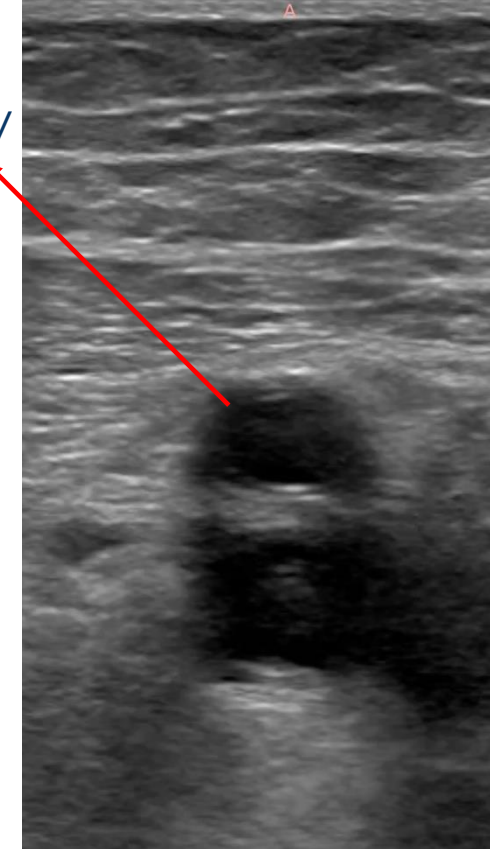
- direct visualization of the thrombus
- Doppler to assess venous flow
- **compression ultrasound**



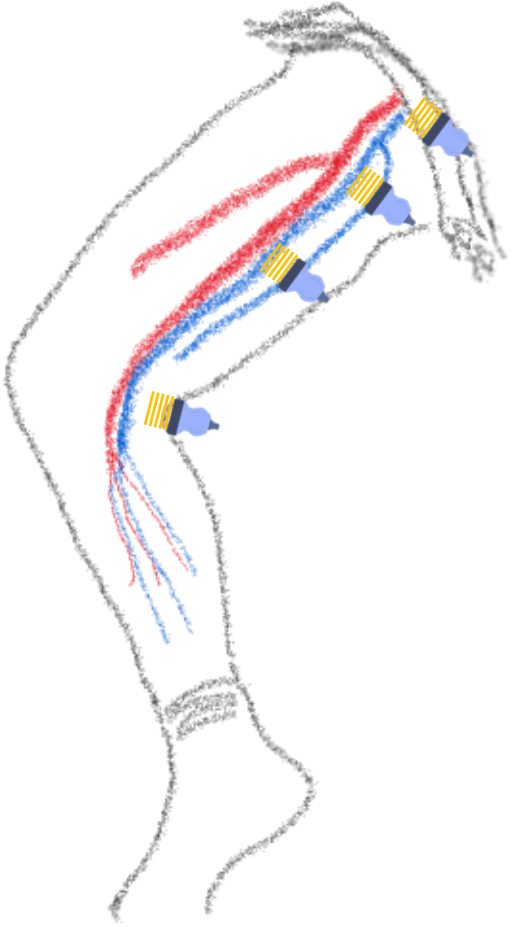
normal,
the vein fully collapses



DVT is present,
vein does NOT collapse



currently, **ultrasonography** is the method of choice for DVT diagnosis



Patients are referred for an ultrasound when they present DVT-related clinical symptoms

however....

