



A novel model of ZigBee in wireless sensor network based on CMOS image sensor and BP neural network

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ABSTRACT

BP neural network is the error back propagation neural network, which consists of an input layer, one or more hidden layers and one output layer, each composed of a certain number of neurons. CMOS image sensor is not only the complete elimination of the fixed pattern noise generated by a circuit, and reduces the random noise, improves the CMOS image sensor sensitivity. ZigBee protocol defined in the IEEE 802.15.4 specification uses the physical layer (PHY) and media access layer dielectric (MAC), and defined on the basis of the network layer (NWK) and application layer (APL) architecture. The paper presents a novel model of ZigBee in wireless sensor network based on CMOS image sensor and BP neural network. Experimental results show the effectiveness of the improved model is better than the traditional model.

Keywords: BP neural network, CMOS image sensor, ZigBee, Wireless sensor network.

INTRODUCTION

Wireless sensor network is deployed in the monitoring area by the large quantity of cheap micro sensor nodes through wireless communication to form a multi-hop self-organizing network system, its purpose is collaboration and awareness, collection and processing of network coverage area, the object of perception the information sent to the observer, so that people can at any time, place and any environmental conditions can get a lot of detailed and reliable information [1]. Sensor networks because of its easy expansion, self-organization, distributed structure, robustness and real-time characteristics.

ZigBee protocol stack length is only an average of Bluetooth 1/4, this simplification to the low cost, interactive and maintainability is very important. ZigBee technology provides data integrity and authentication function, provides three levels of security, flexibility to determine its safety properties, network security can be effectively guaranteed.

In view of the advantages of the BP neural network, and it is to solve many problems by using network. But with the application scope gradually expanding, BP neural network also exposes more and more disadvantages and shortcomings, for example: the local minimization problem: from the mathematical point of view, the optimization method of traditional BP neural network is a kind of local search, it is a solution to a complex nonlinear problem, the network weights through the local improvement is gradually adjusted. This will make the algorithm into a local extremism, convergence to local minima, resulting in network training to failure.

Due to the internal structure of CMOS image sensor, which has high radiation resistance, strong anti-interference ability, so the image sensing, astronomical observation, small satellite, and the star sensor applications showing great potential for application. In addition processing technology based on CMOS image sensor, manufacturing CMOS body sensor device of large array can be easily, more expanded the range of application of CMOS image sensor.

Based on wireless sensor network ZigBee micro array constructed using GSM (Global System for mobile communication) network, CDMA (code division multiple access) network, Ethernet to realize the transmission and control of data, the network can be a star or hybrid topology and wake up on-demand communication module ZigBee, effectively reduce the power consumption of each ZigBee sensor nodes, reduce the probability sensor nodes to the sink node data collision. CMOS image sensor pixel existed in the past, the small signal to noise ratio, low resolution of these shortcomings, has been unable to compete and CCD technology. The paper presents a novel model of ZigBee in wireless sensor network based on CMOS image sensor and BP neural network.

2. The Application of BP Neural Network in ZigBee of Wireless Sensor Network

IEEE based on 802.15.4 standards, in thousands of tiny sensors to achieve mutual coordination and communication. In addition, the relay way through radio waves to move data from one sensor to another, this makes the communication efficiency, and is very high. In general, with increasing the communication distance, equipment complexity, power consumption and system cost are increasing. Compared with the various existing wireless communications technology, low power consumption, low rate of ZigBee technology is most suitable for sensor network standard. ZigBee technology is suitable for carrying less data traffic, especially for sensor networks.

The structure of BP neural network to choose not to a: BP neural network structure selection has no a unified and complete theoretical guidance, in general can only be selected by experience. Network structure selection is too large, the training efficiency is not high, may be over fitting, causing low network performance, fault tolerance decreased, if the choice is too small, it will result in the network may not converge [2]. And the network structure affects the approximation ability and generalization properties of the network. Therefore, application of how to choose the suitable network structure is an important problem, problem of application and network size: BP neural network to solve the application problem instance size and network size problem, which related to the relationship between the possibility and feasibility of the network capacity, namely learning complexity.

High density sensor network nodes distributed in the test environment or surroundings. In sensor network nodes and receiver nodes require a special multi-hop wireless routing protocol. The traditional Ad hoc networks based on multi-point communications. To increase the accessibility of the route and taking into account the sensor network nodes are not very stable, the majority of the sensor nodes using the broadcast communication, the routing algorithm can also be optimized based on the broadcast.

The sensor node is designed in this paper the realization mechanism is serial communication module with IEEE/ZigBee transmission module to replace the traditional, information will be collected data wirelessly sends out. The node also package IEEE/ZigBee wireless communication module, microcontroller module, the sensor module and interface, DC power supply module and an external memory.

