2014 Intel Cup Undergraduate Electronic Design Contest

- Embedded System Design Invitational Contest

Final Report

Project Name: Furniture Preview System Based on Augmented Reality Technique

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FURNITURE PREVIEW SYSTEM BASED ON AUGMENTED REALITY TECHNIQUE

ABSTRACT

Our system implements a new form of furniture displaying. It shows the virtual furniture module in the real space through augmented reality technique and provides some simple gestures to move and rotate this module. By this way, users would get a sense of immersion. The system solves the hard problem to access the information of user's visual angle through a new way which combines the computer vision and sensor measurement technology, so that it could reduce the operating pressure and make itself running smoothly on low power platform. Besides, the system is based on Intel Baytrail embedded platform, extended by Intel Galileo platform which plays a role of controller of many sensor unit such as inertial measurement units and flex sensors and powered by many open source library like Panda3D, ARToolKit, I2Cdev and so on. It implements a highly interactive furniture display platform.

Key words: AR, Computer Vision, Inertial Measurement, Gestures Control

System Overview

As living standard rise, people require a better and better home quality, so they pay more attentions to home decoration for a comfortable life.

Now, the main method for home decoration is that the user describes the requirement of their house firstly, and then the designer gives them the design drawings based on user's requirement. However, the design often needs to be modified because of some problems such as the different understanding of something, too unintuitive design drawings for the some user and ambiguous requirements for some one. Besides, buying and placing furniture is also a problem for users.

Having considered the problems above, we designed a preview system which can help users to decorate their home by themselves. We provide a more intuitive way to show the design drawing to the user. By the gesture recognition and computer vision, the system can provide a view of the home to the users which design by the designer or themselves with some tags.

Based on Intel Baytrail embedded platform, extended by Intel Galileo platform which plays a role of controller of many sensor unit such as inertial measurement units and flex sensors, powered by many open source library like Panda3D, ARToolKit, I2Cdev and so on, using Python, C, C++ as the main develop language, we have realized a preview system to put virtual mode of furniture into the reality space and show the user an after decoration vision of the home.

System Implementation

Hardware Architecture

As shown in Fig.1, we use Intel Galileo for controlling the inertial measurement sensors and other flex sensors directly, processing sampling data and sending data to the Baytrail. Baytrail processor uses gesture movement data from Galileo and the picture captured by the camera to calculate the location of virtual furniture model, then shows the model on the screen.

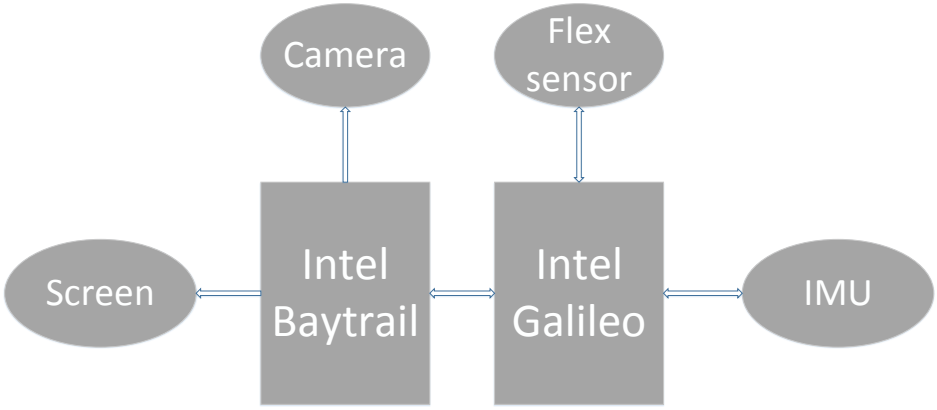

Figure 1 Hardware Architecture Diagram

Software Architecture

It can be seen from Fig.2, our system consists of three modules, including a display module(DM), a location module(LM) and a motion datum sampling module(MDSM). Location module uses the image captured by the camera to analyze the location of the user. Motion datum sampling module uses the data from inertial measurement units to analyze the gesture and the motion of the user. Display module uses the information from the other modules to calculate the vision and send to screen.

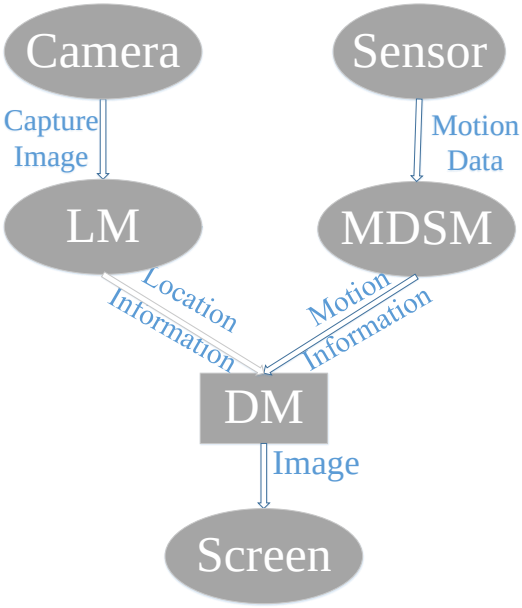

Figure 2 Software Architecture Diagram

Location module checks the tag in the picture grabbed from the camera. If the tag was detected, this module will calculate the distance and angle by this tag and send these values to display module.