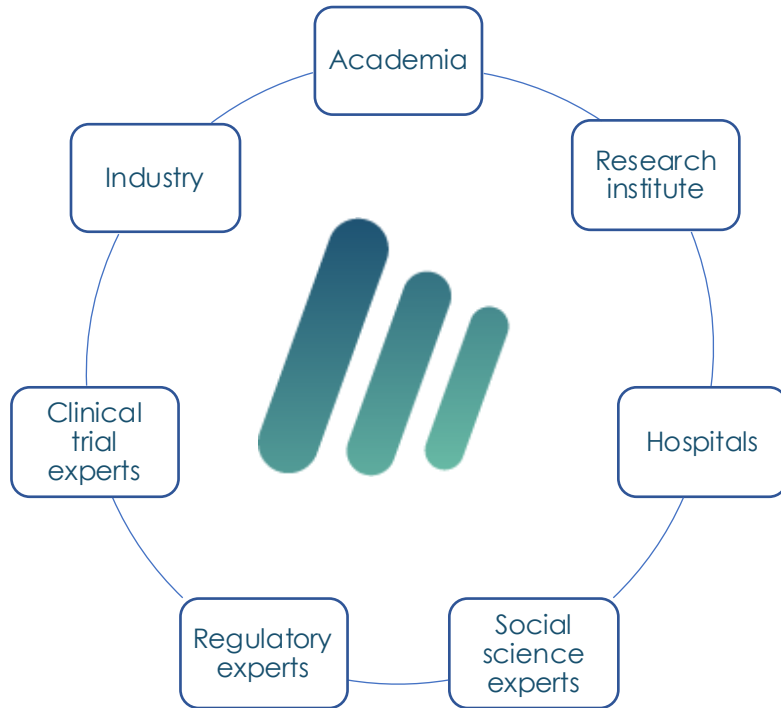
up to **2/3** of DVT episodes are clinically silent and patients are **symptom free**

pulmonary embolism events are **acute**, and 1/4 of these result in death immediately or in a few hours, before a treatment can be applied



prompt diagnosis of DVT is crucial!

ThrombUS⁺



18 partners
from 8 countries

Greece, Lithuania, France, Germany, USA, Finland, Italy, Spain

Wearable Continuous, Point-of-Care Monitoring, Risk Estimation and Prevention for Deep Vein Thrombosis

Horizon Innovation Action | No. 101137227

Co-funded by the European Union

Duration: 42 months

Start: 1 January 2024

End: 30 June 2027

Budget: 9.5 M€



Co-funded by the
European Union

ThrombUS⁺

wearable ultrasound for DVT continuous monitoring

coupled with

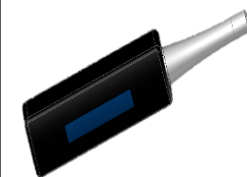
electrical impedance plethysmography

light reflection rheography

and other sensors for:

risk estimation and DVT prevention

Wearable Ultrasound



PZT-based
probes



MEMS-based
probe



Portable beamformer

Wearable Sensors



Electrodes and
sensors for
electrical
impedance
plethysmography



Sensors for
light
reflection
rheography

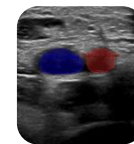
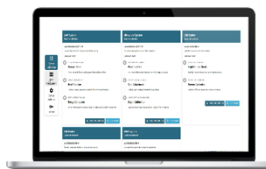


Sensors for
lower limb
activity
recognition

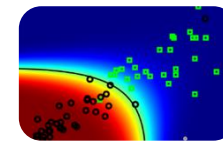


Portable silent
tissue actuator

Software



AI-based
ultrasound DVT
detection



AI-based
plethysmograph
y DVT detection



Extended Reality
& Serious
Gaming for DVT
prevention



Intelligence &
decision-making
application

the 1st wearable, autonomous compression ultrasonography



Sakalauskas A, Novikov D, Jurkonis R. Report on testing of arrays, pump and image formation electronics for image quality and required enhancements, Deliverable D3.5, ThrombUS+ Horizon Europe Innovation Action, EC Grant Agreement No. 101137227, 5 August 2025.
<https://doi.org/10.5281/zenodo.16415191>

machine learning to

- evaluate **diagnostic quality** of the image
- evaluate vein **compressibility**
- decide whether **DVT is present** or not

