A Target Tracking System Based on Imaging Sensor Network with Wi-Fi

1 Aiqun Chen, 2 Hao Xu
1 Chongqing Technology and Business Institute, No. 1, Hualong Avenue, Jiulong Science and Technology Park, Jiulongpo District, Chongqing City, 400052, China
2 Chongqing Electric Power College, Wulong Temple, Jiulongpo District, Chongqing City, 400053, China
1 Tel.: +8613452819764, fax: +8613452819764
1 E-mail: Chenaiqun_cq52@sina.com

Received: 21 March 2014 / Accepted: 30 April 2014 / Published: 31 May 2014

Abstract: With the rapid development of network communication technology, a variety of network technology and communication technology has been integrated into our lives and work, bringing great convenience to our work and life. Current research in wireless sensor network technology in the field of communication technology is more popular because of the use of wireless sensor network technology can achieve the communication between objects and objects, people and things, the application of this technology has greatly expanded the ability for people to obtain information, have important significance to the development of people and society. Based on the powerful function of wireless sensor and bring the influence of people, this paper focuses on the design and implementation of the target tracking system based on image sensor networks with Wi-Fi.

Keywords: Wireless sensor, Image Sensor, System Design, Target tracking.

1. System Design of Target Tracking Based on Image Sensor Network with Wi-Fi

1.1. Architecture of Image Sensor System

Construction of Wi-Fi image sensor network system can be divided into two big modules based on, one is the communication mechanism of Wi-Fi image sensor to achieve the function, another is the system design and implementation of target tracking in Sensor Networks [1]. The system design in terms of hardware, the first use of the sensor nodes is Sanssun244 processors, ARM9 development board. This development board is installed in the camera USB interface enables the nodes of the system with image capture functionality throughout the system development board belongs to the image sensor nodes in the system. In addition, the author studies the target article will be placed on IR diodes shine, and in front of the camera system is also installed the same infrared filter [2], mainly in order to reduce the amount of data acquisition and processing image sensor nodes, the data excessive, will bring users to find some difficulty,
and this approach is to improve the accuracy and timeliness of the target tracking system design.

1.2. Description of System Hardware Environment

1.2.1. Node Processor

Based on the research process chosen processor S3C2440 ARM9 processor model, the system used for embedded LINUX system, which is very powerful functionality, the system as a node of the image sensor, can ensure that the target tracking system such as image acquisition, data processing and transmission of information work stability and security.

CPU chip. CPU chip sensor target tracking is an important sub-system design, equipment, which in turn contains a lot of small elements, each of the original has a different functionality, such as NAND Flash boot, interrupt controller, Cache memory, general purpose I/O ports and a watchdog timer and other devices [3]. Before the target tracking system designed to fully understand the function of individual devices and components, the only way to ensure the integrity of the target tracking system design and reasonable.

Flash chips. Flash is actually a storage unit that data for information has a protective effect, because of its unique features is non-volatile. The so-called chip nonvolatile means that work can be achieved without the use of information stored power [4]. Not only that, the development board using this chip also can improve the information read access time, some of the outside world to fight the destructive power of this feature by Flash chips can be seen in its suitable for application in portable devices.

Power chip. Target tracking system development board, which is used LM2576 type of chip that belongs to a relatively flexible switching power supply chips, using this type of chip can be turned on and off to achieve two states in the system design quickly switching, such switch duty cycle to some extent determines the size of the load to the charge within the system can provide. Since this work, sometimes the chip power in the ON state, and sometimes is in the OFF state, so there will be, in use, substantially the amount of energy wasted, on the functional advantages of this power chip, the kinds of high energy efficiency switching power supply, has been widely used in Wi-Fi image sensor network system.

Interface resources of QQ2440 development board. The interface is composed of multiple sub-resource devices, namely an Ethernet interface, a USB Slave interfaces, a USB Host port, three serial ports, a microphone jack, a stereo audio interface, an SD card interface and a JTAG interface, which is mainly SD interface for video processing buffer, and burn the JTAG interface is used in the code and on-chip debugging.

1.2.2. Peripheral network Equipment of System Node

Wi-Fi network equipment. USB interface Wireless LAN Wi-Fi network equipment is an important component equipment, paper image sensor target tracking system design was chosen WL-167G type of wireless network card, wireless LAN function of the model is very powerful, it can guarantee volume improve overall system sensitivity receiving information data under the same circumstances, greatly improving the efficiency of image sensor target tracking system. The maximum transmission distance can reach 330 m, to run the system porting work has brought great convenience.

Camera selected. Described in the text of the image sensor is actually a camera, the image sensor target tracking system design used in the camera inside the device is a mesh PC350, DSP chip model OV511, Linux system, Linux system also includes a DSP chip internal drive [5], we can see between the camera inside the device are interconnected during operation and mutual influence. In the system design process to focus on grasping the selection and use of equipment inside each sub, so that we can reduce the failure rate of the system design and applications, to improve the overall performance of the image sensor target tracking system.

