Joystick with 6-DOF Motion Tracking Function

BOSCH

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Problem Statement

During the medical rehabilitation process, a tool that can trace the entire process and make the process much more interesting could help patients to recover. This need leads to the idea of using a joystick. However, the current joysticks in the market either have low performance-cost ratio, or need complex external components. This project is to develop a new type of joystick that is able to trace the arm motion, cheap, highly accurate, as well as easy to wear and use.

Concept Generation

The joystick should be able to capture any slight movements of the player's arm. This will make gamers feel that controlling the arm of a character in a game is just like controlling their own arms. With this joystick, actions like waving, hugging or shooting will no longer be pre-programmed and they will be completely carried out by the players.
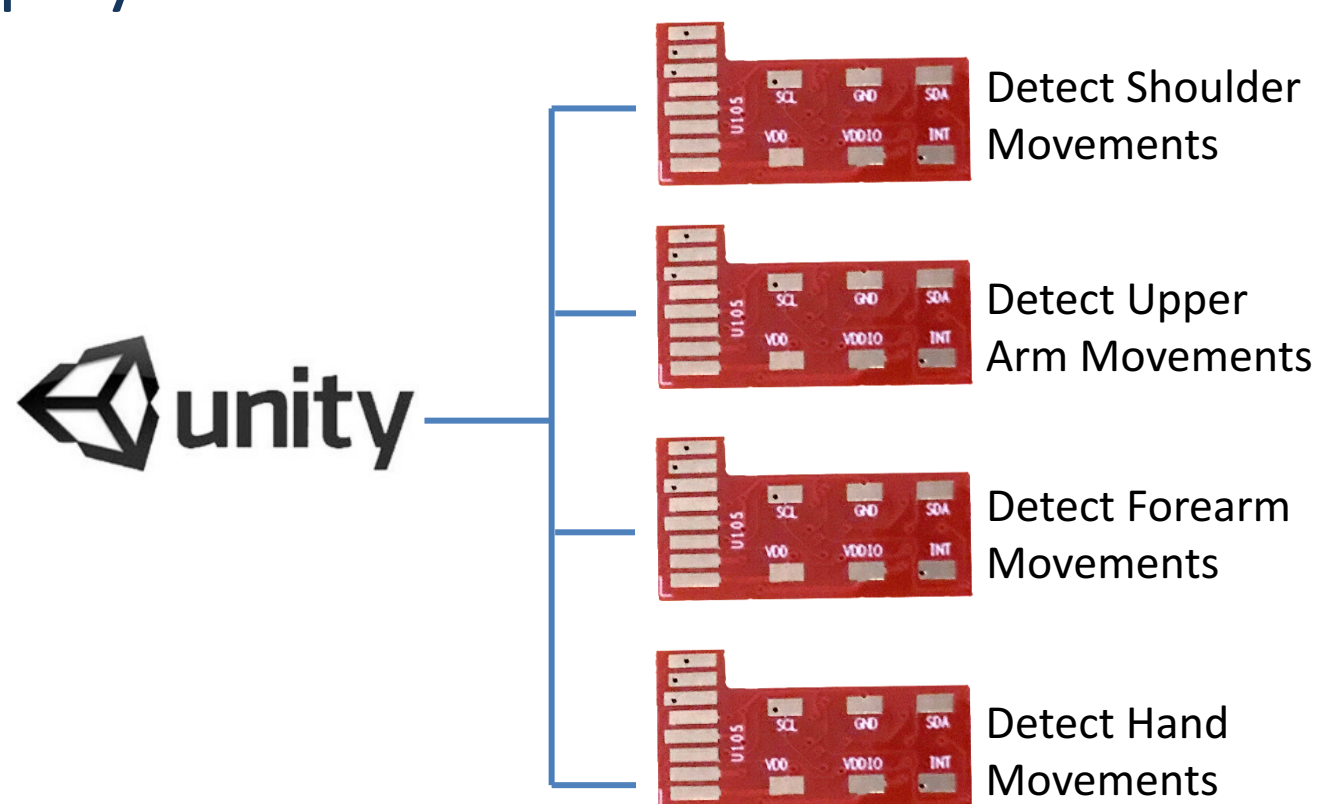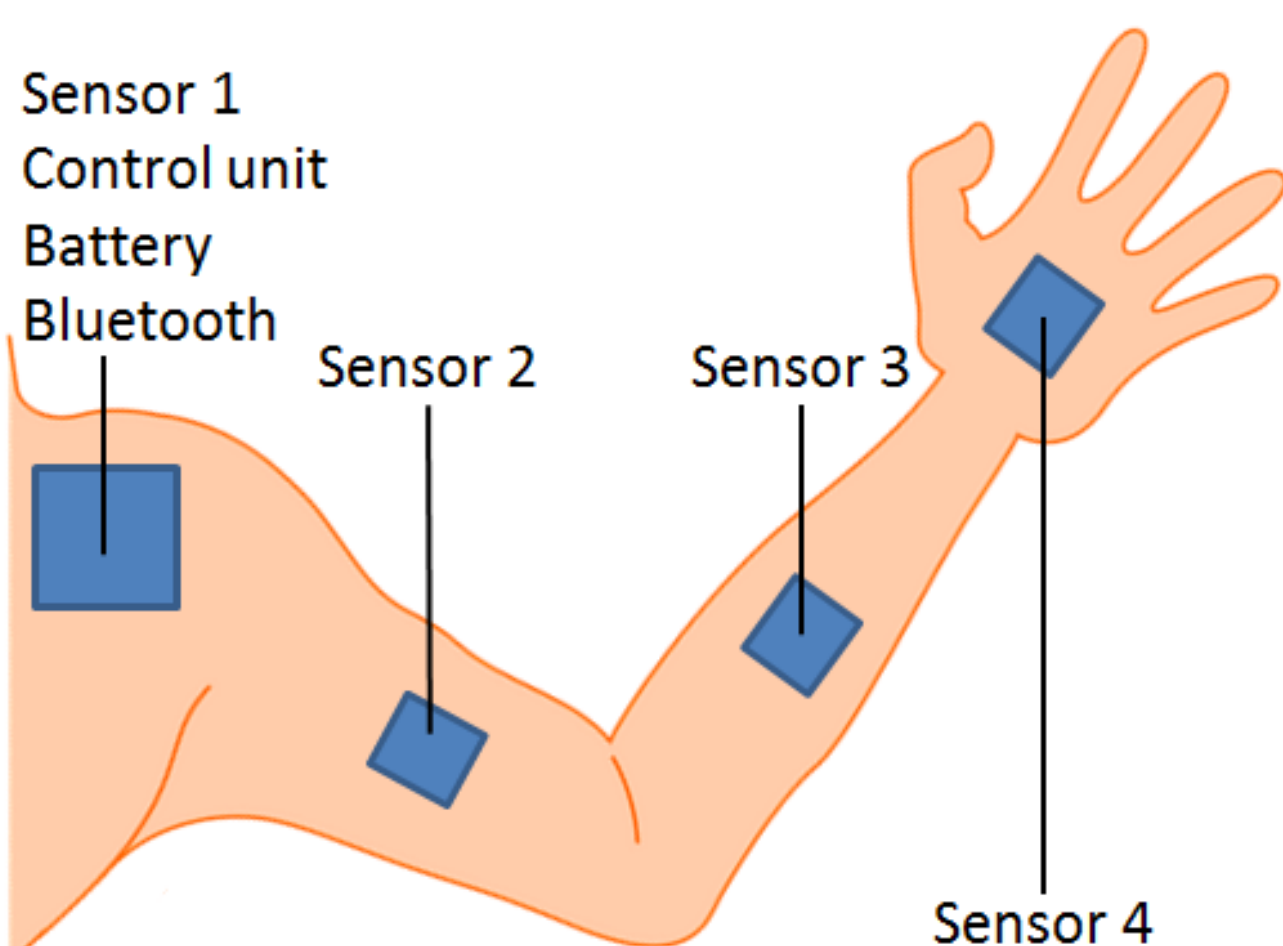

