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

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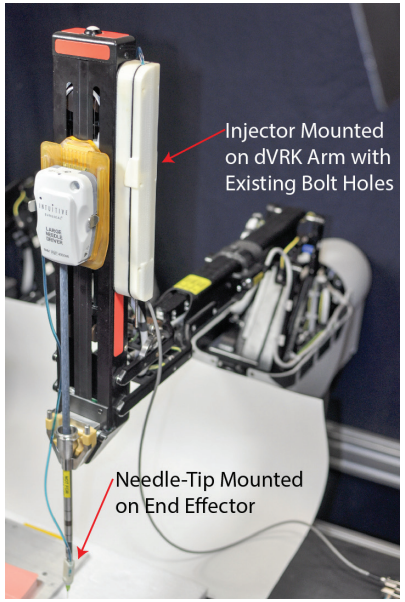
Introduction

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.

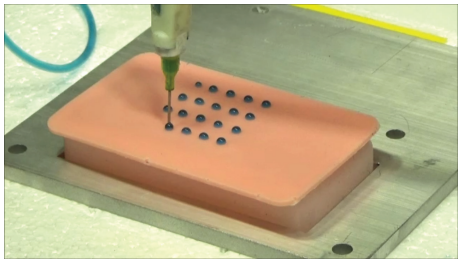


At left: The injector mounted on a robotic surgical assistant.

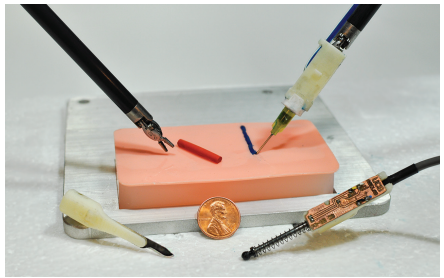
At right: The surgical assistant prepares for injection.

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.



At left: The injector can be used to create precisly spaced injections around a target area.



At right: The injector could be used as a component within a network of instruments developed by ASE Lab.

Future Work

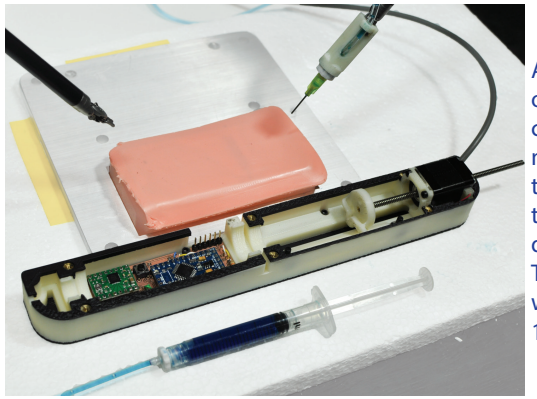
- Inclusion of the Injector as an enabler for automation within multi-step surgeries.

- Further miniaturization and decrease cost of device.

- Development of a class of disposable instruments to augment the automation of surgical robotics.

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 intervenous 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.



At left: The injector opened to show the carriage for a mounted syringe, the actuation, and the stepper-motor drive board. This device fuctions with 3mL, 5mL, and 10mL syringes.

- 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.

Selected References

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