Quantum-Enhanced Emotion Recognition and Decision-Making for Social Robotics

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Abstract: This work presents a quantum-enhanced framework for social robotics, integrating multimodal emotion recognition and decision-making. An 8-qubit variational classifier and Grover-based search enable efficient processing, achieving up to 95% accuracy while addressing current quantum hardware constraints.

Quantum computing is rapidly advancing and offers significant potential across multiple technological domains. In parallel, social robotics aims to enable natural and emotionally aware human–robot interaction in everyday contexts. Recent studies have explored quantum approaches for tasks such as emotion recognition, decision-making, cognitive modeling, and path planning. However, as discussed in [1], the practical implementation of quantum circuits remains constrained by current hardware limitations. This work is developed within the QUADRI Project, which seeks to advance quantum-enhanced human–robot interaction through novel methodological contributions. The system comprises four main modules.

Module A handles the acquisition and preprocessing of classical inputs, which are compressed into an 8-dimensional latent representation.

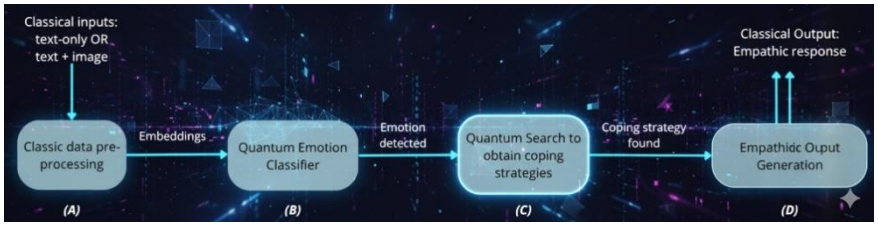

Fig. 1. Pipeline of the QUADRI system.

This embedding is then processed by the emotion classification module (B), based on Ekman's model of fundamental emotions. The classifier distinguishes seven classes (Anger, Disgust, Fear, Happiness, Sadness, Surprise, and Neutral) using an 8-qubit Variational Quantum Classifier (VQC), aligned with the input dimensionality. Coping strategy selection is performed via a quantum search approach inspired by Grover's algorithm, enabling efficient identification within the solution space. Finally, module D generates the empathic response through classical processing, leveraging a natural language model. An 8-qubit Variational Quantum Classifier (VQC) was then trained on these embeddings. With the optimized multimodal embeddings and advanced quantum feature maps, classification performance reaches 82% test accuracy with image only dataset, 93% in the fused (text+image) setting, and 95% in the text-only case.

Fig. 2. Performance evaluation of the simulation interface using the Pepper social robot.

References

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[2] Castrignano, B., De Carolis, B. N., Fiore, A., Longhena, M. R., Losavio, V. N., Miccoli, M. G., & Palestra, G. (2025). Toward Quantum Social Robotics: a Hybrid Architecture for Emotion and Coping Management.