2018

Atraumatic Vacuum Assisted Delivery Demo

STANDARD OPERATING PROCEDURE

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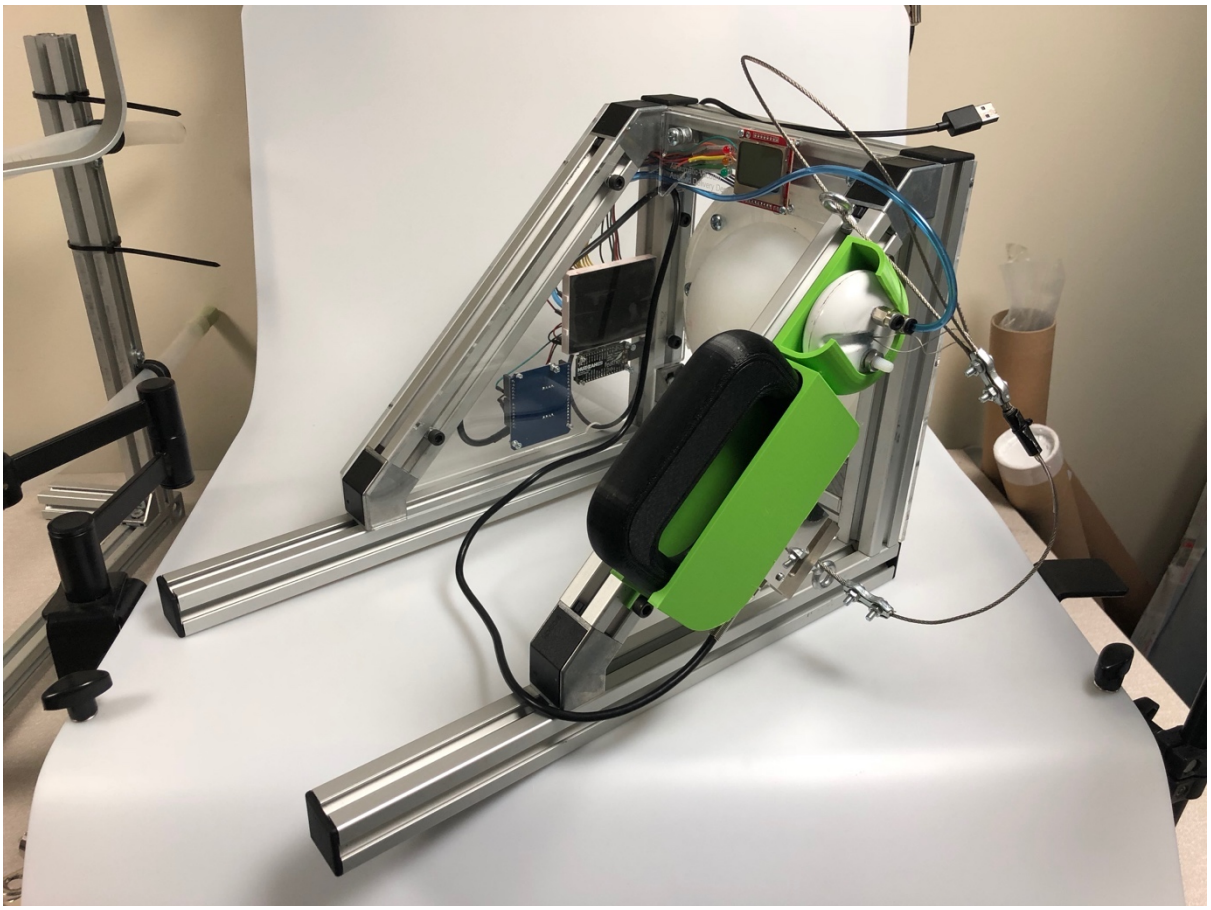
Table of Contents

Introduction

This is the standard operating procedure (SOP) document for the Atraumatic Vacuum Assisted Delivery Demo built by James Kinch on behalf of Dushyant Goordyal and the Surgical Technologies Laboratory (University of Leeds).

