AN AUTOMATED DIAGNOSTIC SYSTEM FOR CARDIAC ARRHYTHMIAS USING MULTIPLE LEADS, FEATURING AN AUGMENTED REALITY REPRESENTATION OF CARDIAC ACTIVITY

KEYWORDS

- ATRIAL FIBRILLATION
- CARDIAC ARRHYTHMIAS
- ECG MONITORING
- AUTOMATIC ELECTROCARDIO-GRAPHIC DIAGNOSIS
- DIAGNOSTIC ALGORITHMS

AREA

- BIOMEDICAL

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Patent Type
Patent for invention.

Co-Ownership
Sapienza University of Rome 50%, AENDUO 50%

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Industrial & Commercial Reference
Clinical engineering, bio-engineering, nanotechnologies, cardiac rhythm management

Time to Market
Technology demonstrated in relevant environment (TRL 6)

Availability
Research, Development and Experimentation

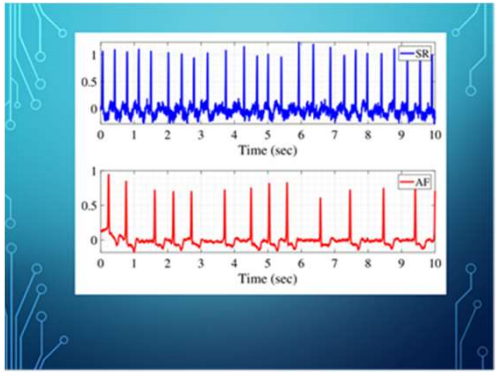

Fig. 1 Forme d'onda ECG in stati fisiologici e patologici

Abstract
A multi-lead system for the diagnosis of cardiac arrhythmias, with specific reference to the detection of clinically silent atrial fibrillation. The system integrates sensors and devices with edge computing capabilities for the calculation of features related to multiple ECG tracks, and is connected to cloud servers for atrial fibrillation detection through machine learning techniques. It can be used with a wearable device connected to the cloud

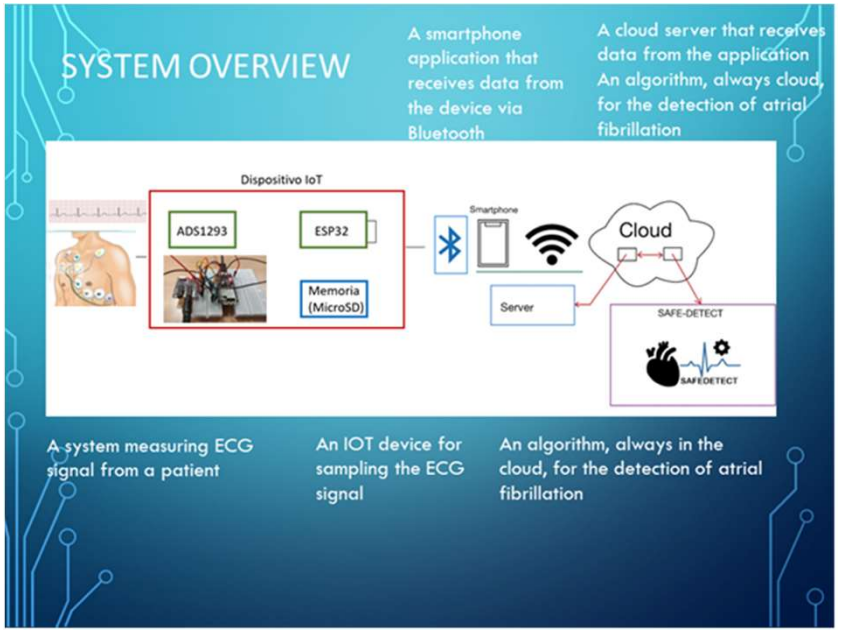

Fig. 2 Schema di funzionamento del sistema di monitoraggio

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Technical Description

The invention leverages the availability of multiple ECG tracks to extract features related to the temporal trend and the augmented reality representation of the spatiotemporal trend of cardiac electrical activity. It has the ability to reduce the effect of noise and artifacts on the acquired tracks, and to integrate information from multiple ECG tracks and, if applicable, from other biological sensors.