Chen PW. Et al., Deep learning model for diagnosis of venous thrombosis from lower extremity peripheral ultrasound imaging. iScience. 2024 Nov <https://doi.org/10.1016/j.isci.2024.111318>

Kainz B, et al., Non-invasive diagnosis of deep vein thrombosis from ultrasound imaging with machine learning. NPJ Digit Med. 2021 Sep, <https://doi.org/10.1038/s41746-021-00503-7>

Tanno R. et al., AutoDVT: Joint Real-Time Classification for Vein Compressibility Analysis in Deep Vein Thrombosis Ultrasound Diagnostics, Lecture Notes in Computer Science, 2018 Sept., https://doi.org/10.1007/978-3-030-00934-2_100

State-of-the-Art **AI-Based** DVT detection relies on **semantic segmentation** of veins and arteries to assess vein compressibility

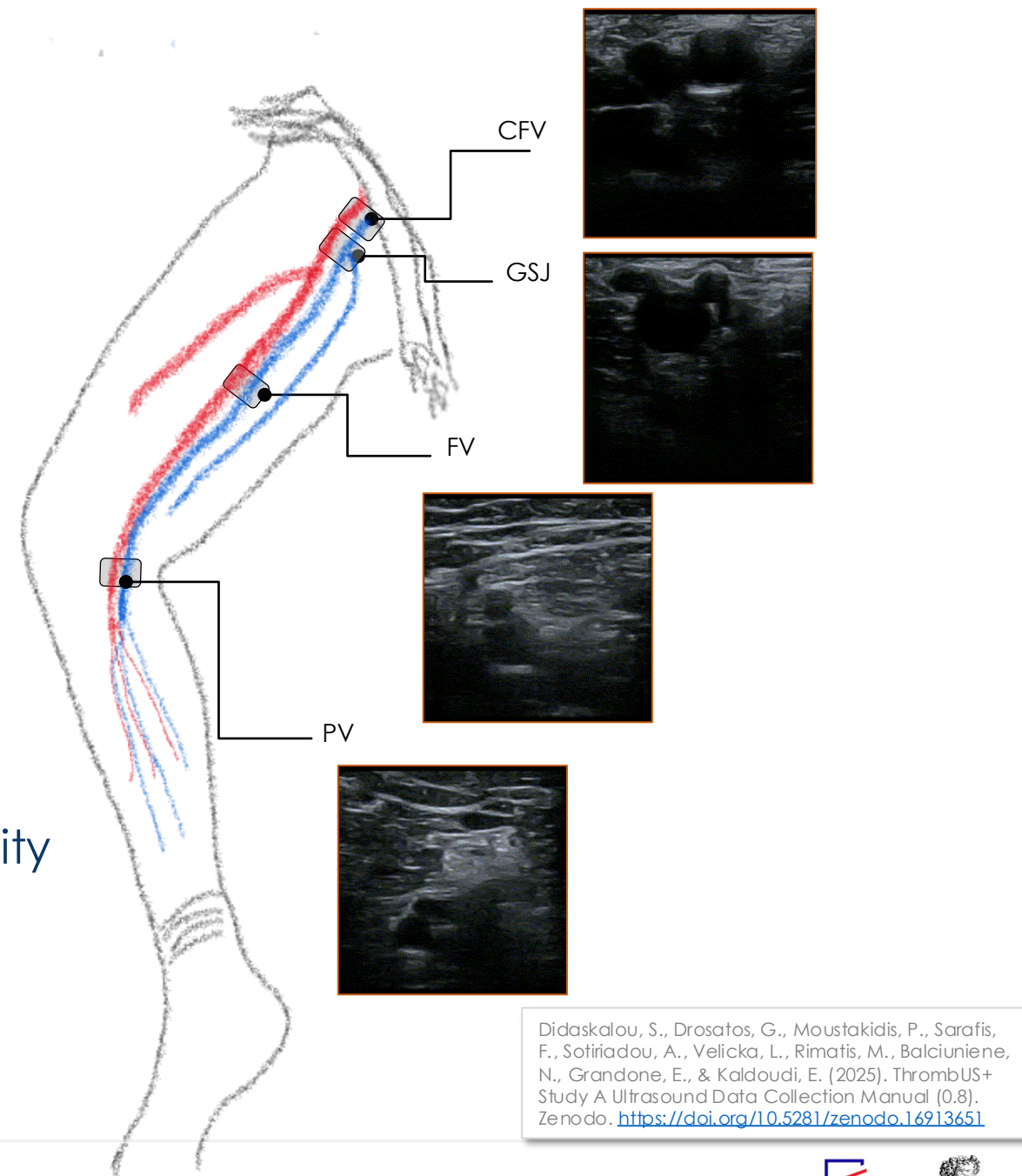


Ground Truth pixel-based annotations requires enormous amount of **effort, time and resources**

There are **no publicly available** datasets of US compression videos for DVT detection

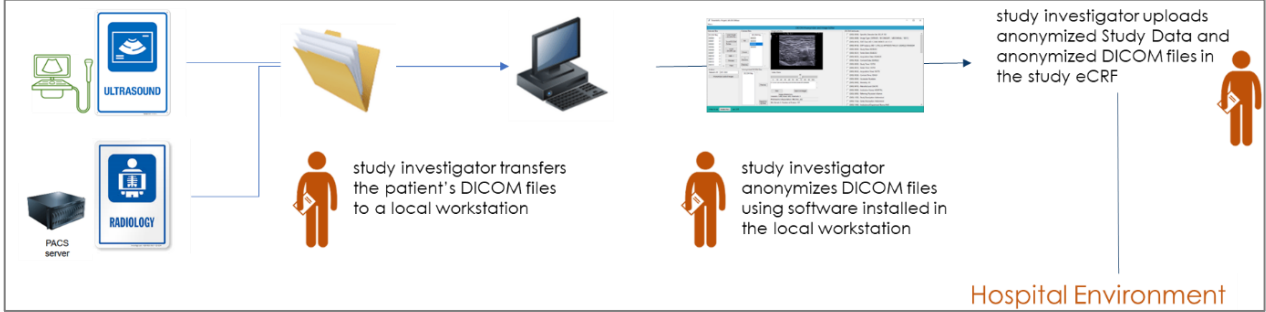
ThrombUS+ Training Data Set

- conventional ultrasound images and videos from 5 hospitals in different countries from >3,000 patients referred for DVT ultrasound [<https://clinicaltrials.gov/study/NCT06989255>]
- ultrasound Data Collection Manual
- per patient:
 - 4 imaging sites
 - 4 compression ultrasound video clips
 - additional images of no diagnostic quality
 - demographics
 - body composition metrics
 - DVT-related medical history