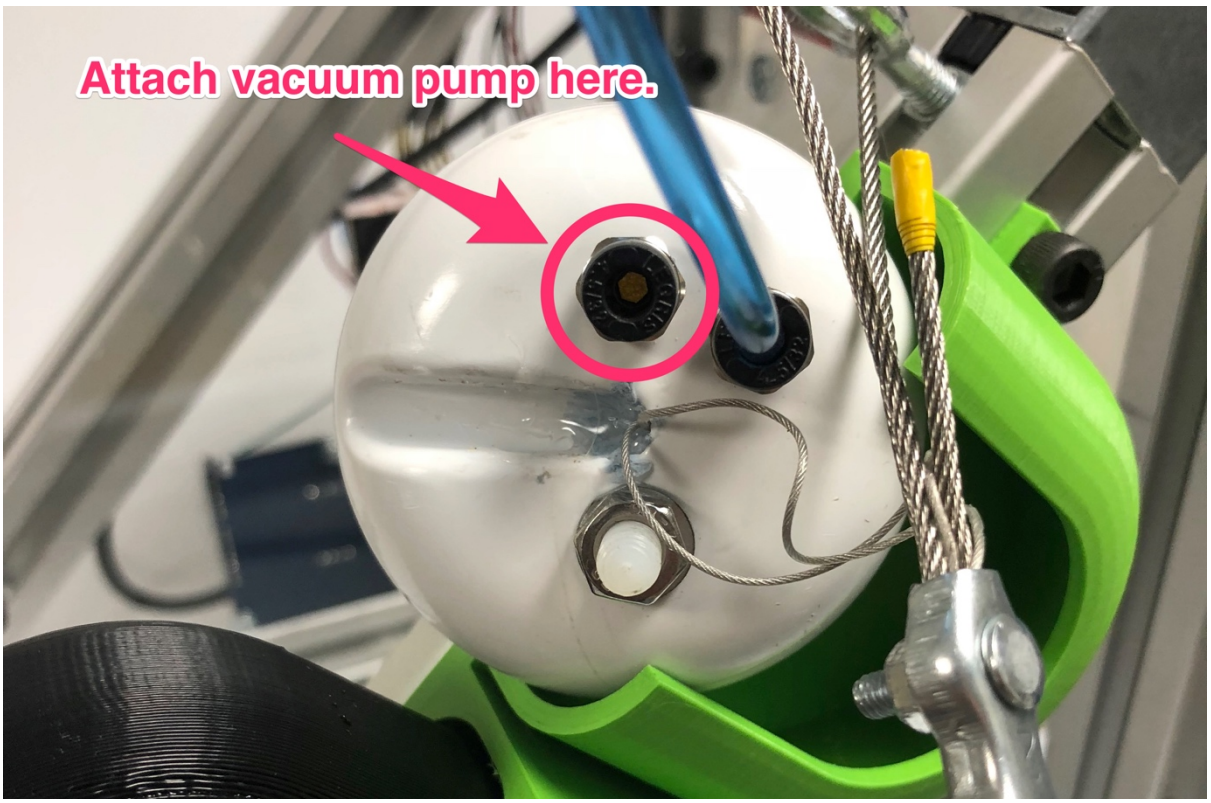


In this document the setup, operation, system schematics, and file locations (within the supporting folder) are covered to provide an understanding of how to use the demo model and where to find the supporting (CAD and programming) files.

Setup

To set the demo model up, there are two steps that need to be carried out. First, connect the attached USB cable to a powered USB port. You'll know the device is booting up correctly if you see each of the LEDs flash individually, and then flash together; this is then followed by the screen displaying a series of messages before resting on a page displaying the force (N) from the load cell, and the pressure (kPa) read by the pressure sensor.

The next step is to attach a vacuum pump to the cup via pneumatic tubing. As the demo does not have an internal vacuum pump, an external pump is required. As a result, the control of the vacuum applied to the simulated scalp is dependent on the operation of the pump.



As a final setup step, ensure the rig is securely clamped to a worksurface or desk as significant pulling forces are likely to occur during us.

Operation

To operate the demo, first press the cup against the simulated scalp, ensuring a seal around the outside, and apply a vacuum to the cup. The system has been designed to operate at 4 different pressures: 55kPa, 60kPa, 65kPa or 70kPa. **Be careful not to apply excessive vacuum to the cup as this may lead to component failure.**

At all of these pressures, you should find the cup is securely attached to the simulated scalp. You should also observe a pressure reading being displayed on the LCD screen (this may vary from the applied due to various pressure losses within the system).

At this point, the demo rig is ready for use. Pick up the handle and pull away from the rig. As you do this, you should see a force read out displayed on the LCD screen showing the force applied to the cup, as read by the in-situ load cell attached to the handle.

The LEDs will change depending on the amount of force applied to the cup. The threshold for the LEDs changing (i.e. from green to amber, or amber to red) is set programmatically depending on the pressure applied by the vacuum pump. A green LED is to indicate safe force application, amber is to indicate excessive force application, and the red LED is to indicate high probability of 'pop-off' occurring.

