6-DoF collaborative robot for assistance in surgery

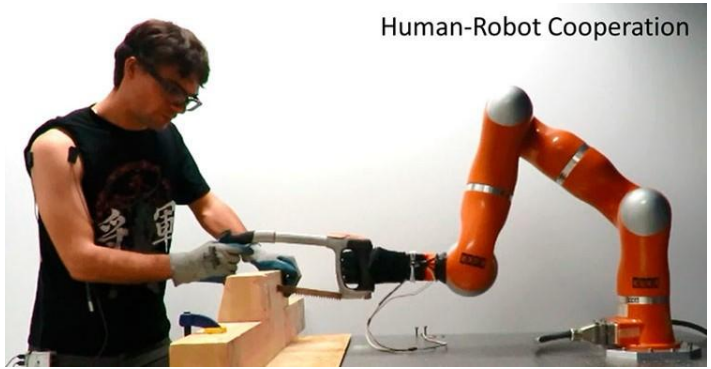
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Introduction

- The goal of this project is to develop a suitable robot that can work in collaboration with a doctor and assist him/her in medical surgeries.
- Fluid human - machine interaction in a highly critical environment is one of the key factors in developing this project.
- For this, a 6 DoF robotic manipulator is developed that can pick up surgical instruments from a tray and hand them over to a doctor upon request.



Prior Work

- There are many robots being developed around the world that can perform complete surgeries on humans.
- In the area of assistive robots for medical applications, there isn't much research conducted on robots that assist doctors during a surgery*.
- Apart from what has been already achieved, scientists and researchers still argue that there is still a lot that has to be done in this field to make it viable for public use.



* - *check references*

Key focus points

- For this particular project, the main focus will be on developing an accurate handover mechanism for the robotic manipulator.
- Another important factor is to find the ideal gripper that can be used with the robot for picking the surgical equipment.
- During the development process, it is imperative to get feedback at every stage from a practising doctor to iteratively improve the design.




