

Wireless Communications and Mobile Networks
Course Project Report
Building Automation Sensor Network

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Abstract

Prefabrication[2] acts as an important role in building procedure. In this method, the building component is built before it is settled in building. Especially in some special conditions, for example, underwater condition, prefabricated component maybe the only way to construct a building(bridge) efficiently. And this method perform well. Nowadays it is the age of Internet of Things, the traditional way of construction has been the bottleneck of the construction speed. So we introduce a method that could help locate and adjust the prefabricated components in low scale.

1 Introduction

Nowadays, there is an increasing need and demand to update the technology used in the procedure of making buildings. In traditional way, prefabrication is a method that has been used for construction which could largely make the procedure efficiently. But as the development of the construc-

tion technology, the manual adjustment of the prefabricated component has been the bottleneck of the speed of the construction. So we introduce a method that could locate and adjust the component automatically with the help of multiple sensors. So it's obvious that the main challenge we meet is how to get the information of its location and gesture. We solve it by using several sensors.

The rest of the paper is organized as below:

Section 2 introduces the result of our survey about different sensors that are suitable or not. Section 3 introduces the primary method proposed to solve the problem. Section 4 will talk about the advanced version of our method to meet wider demand. Section 5 will be a summary and conclusion.

2 Survey

We surveyed a lot of sensors that could be used to measure the distance. The infrared distance measuring sensor is cheap, easily made and safe. But its accu-

racy is low and could only be used to measure the short distance. What's more, it has a high probability to get the light-wave from a wrong direction and it is easily influenced by the sunlight.

Laser distance sensor is high in accurate. But the cost of making and using is high. There is also constraint in the using condition.

Finally we choose the ultrasonic distance sensor. It could be used in some rough conditions and is highly accurate. But the accuracy highly depends on the surface area. The ultrasonic sensor we used is hr-sc04. Building information modeling (BIM) [1] is a process involving the generation and management of digital representations of physical and functional characteristics of places. It is widely used in nowadays constructions procedure. It also includes a guide of the settlement of the prefabricated components. So what we want to do is to implement the adjustment of the prefabricated component.

3 Primary idea

Our primary idea is to use the sensors to locate the component. We first think about the 2-dimensional condition. It could be proved that use only 2 sensors to measure the distances from the sensor to 2 edges of the component, 2 locations (Two black lines in figure 1) are possible. The distance is shown as circles in blue and red in figure 1. So additional sensor is need to make sure which one is exactly true (shown in green color).

As for 3 dimensional condition, the possible conditions are more, which are shown

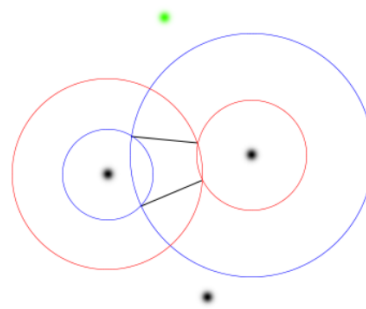


Figure 1: 2 dimensional location

in dark color in figure 2 and form a frustum of a cone. Some conditions (red lines for ex-

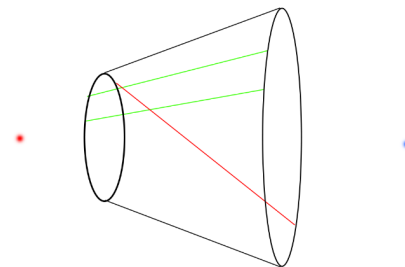


Figure 2: 3d location

ample) is impossible and could be negligible by calculation. Another sensor in this situation is still need to make sure which one is true. To make the result more reliable, redundant sensors are considered to be added. The realization is somewhat complex, we could use the ultrasonic sensors to measure the distance. And use the infrared sensor to synchronize the different sensors and make them able to recognize each other by the signal carried by the infrared wave.

