Intelligent Acanthaster Planci Robot for Gastrointestinal Residency Treatment

Xu, Ziheng (School: Pui Ching Middle School)

The treatment of inflammatory bowel disease (IBD) poses a considerable challenge to improving the public's health worldwide. It usually induces a high requirement for personalized treatment and long-term medication along with the severe side effects of existing drugs. Inspired by the crown-of-thorns starfish (Acanthaster planci), this project proposes a novel design of a starfish-like magnetic soft robot with microspikes on the inward surface, which can reside on the target site of the gastrointestinal tract for long-term medication. Using polymers and magnetic particles, the robot is produced by a series of fabrication steps and prestressing operations. The starfish-like multi-arm design is adopted to enhance the robot's grasping range. The magnetic field is generated by a robotic arm carrying a permanent magnet to actuate the magnetic soft robot. Due to the magnetic-actuation capability, the bio-inspired robot can move to specified target sites by rolling or walking under the external programming magnetic field. Then, it can stick on the target tissue by the microspikes for gradually releasing drugs over a long period. The biosafety of the robot was verified by conducting experimental studies using zebrafish embryos. The stable anchoring capability of the robot was examined in fluidic flows with different flow rates. In addition, the diffusion capability of the drugs carried by different hydrogel membranes was evaluated through the drug diffusion test to determine their relationships. The experimental results demonstrate the attractive advantages of the developed bio-inspired robots in targeted residing and on-demand drug delivery in porcine intestines. The project provides a promising solution for IBD treatment.

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