Cognitive electronic unit for assisted ultrasound: preliminary results and future perspectives

Emanuele De Luca[1], Emanuele Amato[2,3], Vincenzo Valente[4], Marianna La Rocca[2,3], Tommaso Maggipinto[2,3], Roberto Bellotti[2,3] and Francesco Dell'Olio[1,*]

[1]Micro Nano Sensor Group, Politecnico di Bari, Bari, Italy
[2]Dipartimento Interateneo di Fisica, Università degli Studi di Bari Aldo Moro, Bari, Italy
[3]Istituto Nazionale di Fisica Nucleare (INFN), Sezione di Bari, Bari, Italy
[4]Predict s.r.l., Bari, Italy

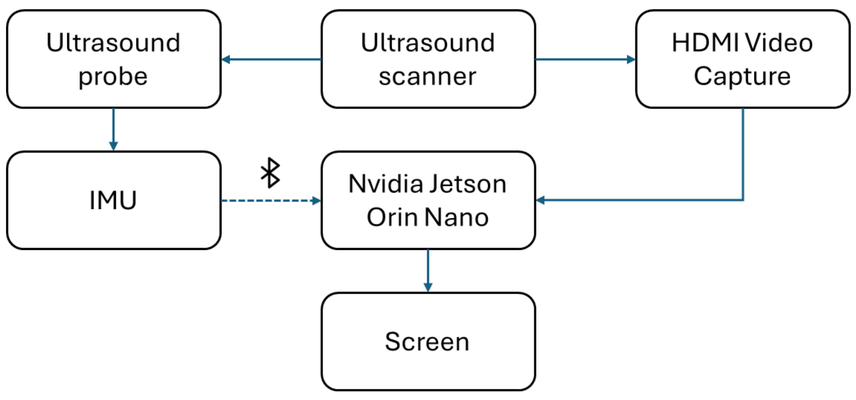
*francesco.dellolio@poliba.it

ABSTRACT

We are developing a cognitive electronic unit for assisted echocardiography. The paper focuses on the selection of the suitable hardware and the design of a neural network model optimized for small datasets. The chosen hardware supports real-time image processing and data transmission, while the neural network is intended for image classification. Preliminary results indicate the potential of the cognitive electronic unit we are developing to reduce inter-operator variability and enhance diagnostic precision in echocardiography. Further data collection and model refinement are still ongoing