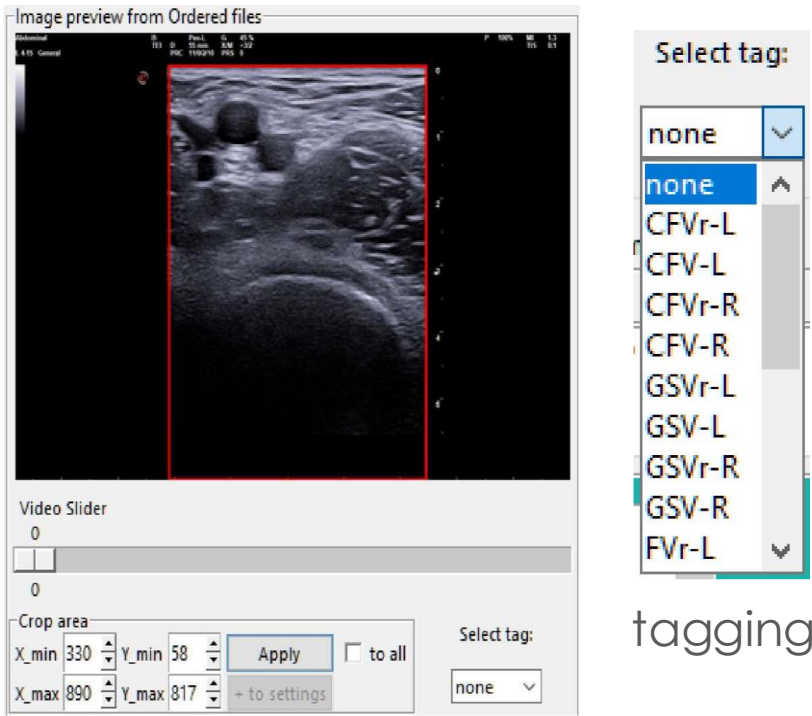


Didaskalou, S., Drosatos, G., Moustakidis, P., Sarafis, F., Sotiriadou, A., Velicka, L., Rimatis, M., Balciuniene, N., Grandone, E., & Kaldoudi, E. (2025). ThrombUS+ Study A Ultrasound Data Collection Manual (0.8). Zenodo. <https://doi.org/10.5281/zenodo.16913651>

data collection process



anonymization & tagging



Pechlivanis D, Didaskalou S, Kaldoudi E, Drosatos G, Preparing Ultrasound Imaging Data for Artificial Intelligence Tasks: Anonymisation, Cropping, and Tagging. BIOSTEC 2025. <https://doi.org/10.5220/0013379400003911>

Electronic Data Capture info



Venous system of the RIGHT lower extremity

Common femoral

Check if assessed ☒ Yes

Compressible Yes *

Thrombosis No *

Femoral-saphenous junction

Check if assessed ☒ Yes

Compressible Yes *

Thrombosis No *

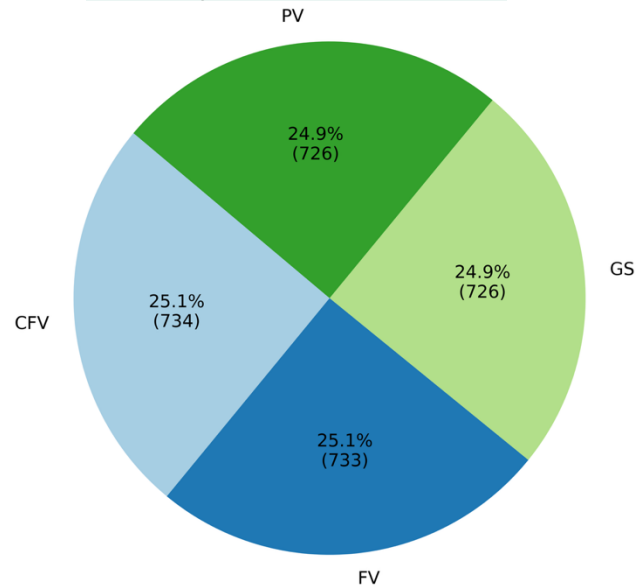
Weekly-Supervised dataset

Column Label	Label Description	Label Values	Comments
→ File Name	Full video filename as exported by the anonymizing software including name-based tags	n/a	DICOM filenames have been replaced with anonymized hash values. For the training set, all annotations are provided in the accompanying CSV file. For the test set, only the hashed filenames and non-label metadata are included.
SubjectID	Subject ID assigned during recruitment	n/a	Label format: SSN-XXXX, where SSN is the hospital's unique ID [GR1, GR2, IT1, FR1, or LT1] and XXXX a unique 4-digit patient ID.
Age	Age of patients in years	Value range: [18, 115]	n/a
Height	Height of patient in cm	Value range: [140, 240]	n/a
Weight	Weight of patient in kg	Value range: [35, 200]	n/a
Limb	Denotes the left or right limb	R or L	R: for right limb and L: for left limb
Thigh Circumference	The circumference of the limb in cm, measured at the FV site	n/a	n/a
Anatomical Site	Represents the anatomical site visualized	CFV, GS, FV, PV	CFV: common femoral vein, GS: great saphenous FV: femoral vein PV: popliteal vein
→ Compressibility	Represents the vein compressibility as assessed by the medical expert	2, 1, 0	2: Fully compressible 1: Partially compressible 0: Uncompressible
→ Thrombosis	Whether DVT is present at the scanning anatomical site as assessed by medical expert	1, 0	1: Thrombosis (DVT) is present 0: No thrombosis (DVT) is present