Infrared LED. The image sensor target tracking system using infrared light emitting tube is intended to simplify the system organization, reduce the difficulty of network nodes in the system when processing information data. Use the camera system to identify the location of infrared light-emitting tube, and look for objects you can quickly determine the target location [6]. But this article in the system design in order to fully utilize existing resources are used in ordinary light-emitting diodes, the move is intended to allow the system to the target object camera is just an ordinary light-emitting diode location shooting.

1.3. Summary of System Software Environment

1.3.1. Embedded Linux System

From a software perspective, under normal circumstances embedded Linux systems can be divided into four program levels, as shown in Fig. 1.

Boot loader. This program belongs to the system power-running operation, the first code segment runs, the preparation of the implementation of the code segment is completed by the boot loader, which is a short program target tracking system kernel before running the whole operation, according to which a short You can run the extent necessary to restore the system to initialize the hardware status, and automatically creates the core part of the data needed for information systems and the extent of the use of information delivery will be created by running.
related equipment into the kernel, thus ensuring internal target tracking system hardware environment and software environment in a proper state. The system can be adjusted during operation system kernel, boot and load in order to achieve the purpose of the system kernel.

2. Description of Working Principle of Target Tracking System Based on Image Sensor Network with Wi-Fi

The image sensor target tracking system running at work can be divided into four stages, namely the announcement phase and system servers track system between the target object detection phase, the system node data processing phase, the system draws the node stage [8], these four stage is directly related to the security and stability of the target tracking system running on the system design is important to ensure that the target tracking system design is reasonable, it is necessary to conduct a comprehensive these four stages to control, for which the following is the author analysis of the principle of four stages.

2.1. System Objects Detection Stage

Starting operation of a system node detection phase of the target object can be achieved in two ways, first whether the system can be used in the field of view of the image sensor system target appears, the second is the use of the continuity of the system node adjacent snoop messages sent operation node. In the process, if the system detects a warning message stating that the goal has been entered in the system visual range, then the system will start the image acquisition process nodes at once.

2.2. System Node Data Processing Phase

After the system node is the target objects in the visual range of the system started running, it will be in a fixed time period of image information acquisition and processing operations in operation, extraction system objectives included in the mass of information systems in different time periods in which the coordinate position. Then the system will use the coordinate transformation node way to get in the actual operation of the system of coordinates of the location of the target object.

2.3. System Nodes Between the Circular Stage

According to the particularity of the notice stage between system nodes can be divided into two parts, the first part is the actual use of the system nodes to transport data processing phase coordinate location information obtained by the system of the target object and related information to the system server, then application server for further processing the data of system information. The second part of the system
is the use of a plurality of nodes of the system collaborate to track the target object, so as to ensure the continuity and consistency of the system tracking phase [9].

2.4. Server Path Drawing Stage

Server rendering phase trajectory is achieved by servers on the Internet, the system is running in the server also will monitor the transmission of information has been a port when there is a target object coordinate information transmission system node, the server receives the target object coordinate timely information, and the information received in the prior coordinate point calibration coordinate system draw a good, smooth curve followed by the use of the connection operation of the system together with all the coordinate points, to arrive at the target object motion trajectory of the system.

3. The Realization of the Image Sensor Target Tracking System

3.1. Summary of Target Tracking System Initialization

3.1.1. Camera Calibration Theory

Three levels of coordinate system. This paper studied the internal target tracking system by the use of the camera hole is a classic model, mainly by its internal camera coordinate system, the image coordinate system and the world coordinate system consists of three parts. The so-called camera coordinate system refers to the classic model of focusing center hole as the origin to the camera optical axis of the shaft set up a three-dimensional Cartesian coordinate system. Image coordinate system is a two-dimensional image coordinate system, the origin position in the upper left corner of the image. Special world coordinate system, which is an absolute coordinate, the user can be arbitrarily defined three-dimensional space coordinates.

DLT algorithm. There are a lot of camera calibration methods, the paper target tracking system implementation is the use of the traditional camera calibration algorithm DLT method contained to complete the calibration process. DLT transform popular terms that direct linear transformation using DLT transform the environment to determine the relationship between objects and images between the camera and the camera imaging to establish a linear model, in fact, this linear model parameters can be interpreted entirely out of linear equations. Solving manner as shown (1):

\[
s \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = K (R t) \begin{bmatrix} X_w \\ Y_w \\ Z_w \end{bmatrix} = P_{3 \times 4} \begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix}, \tag{1}
\]

where \((u, v, 1)\) is the next mid-point coordinates of the image coordinate system in formula(1); and \((X_w, Y_w, Z_w)\) refers to the Euclidean space in the world coordinate system coordinate points, ‘s’ behalf unknown scale factor, ‘P’ is a \(3 \times 4\) perspective projection matrix.

3.1.2. Realization of Target Tracking System

According to the DLT algorithm analysis, to complete target tracking system camera calibration requires at least four points, calibration code based on the experimental operation was the camera, then you only need to build a target tracking system need camera calibration environment and related debugging code can be completed. Camera calibration code the entire process is as follows:

3.2. Target Tracking Information Processing

Tracking information processing system nodes. First, the image capture image sensor target tracking system and part of the information processing function is a function of the existing internal use OpenCV implementation. Node in the system trace information processing needs through CvCapture initialization sequence structure, acquiring the image frame, the image is saved, CvCapture structure release, time format, time to visit the local system and many other aspects.