4 Advanced idea

Considering the complexity of the previous idea, we choose another method. In the new method, we add some constraints on the place where the sensor network is used. If the prefabricated component is only settled inside the room where 3 walls could be found. Then the 3-d positions information could be collected by our sensor. In following subsections, I would talk about the problems and how we apply this model to a wider situation.

4.1 Gesture adjustment

The total task of our model is to locate the component and adjust its gesture. The method mentioned above is mainly about how to locate the prefabricated components. Then I would talk how we could get the gesture information.

We use the acceleration sensors to collect the information of offset of from the gravity its normal to surface direction. The sensors we used are Axcel335. And in order to know the direction information, we use a magnetic field sensor.

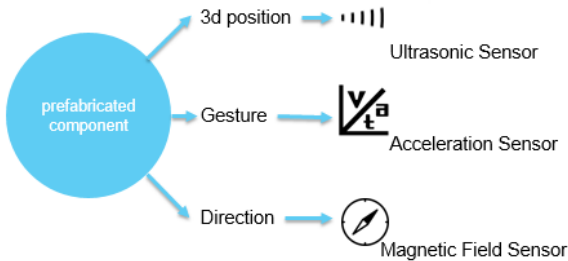


Figure 3: Sensors we used

4.2 Protocols

There still exist many constraints in our design, for example, we can not apply our method to a site where there is no enough walls to help locate. So we want to solve them and apply our model to a wider condition.

4.2.1 Protocol 1

Protocol 1 is shown in figure 4. The sonic sender send a signal to the sonic receiver, then both of them sleep for 20 ms(in order to avoid that sender receives the sonic reflection rather than the receiver's reply). After 20 ms, the receiver send the reply back to the sender. And the sender count the time delay between two green triangles in figure 4.

But there exists a limitation that the receiver cannot keep listening for any arbitrary long time. The challenge of how to synchronize the sensors is a problem we need to face. So we design the 2nd protocol.

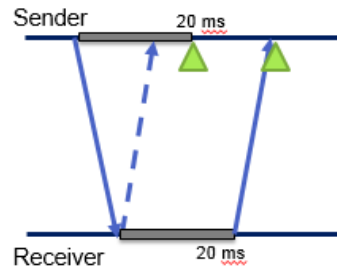


Figure 4: Protocol 1

4.2.2 Protocol 2

Protocol is shown in figure 5. In this protocol, we use a remote infrared controller to send infrared light wave to both senders. And then the sender send sonic wave to the receiver. And receiver could count the distance between them.

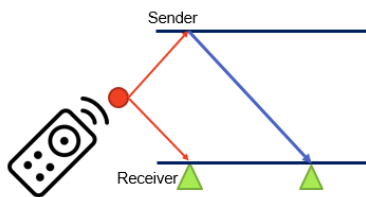


Figure 5: Protocol 2

4.2.3 Protocol 3

We design the third protocol, which is shown in figure 6. The sender sends both infrared wave and ultrasonic wave to the receiver. And the receiver could calculate the time delay and know the distance.

Something interesting is that we could make the infrared wave carry some signal (just like the TV infrared controller we used in daily life) and use this signal to make the receiver recognize different senders (different senders send different signal).

5 Conclusion

We present our design and implementation about the prefabricated component. Our future work will include the more detailed experiment to measure the accuracy of our model and add more sensors to make it re-

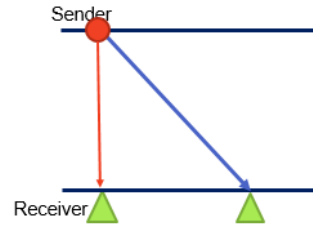


Figure 6: Protocol 3

liable in real life. Thanks for teachers' help and my group mates.

References

- [1] Wikipedia. Building information modeling — wikipedia, the free encyclopedia, 2016. [Online; accessed 19-June-2016].
- [2] Wikipedia. Prefabricated building — wikipedia, the free encyclopedia, 2016. [Online; accessed 19-June-2016].