Report of Project – Building Automation Sensor Network

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1 Abstract

In this semester, our team (Qin,Duan and me) aimed at using network of sensors to help finish building task under instructions of professor Tian. We started the project with no former material and experience accumulation. The whole process, including investigation and research, building the sensor network, debugging and testing, was all done by us. And we has made a preliminary demo which can adjust gesture and position itself with help of two walls.

2 Introduction

Our work is aimed at help prefabricated building using machine. A prefabricated building is a building that is manufactured and constructed using prefabrication. It consists of factory-made components or units that are transported and assembled on-site to form the complete building. Usually the assembling work is done by human. We are going to find a solution to get the gesture and position of each part on the building sites. Then we can use operating arms to do the assembling work, or at least help assembling work. By this way, we can ease the whole building task and at the same time finish it more efficiently.

3 My Contribution

3.1 Investigation

Because the work is almost zero-based, first of all, we spent a lot of time doing investigation and research. In this period, I did a large amount of investigation,paving the way for the following work.

I searched the material of all kinds of sensors and compared several common sensors: Laser,ultrasonic and infrared. Laser can always has a high-precision, as well as good directivity. It is the most ideal choice for this project. But a laser distant sensor will cost a lot due to the production technical requirements. Infrared sensor is cheap and easy, while it can't promise the precision. It also has some shortcoming like small range and weak directivity. So infrared is removed from our list. Ultrasonic is also cheap and has good environmental adaptability. It can work although there are dirts and dusts.But it will be influenced by temperature and humidity. And then we chose ultrasonic sensor to our demo.

My remain investigation was focused on laser sensors. I found a rotatable laser array designed for using on sweeping robot. It can measure the distance between it and the environment by rotating the laser array. The array acts as 3D scanner and may be also a good choice to overcome the shortcoming of ultrasonic. Ultrasonic sensor will not receive the return wave and then become useless if the wave is not sending vertically to the reflecting surface. And to solve the problem,there is also some solution inspired by Kinect.

Kinect 1 uses Light Coding Technology. It uses laser diffraction to produce laser speckle in the space. The process codes the scene with near-IR light, light that returns distorted depending upon where things are. The solution then uses a standard off-the-shelf CMOS image sensor to read the coded light back from the scene using various algorithms to triangulate and extract the 3D data.

Kinect 2 uses the time of flight method to measure the distance. But the time of flight is so short that it bring a high sensitivity requirement for the elements, which is also the reason why laser sensor is expensive. Kinect 2 smartly checks phase of light wave instead of time to make the cost decrease. It modulates the light wave into sine and compares the difference between sender and receiver to calculate the time of flight. The method is worth learning for our project.

3.2 Debug

After buying the sensors, we were going to build the sensor network. I was mainly responsible for the acceleration sensor and magnetic field sensor. My achievement are making sure that the sensor work correctly and debug to resolve conflicts when combine several sensors together on one MCU.

At first I found that the acceleration sensor can't work at all on our MCU which supports our ultrasonic sensor. Consulting the manual, I find the key problem that our former MCU didn't contain the the ADC module required by the acceleration sensor. So we bought another MCU (stc12c5a60s2) to make it work.

When combining the sensors to work together, there came out many register conflict, register for mode of timer for example. And the result was that code got stuck somewhere and both of them didn't work. The process of debugging and reading manuals for all sensors and MCUs was boring and costed a lot of time. However they can work peacefully at last.

4 Our System

In this section I mainly introduce the working theory of our demo. First we use the acceleration sensor to measure the gravity component to get incline angle. Using incline angle,the object can adjust to horizontal position. Then we use the magnetic field sensor to calculate the deflection angle. Making sure the object is in the right gesture, we know that sensor can receive the reflection. Thus the distance measure by ultrasonic is credible enough to be used to adjust position. The presentation of achievement has been showed in my PPT and video given by other teammates.

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