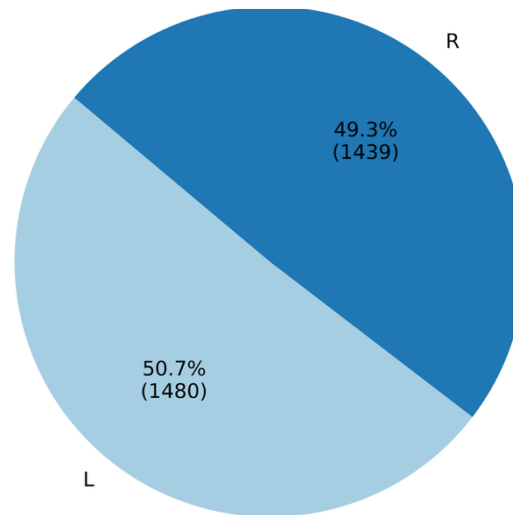
ThrombUS+ Ultrasound Dataset #1

- 2,919 compression US videos
- 742 patients
- 5 Hospitals (2x Greece, France, Italy, Lithuania)
- >6 different US machines
- >10 different operators

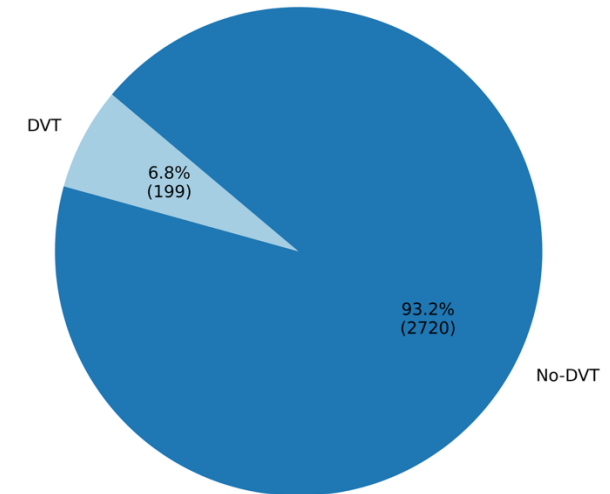
Videos per Anatomical Site



Videos per Limb



Videos with DVT and No-DVT



dataset is inherently unbalanced!

enable Weakly-Supervised model development through Data Challenges

- dataset was split into training/testing using an 80/20 ratio
- datasets are publicly available through Zenodo
 - <https://zenodo.org/communities/thrombus>
- data challenges created via Kaggle to promote transparency



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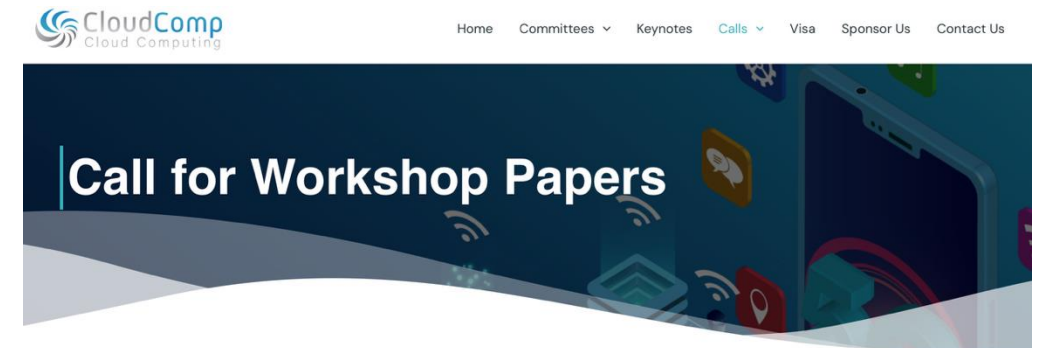
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Workshop