Technologies & Advantages

Atrial fibrillation (AF) is a very common arrhythmia and a major cause of ischemic stroke. It often occurs without symptoms, and in these cases, the first diagnosis is made through occasional electrocardiogram (ECG) recordings. Early identification of AF in high-risk cardiovascular patients has important implications for mortality and morbidity. To increase the likelihood of early diagnosis, prolonged ECG monitoring systems have been designed that are implantable or wearable. However, the devices currently in use have limitations in terms of cost and effectiveness in diagnosing the arrhythmia.

To improve the automatic recognition of AF, a new algorithm based on machine learning and artificial intelligence (AI) has been developed that can process ECG signals and automatically diagnose AF through morphological analysis of the waveform.

Applications

- Early diagnosis of silent atrial fibrillation;
- Prevention of ischemic stroke and morbidity/mortality associated with atrial fibrillation in high-risk populations.

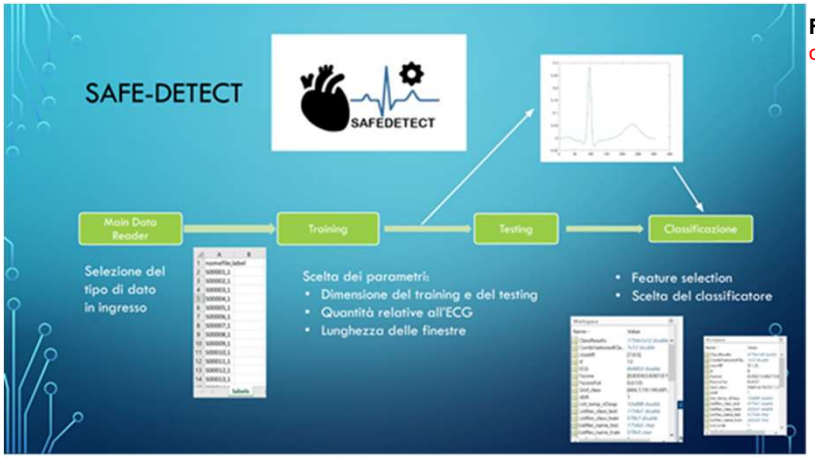
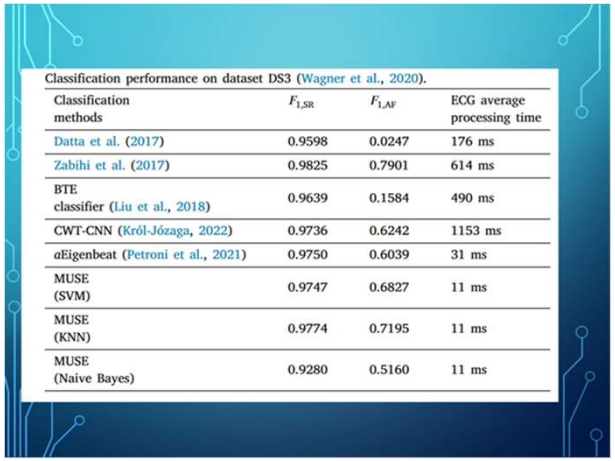


Fig. 3 Architettura di calcolo dell'algoritmo



Classification performance on dataset DS3 (Wagner et al., 2020).

Classification methods	$F_{1,SR}$	$F_{1,AF}$	ECG average processing time
Datta et al. (2017)	0.9598	0.0247	176 ms
Zabihi et al. (2017)	0.9825	0.7901	614 ms
BTE classifier (Liu et al., 2018)	0.9639	0.1584	490 ms
CWT-CNN (Król-Józaga, 2022)	0.9736	0.6242	1153 ms
*a*Eigenbeat (Petroni et al., 2021)	0.9750	0.6039	31 ms
MUSE (SVM)	0.9747	0.6827	11 ms
MUSE (KNN)	0.9774	0.7195	11 ms
MUSE (Naive Bayes)	0.9280	0.5160	11 ms

Fig. 4 Stato dell'arte: prestazioni

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