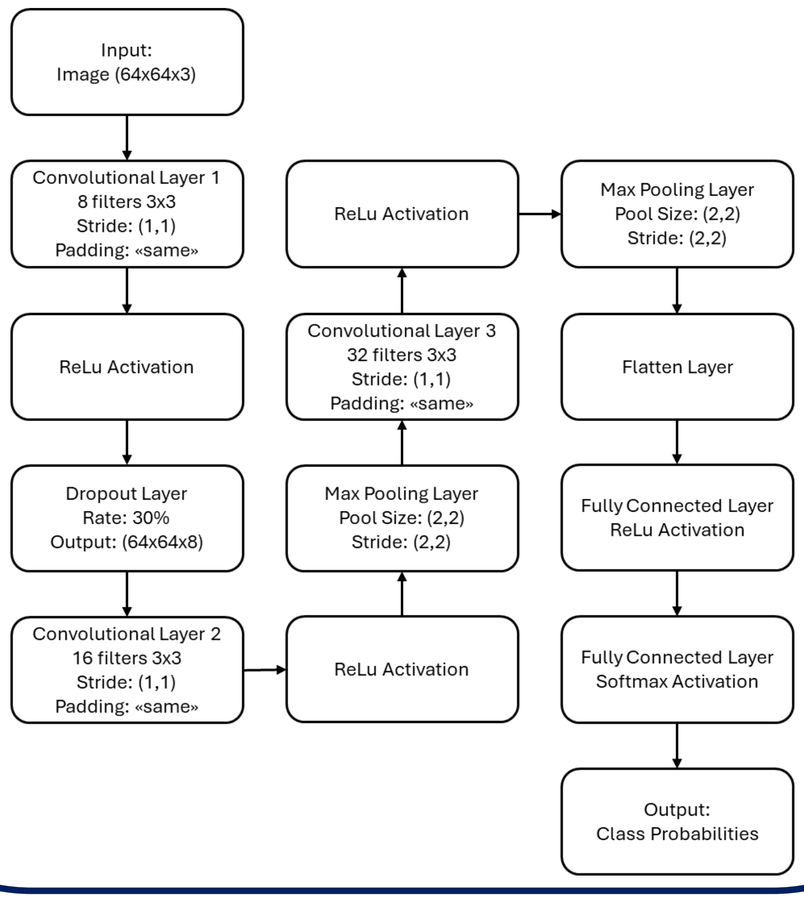
HARDWARE SETUP

The Nvidia Jetson Orin Nano has been selected for its robust performance according to comparative analyses available in the literature.



NEURAL NETWORK MODEL

The neural network classifies automatically and in real time echocardiographic images into 'Apical projection with 2 chamber view (2CH)', 'Apical projection with 4-chamber view (4CH)', and 'Unknown', with the latter including all non-classifiable images.

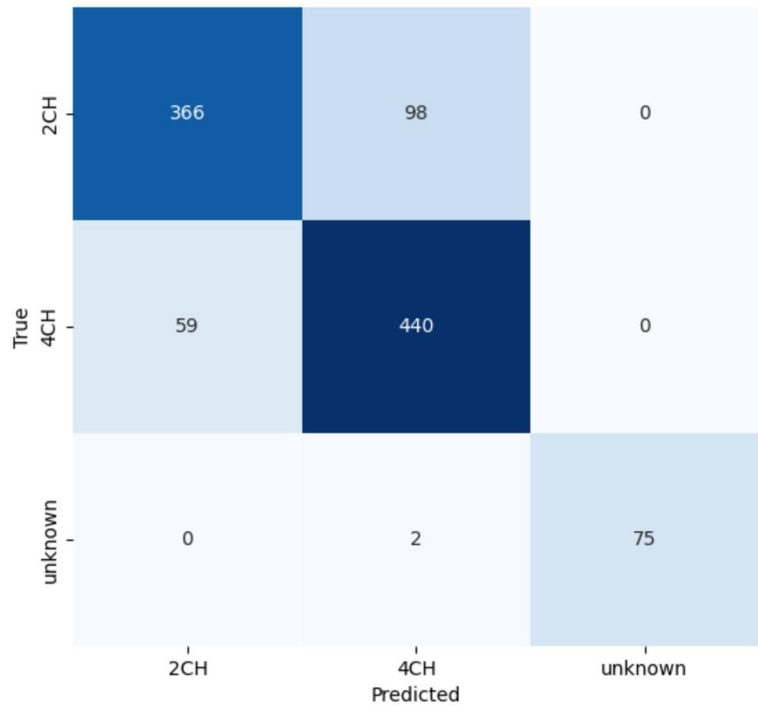


PRELIMINARY RESULTS

The performance of the neural network is reported below:

	precision	recall	f1-score
2CH	0.86	0.79	0.82
4CH	0.81	0.88	0.85
Unknown	1.00	0.97	0.99
Accuracy			0.85
Macro Average	0.89	0.88	0.89
Weighted Average	0.85	0.85	0.85

Confusion matrix on Test Set:



In order to verify the performance of the neural network on the embedded hardware, the ultrasound video stream has been acquired during an echocardiography performed on a volunteer. Using the neural network, the cardiac projection contained in each frame in real time has been classified. During the test, the CPU and its temperature has remained stable around 55.5 °C, and the RAM usage has been approximately 70 %. The average inference time for a single frame has been measured at 13.74 ± 2.48 ms.

CONCLUSIONS

The research is in its preliminary stages, but the initial findings establishes a foundation for developing a system capable of supporting more precise and reliable echocardiographic diagnostics. The next essential step involves the comprehensive collection of a dataset and collaboration with sonographers for accurate frame labelling. Future efforts will focus on integrating software advancements with the chosen hardware to improve overall system performance.