Detect Shoulder Movements
Detect Upper Arm Movements
Detect Forearm Movements
Detect Hand Movements

Fig. 1 Detailed structure function

Sensor 1
Control unit
Battery
Bluetooth
Sensor 2
Sensor 3
Sensor 4

Fig.2 Concept Diagram[1]

Design Description

BNO055 Sensors

I2C Switch

3.7V Li Battery & 3.3V VRM (Charge Devices)

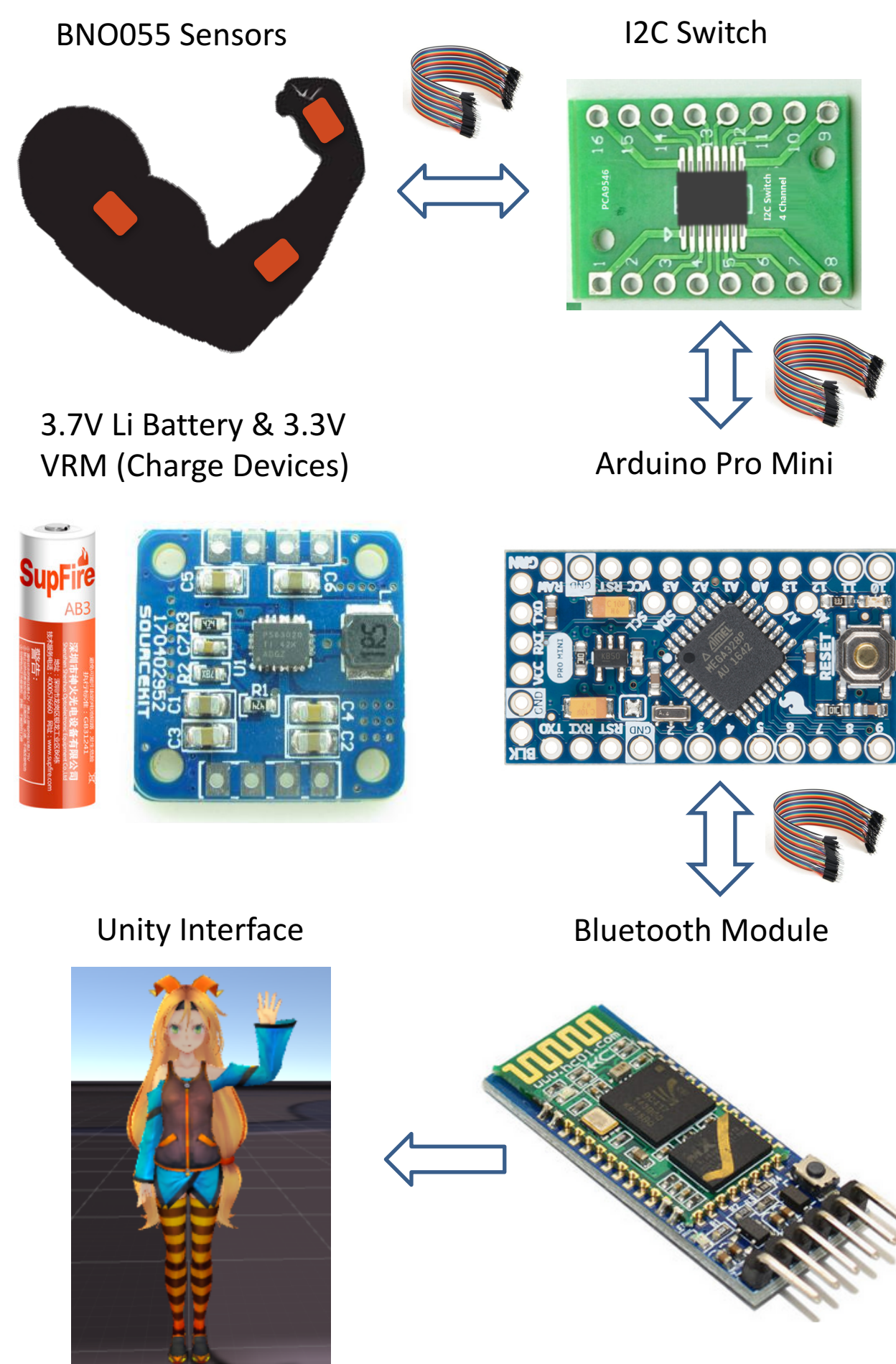Arduino Pro Mini

Unity Interface

Bluetooth Module

Fig. 3 Design Concept [2]
(Unity model from asset store)

Modeling and Analysis

Unity is used to model the arm motion. After receiving the data from sensors, the cartoon character in Unity will behave in the same manner. The following figures shows two human motions and corresponding Unity figures.
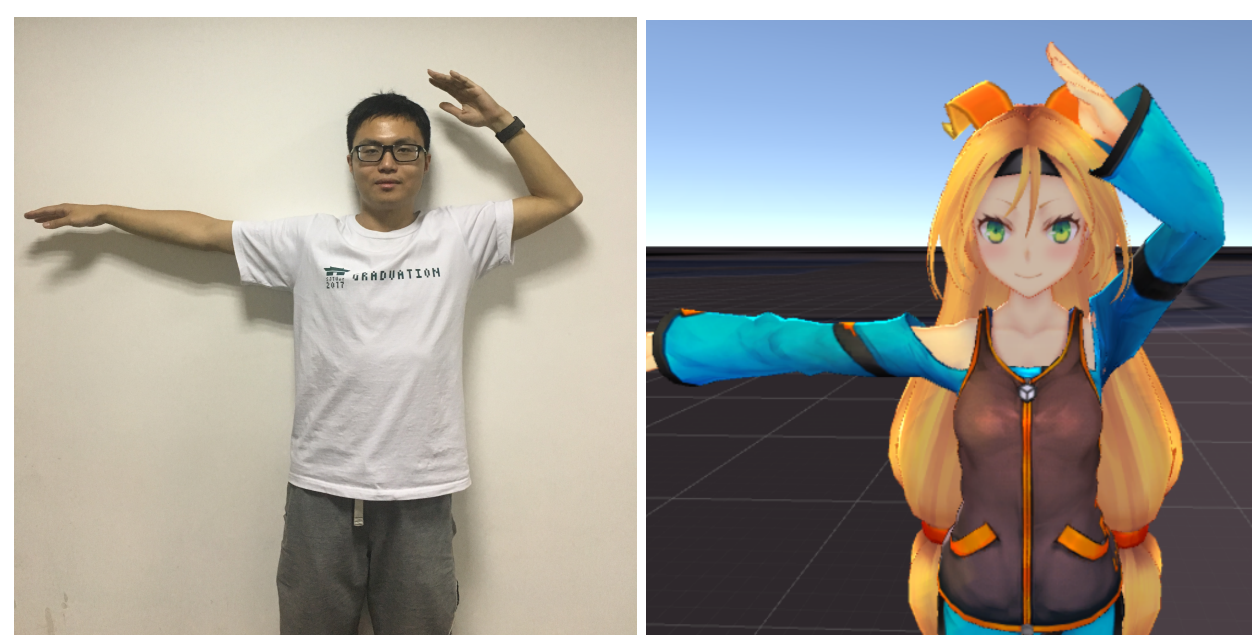