Workshop on ThrombUS+ Data Challenge: A Machine Learning Challenge for Automated DVT diagnosis based on Compression Ultrasound Videos. - AI4DVT 2026

2 - 4 March, 2026 - Marbella, Spain

In conjunction with the 19th International Joint Conference on Biomedical Engineering Systems and Technologies - BIOSTEC 2026



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Benchmarking Weakly Supervised, Segmentation-Free AI Models for Autonomous Deep Vein Thrombosis Detection

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<https://cloudcomp.eai-conferences.org/2026/call-for-workshop-papers/>

ThrombUS+ Ultrasound Dataset #1 - Compression Ultrasound Videos - Training Set

Didaskalou, Stylianos (Project manager)¹ ; Portokallidis, Nikos (Project member)¹ ; Kaldoudi, Eleni (Project leader)^{2, 1} 

Show affiliations

Venous thromboembolism conditions, including deep vein thrombosis (DVT), are the third most common cause of vascular mortality worldwide after heart attack and stroke. Prompt diagnoses of DVT is essential to decrease the risk of fatal complications. Machine learning (ML) models have emerged as a valuable tool for assisting prompt diagnoses. These models, by performing pixel-wise segmentation in ultrasound videos, assess vein compressibility, an indicator of DVT or no-DVT. Training such models, requires an enormous amount of effort for creating the ground truth datasets. Thereby, this dataset aims to foster the development of AI models for DVT detection using ultrasound videos without the need for exhaustive pixel-wise annotations, reducing the burden of manual labeling, while also enabling robust and clinically relevant predictions.

The dataset consists of **compression ultrasound video scanings** of lower limbs collected during a multi-center cohort study in European Hospitals (Greece, France, Italy and Lithuania [<https://clinicaltrials.gov/study/NCT06989255>]). Patients suspected of DVT are scanned using conventional ultrasound machines, after they had given informed consent form, according to a dedicated scanning protocol. All hospitals have been granted ethics approvals from their respective local ethics committees, prior enrollment and data collection.

480
 VIEWS




165
 DOWNLOADS

▼ Show more details

	All versions	This version
Views 	480	480
Downloads 	165	165
Data volume 	2.8 TB	2.8 TB

[More info on how stats are collected....](#)

Kaggle results

#	Team	Members	Score
1	Team Alpha		0.29096
2	Team Beta		0.22325
3	Team Gamma		0.30157

conclusions

- 1st large-scale, publicly available dataset with compression US videos
 - will continuously be enriched
- the scale and heterogeneity reflect real-world clinical conditions
 - development of Weakly-Supervised learning approaches
 - reducing the dependence on costly pixel-level annotations
- large vision models (e.g. ResNet, VLMs etc.) provide the capacity to learn from weakly supervised datasets
- scalable AI-based decision support for compression ultrasound
 - easier adaption to clinical practice

limitations

- class imbalance
- preprocessing, harmonization and quality control required
- four standard anatomical sites



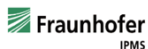
thrombus@athenarc.gr



<https://thrombus.eu/>



<https://www.linkedin.com/company/thrombus-eu-project/>



ThrombUS⁺

Wearable Continuous Point-of-Care Monitoring,
Risk Estimation and Prevention for Deep Vein Thrombosis

Horizon Innovation Action | No. 101137227 | 2024-2027

Co-funded by the European Union

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Neither the European Union nor the granting authority can be held responsible for them.

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Co-funded by the
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