Animating living robots with compliance and biosensing

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Soft robotic systems often present bio-mimicking designs that resemble actuation mechanisms of certain biological organisms, such as swimmers resembling fish or flagellated microorganisms. However, there are some unique properties from living organisms that are specially challenging to obtain in their artificial counterparts, such as self-healing, adaptability, or bio-sensing capabilities.[1] Among these capabilities, it should be remarked the high level of adaptability, activity and autonomy that such biomaterials present, following the three principles of animacy.[2] Ideally, such three aspects should be accounted when designing bio-hybrid robots, regardless of their size or further application.

In the field of bio-hybrid robotics, several platforms across different scales had been developed,[3] but the ones based on living muscles have attracted increasing attention.[4] Regarding the design and fabrication of these robotic platforms, 3D printing technologies are particularly advantageous for creating advanced living robots incorporating skeletal muscle cells. While biohybrid swimming robots generally resemble the design and motion principle of animals, exploring alternative configurations that are not bio-mimetic is of great interest, especially when providing additional advantages, like mechanical self-stimulation.[5] Another important challenge in the development of such living robots is the integration of control systems, which could be aimed at guidance purposes to gather real time information over robot performance (i.e., exerted force).[6] We particularly explored the will be covered the implementation of flexible strain sensors for real-time force detection in non-modified skeletal muscle actuators,[7] which is of great interest to allow for better automation and improved animacy of such devices in the future.

In this talk, I will be covering which are the challenges when integrating such small electronics when reducing their size, as well as exploring other biomaterials of interest for bio-hybrid robots. Overall, the key features when designing these new generation of robots using living components as active material and biosensors as potential controllers will be discussed, as well as their animacy level and their main applications in the biomedical and the environmental field.

References

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