Automated Delivery Instrument for Stem Cell Treatment Using the daVinci Robotic Surgical System

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Introduction
We present a stem-cell injector to be used with the da Vinci Robotic Surgical Assistant. This device consists of a reusable stepper-motor drive assembly that supports a disposable syringe and disposable needle-tipped end effector that enables precise local injections of stem cells in vivo during minimally invasive surgery.

We demonstrate the use of the palpation probe as a tool mounted on the dVRK to perform automated injections with silicone-based tissue phantoms.

Motivation
- There is extensive research on methodologies to harness and differentiate stem cells, but there is less innovation and no clear consensus on viable modes of stem cell delivery in the clinic.
- Systemic delivery employs an intravenous injection of high volumes of cells with the expectation that some of the injected cells will migrate to the targets of interest.
- However, systemic delivery of stem cells in very high numbers also introduces risk for pulmonary emboli or infarction, as many of the cells will become trapped in the lung.
- Local delivery via direct injections allow a controlled and precise stem cell delivery to organs in more inaccessible locations within the thorax, abdomen and pelvis but is challenging because of its relatively high degree of invasiveness.
- Novel procedures or delivery devices are needed to reach certain anatomic locations such as organs located within the abdominal cavity.

Future Work
- Inclusion of the Injector as an enabler for automation within multi-step surgeries.
- Further miniaturization and decrease cost of device.
- Development of a class of disposable instruments to augment the automation of surgical robotics.

Experiments
- This injector was used on simulated surgical flesh to test the ability of the dVRK and injector to reliably dispense liquids.
- Silicone phantom flesh models were constructed to serve as tissue analogs for surgical procedures.
- A communications network was created using an i2c bus to communicate between ROS and the surgical environment.

Selected References