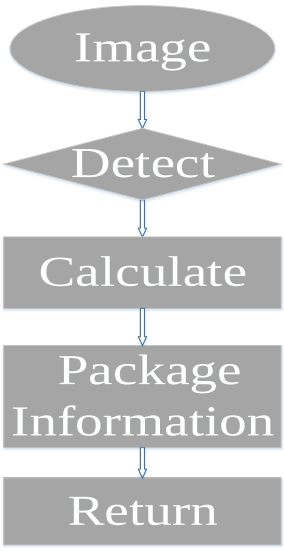

Figure 3 Location Module Diagram

Fig.4 is the architecture of Motion Datum Sampling Module (MDSM).

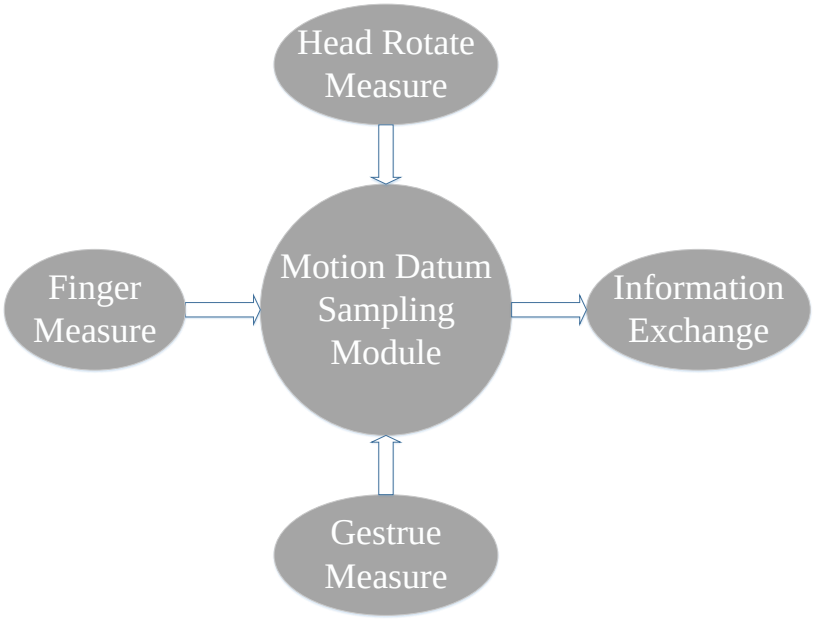

Figure 4 Motion Datum Sampling Module Diagram

As shown in Fig.4, two Inertial measurement units (IMU) and flex sensors are used as information collectors in MDSM. One IMU, which is called as Heading Detection IMU, is placed where near the camera, so that it can obtain the rotation angle of the camera then send the value to Galileo platform. The other IMU, which is called as Gestures Detection IMU, is placed on the gestures glove. When user waving their hand, the angle change is perceived. The flex sensors are pasted on the fingers of gestures glove. They collect the flex of user's fingers. All of these data are packed into a frame and sent to the other modules.

Using the data comes from the location module and motion datum sampling module, display module could be able to get the location and the movement of the user. The module adds virtual furniture mode and calculates the correct angle then shows it.

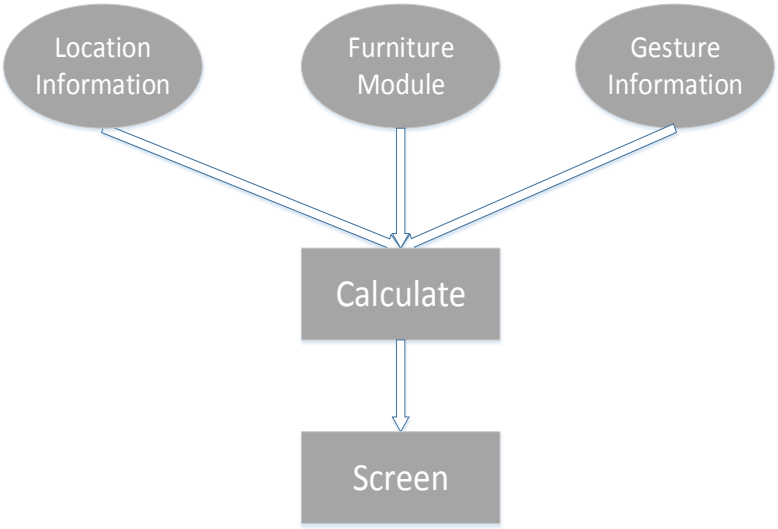

Figure 5 Display Module Diagram

System Testing

Location Module Testing

Test content: the recognition rate with different tag size in different distance.

Table 1 Recognition rate

Tag Size(cm) / Distance(m)	8.7	14.7
< 1	92.8%	97.2%
1 ~ 3	81.2%	89.5%
3 ~ 5	34%	67%

We can see the size of tag is very important for the system to recognize, so we use a much big tag in the system.

Distance Measurement Accuracy Testing

Test content: the error rate in different distance.

Table 2 Error rate

Real Distance (cm)	Measurement Distance (cm)	Error Rate
20.8	20.14	3.18%
58.45	60.86	4.12%
102.55	105.34	2.72%
152.32	148.93	2.22%
204.32	208.68	2.13%
320.33	328.68	2.61%

Motion datum sampling module testing

Test content: the accuracy of Yaw, Pitch, and Roll

Table 3 Accuracy

Value / Data	Actual value	Measured value	Actual value	Measured value	Actual value	Measured value
Yaw	0	0.35	45	43.57	90	86.84
Pitch	0	0.35	45	44.21	90	89.17
Roll	0	0.21	45	44.03	90	88.79