Development and Characterization of a Bionic Vine: A Novel, Flexible, and Stable Wire-Driven Soft Robot

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Today, millions of farmers have to pick fruits by hand. Those farmers put in much effort but get little because of low efficiency and lack of mechanization in picking fruits. Complicated environments in orchards require robotic arms for both flexibility and stability. In my project, vine motivates me to combine rigid-body and soft-body structures to develop such a robotic arm. I designed a modular, circular joint consisting of springs (provides flexibility) and 3D printed material (provides stability) through SolidWorks. By combining several identical joints, a long robotic arm is created. At the bottom of the robotic arm, several servos and a track car make up the drive system. By extending or shortening four steel wires connected to the top of the robotic arm and the movement of the track car, the gesture and the location of the robotic arm can be changed. I also developed some ideas for an automated control system. By analyzing the data collected by the camera installed on a robotic arm, fruits can be located, and robotic arms will be automatically controlled to grab the fruits and put them in the basket. After this, I used the SolidWorks simulation to determine the best proportion of springs and conducted a performance test. The combination of soft and rigid body parts makes its capacity to load heavy objects better than traditional rigid-body robots. Also, it can achieve lots of gestures, which proves its flexibility. Finally, I developed some theories for future improvements. As proof of its successful performance and utility, I used it in my school to help the orchard manager grab some apples. All in all, I created a kind of wire-driven soft robot with both flexibility and stability, and the robot could be effectively used in complex environments like orchards.

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