Vacuum Gripper


Pneumatic Gripper


Hydraulic Gripper


Servo-Electric Gripper

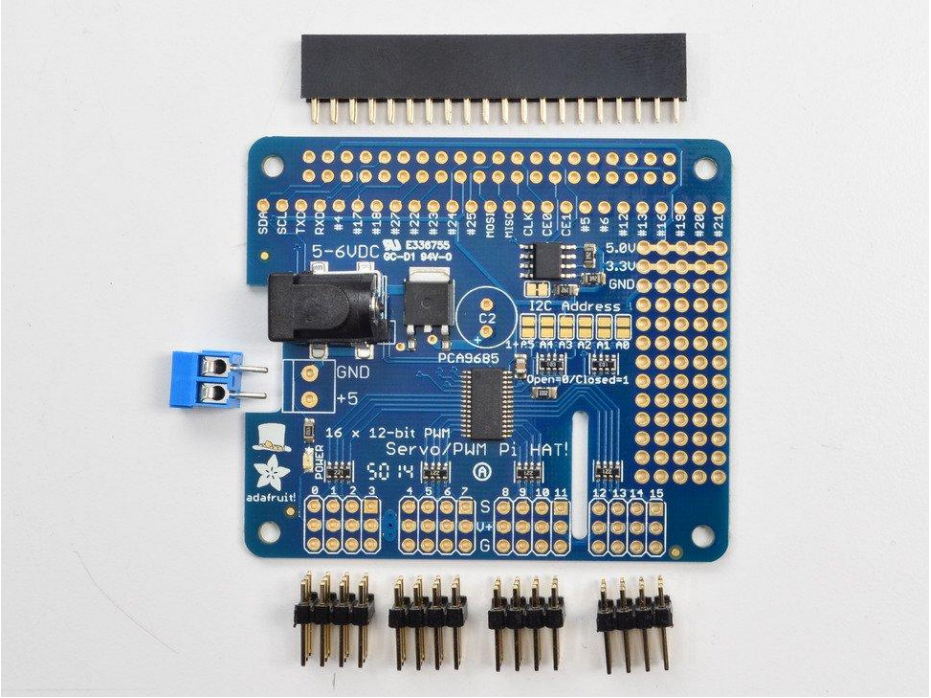


Hardware used

- For the prototype, a 6 DoF manipulator is acquired that can be programmed as per specifications.
- Raspberri Pi 3 with an additional servo shield is used to control the servo motors of the joints.
- A constant voltage supply of 6V and 3A (max) is used to drive the motors.
- Servo specs:
  - Frequency - 50 ~ 60 Hz.
  - Stall Torque: 13 kg / cm (4.8V), 15 kg / cm (6.0V).
  - Operating Speed: 0.17 sec/60º (4.8V no load), 0.14 sec / 60º (6.0V no load)
  - Dead band width: 5 usec.

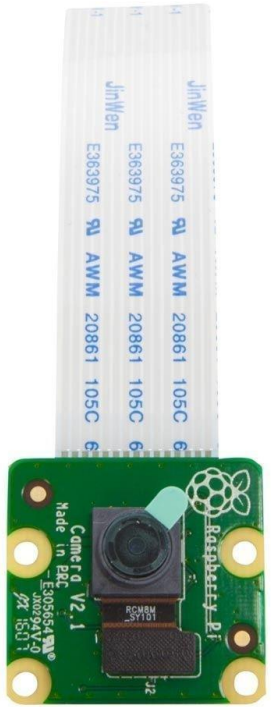
Hardware used

- Servo Shield: The Adafruit 16-Channel 12-bit PWM/Servo HAT will drive up to 16 servos or PWM outputs over I2C with only 2 pins.
- The on-board PWM controller will drive all 16 channels simultaneously with no additional Raspberry Pi processing overhead.
- It can also do PWM up to 1.6 KHz with 12 bit precision, all completely free-running.



Hardware used

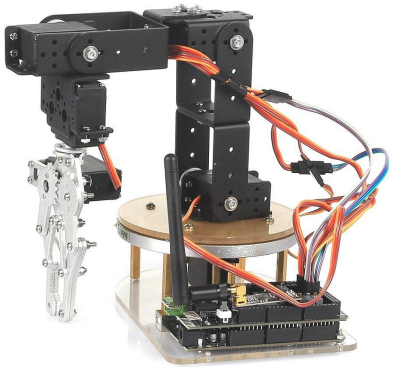
- Raspberry Pi Camera that has Sony Exmor IMX219 Sensor is used for human hand tracking to guide the gripper.
- As of now, it is proposed that the camera will use computer vision algorithm to track a colored shape on the palm of the doctor's hand.
- Once the correct position of the hand is determined, the gripper will release the surgical instrument and complete the handover process.
- The camera is an 8 megapixel, 1080p second generation (V2) Raspberry Pi Camera Module with fixed focus lens.
- 2A power supply highly recommended for using this camera.



Problems faced so far

- Servos:
  - The original motors that came with the robotic manipulator had four standard servos and two digital servos.
  - Digital servos do not work on the same operating frequency of PWM commands as the standard servos. They require at least 300Hz of PWM input.
- Power requirements:
  - Originally, the power supply used to drive the servos was a 5V/1.5A DC supply.
  - After testing it with six servos on board at a time, it was decided to increase the power supply to 6V/3A DC. Mainly due to large current draw by stall servos.
- Gripper:
  - As the end effector is crucial for the project, a robust gripper mechanism needs to be developed that can work effectively with all types of surgical equipments.

Summary



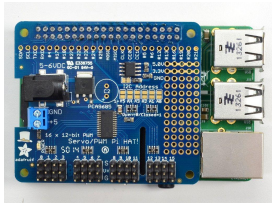
Robotic Manipulator

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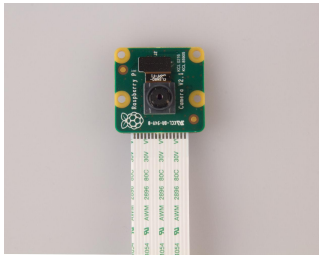
Appropriate Gripper

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Microcontroller with Servo Shield

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Camera Sensor

References

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Thank You!!

have a great day....