Fig. 4 Arm motion 1 in real life and in Unity
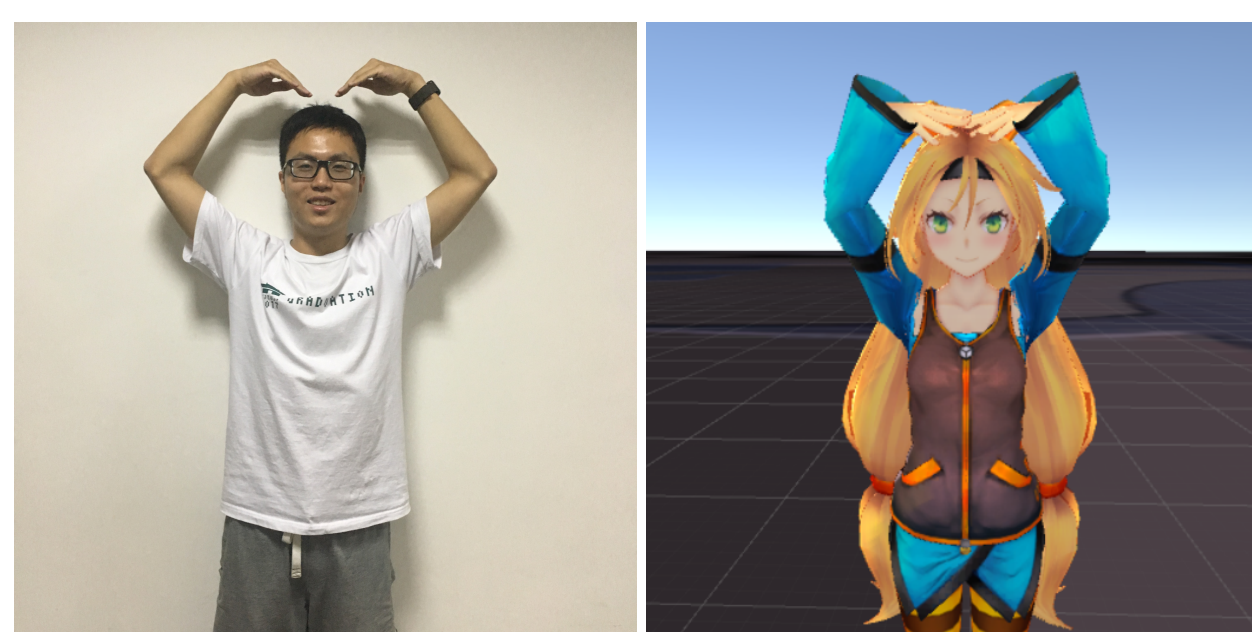

Fig. 5 Arm motion 2 in real life and in Unity

Validation

1) Compare the calculation result with the actual movement distance to calibrate; repeat the experiments to check the accuracy.
2) Weigh all the components with the 3D printed cases to check the weight, and use a small box to check the size.
3) Check the status every 15 minutes to measure the battery capacity.
4) Except for the sensors provided by Bosch, other components cost about 200RMB, which means the total expenditure <300 RMB.

Results:
After experiments, the following engineering specifications are met.
- Detection accuracy < 5cm
- Overall weight of joystick < 320g
- Size of joystick < 2dm^3
- Battery capacity > 2.5hrs
- Expenditure < 300RMB

Conclusion

This joystick can be easily wear, and could track the arm motion of the user, as well as display it through the built model. The accuracy, size, weight, and working time could meet the engineering specifications, and the expenditure is much lower than the current products in the market.

Acknowledgement

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Reference

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[2]UNITY-CHAN! OFFICIAL WEBSITE. (n.d.). Retrieved June 01, 2017, from http://unity-chan.com/