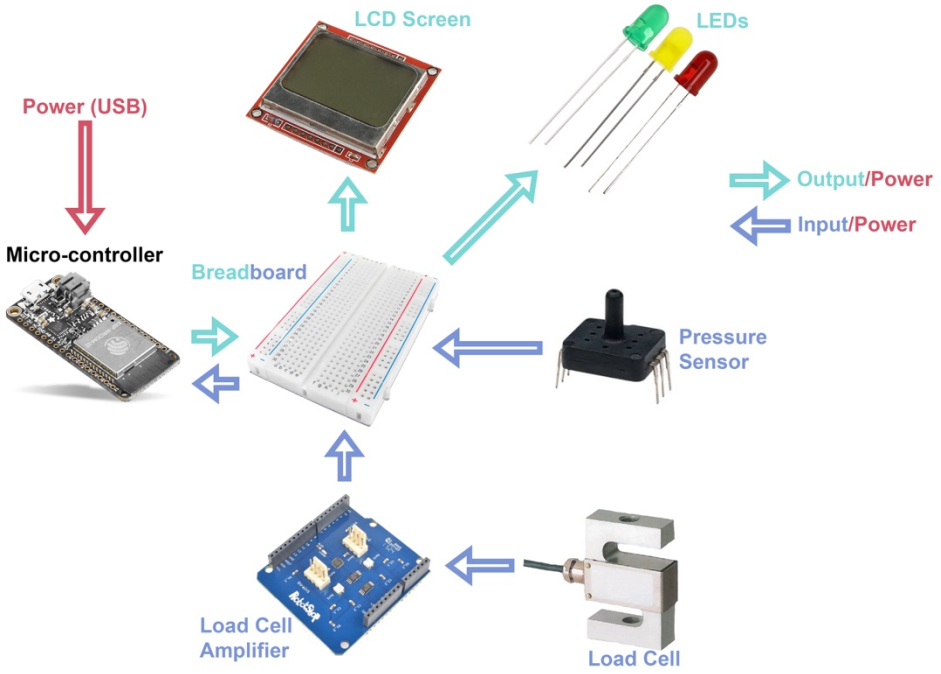
Components

Only the primary components are listed here; components including Perspex, wires, Rexroth, any 3D printed components, and nuts and bolts are not given. These can be determined either through inspection of the demo rig itself, or inspection of the CAD files (particularly the full assembly file) provided as part of the supporting files for the demo.

Component	Quantity	Notes
Load Cell	1	S-configuration 100kg capacity load cell
Vacuum Cup	1	
Steel Cable	N/A	2mm diameter steel cable
Pneumatic Tubing	N/A	4mm OD
Simulated Scalp	1	Produced using silicone over a Perspex dome
Pressure Sensor	1	
LCD Screen	1	Nokia 5110 LCD screen
LED	3	Green, amber and red for traffic light configuration
Breadboard	1	8cm x 6cm size
Load Cell Amplifier	1	Robot Shop load cell amplifier – only 1 channel used
Micro-controller	1	Adafruit HUZZAH ESP32 board
Cable Lock	2	

Schematic

The schematic presented here is a general overview of the electronics used for the demo rig. Specific connections to and from the various components are not given here. For further details on these, refer to the demo rig or the Arduino .ino program file.



CAD and Program Files

The supporting files for this demo are structured into two parts: CAD files, and program files. The CAD files are broken down further into five separate components:

1) **Acrylic Electronics Mounts:** these are the acrylic panels that are fitted to the demo rig allowing the electronic components to be mounted on to the Rexroth frame. It should be noted that the engraving of the credits for the demo were applied within CoralDraw post CAD file creation.
2) **Frame:** this contains the full assembly of the demo rig; everything from the acrylic plates, the handles, to the Rexroth frame. This is called **Full Assembly.sldasm** – there are subassemblies that pull from the other folders within the CAD folder so take care when renaming files to avoid missing components.
3) **Handle:** this is the CAD design for the demo rig handle. It was originally adapted from another CAD design that is contained within the subfolder '**Original**'.
4) **Handle and Cup Holder:** this is a novel holder design for the handle and the VAD cup.
5) **Mounting Plate:** this is a CAD file for the simulated scalp mount plate. This plate is used to attach the simulated scalp to the Rexroth frame.

Within the '**Program Files**' folder, there is only one file; Dushyant_Demo.ino. This is the Arduino IDE program file used to program the Adafruit Huzzah ESP32 micro-controller. For instructions on setting up the Arduino IDE, see here - https://learn.adafruit.com/adafruit-huzzah32-esp32-feather/using-with-arduino-ide