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Robotic lower limb exoskeleton: A control software

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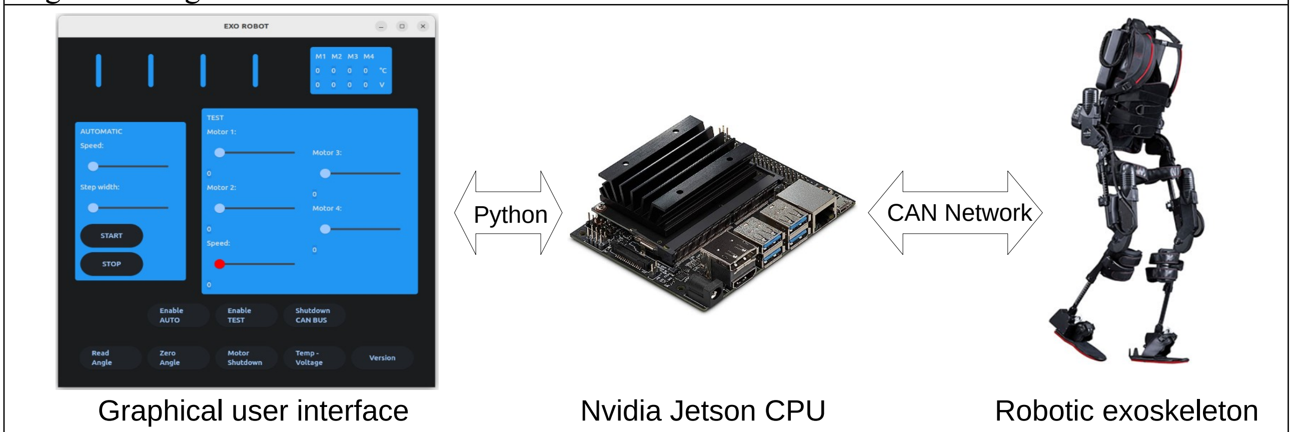
Introduction: Robotic exoskeletons are designed to assist people with gait abnormalities in their locomotion, increase physical capabilities, or rehabilitate patients after surgery or patients suffering from various neurological disorders [1]. The system is composed of several subsystems such as electrical, mechanical, digital network, and embedded control software. The main purpose of the control software is to drive an exoskeleton along the trajectory, providing the correct activation of the electric motors and ensuring the safety of the users [2]. The current project depicts embedded software for robotic exoskeletons to understand back-end and front-end functionalities. A graphical interface is provided to the user to facilitate interaction with the hardware and enable quick system diagnosis. To manage the movement and safety functions, embedded control software was developed to perform the necessary control functions and manage the system's communication network.

Materials and Methods: A physical prototype of a robotic exoskeleton was used for the development and testing of the control software, 4 BLDC motors model RMD-X were used as actuators, two motors drove the hip joints, and two motors drove the knee joints. The embedded software was developed with the Python language using the flet graphical framework and the CAN (Controller Area Network) communication bus. The central processing unit used is a Jetson Nano card from Nvidia. The system also has a 20A/h 48Vdc rechargeable lithium battery.

Results: The control software is capable of controlling each motor by sending actuation angle, speed, and torque commands, it is also possible to read motor data such as temperature, electric current, voltage, current angle, and adjustment data from the motor's PID controller. The graphical user interface is fully functional, enabling quick access to data and enabling remote configuration and startup of the system.

Discussion/Conclusion: Although the tests were conducted without the application of exoskeletons on human legs, it was possible to conclude that the development of the embedded control software allowed the correct control of leg movements and also opened up wide options for testing and operational analysis. Allowing the onboard control software to send tuning data from the motor PID controllers. The control software also allows the collection of data for later analysis or even for training neural networks in order to expand their functionalities and improve the system's response.

Figure 1: Organization and interaction between embedded control software and hardware.



References: [1] Kapsalyamov A et al., doi: 10.1109/ACCESS.2019.2928010 [2] Ristiana Ret al., doi: 10.1109/ICWT55831.2022.9935372