作品資料 Information about Project

作品名稱 Name of Project:

Sign Language Educator – Vision Aided Sensor Glove

作品的設計目的 Objectives of Project:

Sign Language Educator is a low-cost, user-friendly sign language education system for both deaf and hearing people.
Preliminary investigation shows that pre-school sign language education for deaf children are overlooked by parents due to the lack of awareness, the short of capable teachers and high tuition fees.
In addition, lack of knowledge on sigh language among general public also prevent communication between hearing people and deaf people, which keeps deaf people from integrating into society.
Therefore, Sign Language Educator is aimed at improving users' learning experiences, so that deaf children can enjoy convenient sign language education and sign language can make its way into general public.

作品的創新之處 Innovativeness of Project:

1. First interactive sign language education system with wearable device.
2. Vision aided sensor glove for dynamic sign language gesture tracking.
3. Combination of facial expression recognition with hand gesture tracking.
4. Replacement of fiber optic sensor or flex sensor by low-cost Inertial Measurement Unit sensor in sensor glove.

作品的商業價值 Commercial Value:

1. Large demand of convenient and effective sign language education, potential users are the deaf themselves, their families and friends.
2. Low-cost sensor glove for commercial scale production.
3. Potential accessory for iPad or other mobile devices.
4. The technique can be generalized into other hand motion tracking applications.

作品簡介 – 例如：動機、研究方法、發現結果及重要性、後續發展…等等 (以600字為限)
Description of Project - e.g.: Motivation, Methodology, Findings & Impacts, Future Development, etc. (Maximum 600 words):

I. Introduction

We propose to develop a sign language educator using sensor gloves and camera. It uses Inertial Measurement Unit (IMU) sensors, collaborating with 2D camera calibration and facial expression recognition, to track and rectify the movement of our fingers and our faces. After 3D modeling, visually highlighted 3D response will prompt us the way to correct our irregular hand movement and insufficient facial expression. In this project, iPad is chosen as an auxiliary equipment because of its built-in camera and portable computing resources.

II. Literature review

In the past, there were some projects related to sign language, like Enable Talk and Kinect Sign Language Translator. Using sensor glove alone, since major sensors are flex sensors, they can only detect finger bending, but other sign language features, like hand orientation, abduction angle between adjacent fingers (fiber optic sensor can solve this but it's expensive) and facial expressions, cannot be detected, which limits its power of sign language recognition. Using 3D camera alone, the limitation is that the camera is easy to be affected by surrounding color and different view angles. Moreover, it is harder for 3D camera to detect detail movement of hand gesture compared with using sensor gloves, which decreased its recognition accuracy of sign language. Some projects also tried to use 2D camera as supplement to sensor glove, but they only focus on static hand gesture recognition, while sign language needs dynamic hand gesture tracking as well as facial recognition.

As for sign language education, some companies have release their PC software. However, they are more like a digital sign language dictionary rather than education system since they lack of methods to detect users' movement, not to mention feedback information.

There are two main improvements in our project:

1) Low-cost IMU sensors are used, collaborating with 2D camera, to achieve dynamic hand gesture tracking and facial recognition.

2) Interactive learning system provides better sign language learning experience.

III. Methods

For each glove, the CPU (STM32F407ZGT6) is placed on the back of the hand, surrounded by a Bluetooth module and one MPU9150 (IMU) module. On each finger, there are two MPU9150 modules locating at proximal interphalangeal joints and distal interphalangeal joints respectively and one touch sensor on the fingertip.

The first challenge is sensor drift. Since the IMU is continually adding detected changes to its previously-calculated positions, any errors in measurement are accumulated. Complementary filters are designed to calibrate this sensor drift. The second challenge is the fusion of sensor gloves and camera. In order to achieve dynamic tracking, captured images locate the initial position and IMUs record the gesture, orientation and displacement of the sensing point. Image processing traces the abduction angle between adjacent fingers, recognizes facial expressions and measures the relative position between sensor glove and human body. After these, Unity 3D engine will use calculated parameters to build hand skeleton and face model. On this basis, the 3D model will be generated to reconstruct the hand movement and facial expression of users.

To rectify irregular performance, iPad will analyze the parameters and mark the difference compared to the standard performance. The irregular performance will be highlighted to remind users of which part to be improved in a straight forward way.

IV. Expecting Results

1) Import a collection of sign language entries for users to learn.

2) Detect detailed information of users' movement and reconstruct the 3D model.

3) Give feedback of users' performance to realize effective sign language learning.

(573 words)

其他資料－ 例如：參考文獻、照片、圖表 (不超過3頁)
Other Information of Project - e.g.: Reference, photo, graph (Not more than 3 pages):