Followed by a gray image processing, target tracking system by the internal camera photographs taken generally default to a color image, so the need for these pictures binarization processing, and image processing is the key gray binarization in gray scale image processing functions have the need to use a reasonable allocation of space and gray gray image processing [10].

Furthermore is image binaryzation, the operation is completed after the gray image processing carried out. Binarization means that the gray image midpoint setting is 255 or 0, let showing obvious black and white. The reason for image binarization, because after the pixel gray values of the binarized image has a value of two, so that the information can greatly reduce the difficulty of processing the data.
About Wi-Fi ode data transmission, to use Wi-Fi for data transmission method in target tracking system, the need to operate in strict accordance with the relevant processes. The first step to establish Socket, you can call the establishment in Socket Socket function; Step two ports should be tied to the system [11]; third step should be to ensure that the data exchange system information, because the local and remote machines Socket no correlation between established connections, so when the system sends data should be pointed out that the specific address; fourth step is to end the entire data transmission, when the system is completed all the operational data transport, it should release Socket by calling function close(), and stop all the data on the Socket operation [12].

Collaboration between the tracking information processing nodes. In response to the node running target tracking system rationalization arrangement, the arrangement of the nodes to ensure that the system matches the actual operating conditions and with certain regularity. Before tracking process collaboration between the nodes, the need for the system to detect target objects in the detection process when the discovery of the target object into a node within the scope of the system, it can be based on the information notice between nodes within the system enabling collaboration between system nodes tracking information processing.

4. System Test and Analysis of Experimental Results

Testing should be created in the system during the experiment image sensor network target tracking system test scenarios, the camera is fixed at 55 cm perpendicular to the ground, straight down angle to 45 degrees, by way of experiment to determine the field of view video camera is 50×60 cm² the actual coordinates of the lower left is the terrestrial network as the origin of this range is the smallest unit of measure by 10 cm, and a reasonable division of the coordinate system is 30 square grid, in order to coordinate system as the actual test. Before the system test camera shoot, the need for a focal length of the camera to make reasonable adjustments to obtain high-definition image, if not for the camera focal length adjustment will cause the image quality is not high, this will directly affect the calibration of the late cameras and related data processing work [13]. At the same time, factors affecting the image quality still camera IR filter in front of the camera position to determine if the infrared filter just a simple fixed, then the outside of the camera lens light leakage is likely to occur. The correct approach is to open the camera lens cover, and the filter is placed between the lens and CMOS sensor both, filters closer to the lens, shooting it generates will be better.

5. Prospects of Target Tracking System Based on Image Sensor Network with Wi-Fi

The image sensor network target system integration of a variety of communication technologies, the system uses ARM9 and Linux platforms, by way of porting USB wireless adapter enables the image sensor nodes Wi-Fi communication mechanism. And be able to clearly and accurately target objects on the system according to the camera’s image sensor nodes on the fast image acquisition, data processing, coordinate extraction and coordinate conversion. Effect on the functionality and image sensor network target tracking system, its bound to be more widely used in the future development [14]. The reason can be two ways, the first image sensor node target tracking system able to coordinate information collected automatically transmitted to the Internet server, and the server receives coordinate information will be complete by the target object inside the Linux platform Qt toolkit trajectory drawn. Secondly, the range of the coordinate position of a target object region and target tracking system using the image sensor nodes involved in the camera contrast, if the target object enters the range of the camera, the target tracking system node will issue a warning signal to its neighboring nodes, in order to each node warning system and related procedures are ready to start, to protect the safe operation of the entire image sensor network target tracking system.

Although with strong functionality, but there are still imperfect, and there are some room for development in this paper the design of target tracking system based on image sensor network with Wi-Fi, such as this target tracking system designed cameras are inside is set in advance, involving the scope of its coverage is smaller, so that the system has certain limitations in monitoring in the future development of PTZ cameras can try to use the system, the greater the scope of this type of camera visible greatly reduces the system nodes during deployment density, to a certain extent, can save a lot of hardware resources and energy researcher, has a certain significance for researchers in terms of economics. Thus, the image sensor network target tracking system design also can continue to improve in practice, extend functionality of target tracking system, so that the scope of application of the image sensor network target tracking system is broader.

6. Conclusions

The design of image sensor target tracking system is ultimately via Wi-Fi communication mechanism, it can’t achieve an effective data transmission and processing system, in addition to a small amount of information because of data processing the
acquired data of the image coordinate system, to ensure that the target tracking system will coordinate the secure transmission of information to the server, to achieve the security and stability of the image sensor target tracking system. Powerful functionality can be seen by the target tracking system information technology such as Wi-Fi communication technology in the future there will be a more broad space for development.

References


[7]. S. Xinong Wang, Design and implementation of the system of image sensor network target tracking based on Wi-Fi, *Beijing Jiaotong University*, 18, 4, 2010, pp. 68-73.