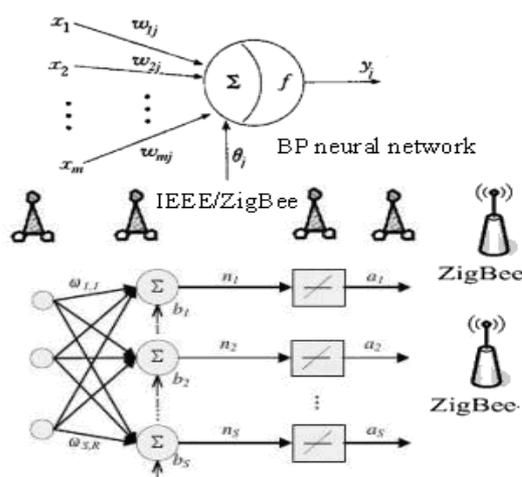


Fig. 1. Structure of BP Neural Network in ZigBee of Wireless Sensor Network

BP algorithm is one of the steepest descent static optimization algorithm, the right of revision coefficient, just follow the negative gradient when the amendment, without taking into account the previous accumulated experience, often leads to the training process appear oscillation, can solve this problem by using momentum method. In addition, the learning rate of BP network training is an important parameter, the learning rate is too small, slow convergence; the learning rate is too large; it may lead to over correction, even divergent oscillation. Therefore, it is the adaptive learning rate algorithm.

Wireless sensor node. Node a peripheral circuit connected with EMD, the receiver on the other hand, through the IEEE 802.15.4 protocol to communicate with the other eye and robot, thus providing channel ocular nerve system; at the same time, fusion and behavior sequence eye information to generate such operation to complete in the node.

The Zigbee protocol defines two frame formats: KVP key value pairs and MSG message frame, KVP: is a special data transmission mechanism defined in ZigBee standard, through a provision to standard data transmission format and content, mainly for the transmission of simple values format. MSG: is a special data transmission mechanism defined in ZigBee standard, it does not make more provisions in the data transmission format and content, mainly for the transmission mechanism of special data stream or file data, a large amount of data, as is shown by equation1.

$$\langle f_i \rangle_t = \frac{\int_{-\infty}^{\infty} V(t, f) f df}{\int_{-\infty}^{\infty} V(t, f) df} \quad (1)$$

BP network is the use of Widrow-Hoff learning algorithm and nonlinear differentiable transfer multi-layer network function. A typical BP network uses a gradient descent algorithm; Widrow-Hoff algorithm is required. Backpropagation is a method for nonlinear multilayer network computing gradient. Now there are many basic optimization algorithms, such as variable metric algorithm and the Newton algorithm. Neural Network Toolbox provides many such algorithms.

The ZigBee protocol is proposed for wireless sensor network node structure of Zig-Bee, via the GSM network, CDMA network and Ethernet in a larger range by ZigBee wireless sensor network of information control and data acquisition. This method has a strong application in reality. In the not too distant future, will have a built-in ZigBee function more and more investment in equipment application, and will greatly improve the way we live and experience.

Due to the large number of sensor nodes are usually randomly, put in the monitoring region, and it is difficult to replace the power supply. Usually the distance between neighboring nodes is very short, suitable for multi hop communication mode with low power consumption, while saving the enhanced communication concealment and anti - interference. Because the WSNs is scalable, self-organizing, distributed, robust and real-time, which provides a traditional network can not match the advantages in military, architecture, agriculture, environmental monitoring, medical and other fields.

$$MAD(d) = \frac{1}{N \times N} \sum_{x=1}^N \sum_{y=1}^N |I_k(x, y, d) - I_t(x, y)| \quad (2)$$

Zigbee equipment to other nodes in the network information is stored in a non - volatile storage space in the neighbor table. After power on, if the child had joined the network equipment, the equipment will perform the orphan notification procedures to lock in a previously added network. Received orphan notification equipment inspection its neighbor table, and determines whether the device is the child, if the equipment will inform the child, its position in the network, otherwise the child equipment will be used as a new equipment to join the network. Then, the child device will generate a potential parent table, and as far as possible to the appropriate depth is added to the existing network.

TinyOS components can usually be divided into the following three categories: software components, hardware abstraction components synthesis component, high levels of physical hardware; hardware abstraction components will be mapped to the TinyOS component model. Advanced hardware synthesis hardware is component simulation behavior. High level software module control and it is routing and data transmission.

BP network with teacher learning methods - need to set expectations and unsupervised learning methods - just the input mode of. Self learning model to $\Delta W_{ij}(n+1) = \eta * I * O_{j+a} * W_{ij}(n) - \eta * \text{learning factor}$; calculation error with i - output node i ; calculate the output O_j - output node j ; a - momentum factor. Defect analysis and optimization strategy of BP network model, the optimization of H learning factor and the variable step number method according to the output error automatically adjust the size of the learning factor, to reduce the number of iterations and convergence speed. $H = \eta + a * (E_p(n) - E_p(n-1)) / E_p(n)$ a as the adjustment step, $0 \sim 1$ value.

The processor module is composed of processor and memory, is responsible for coordinating the wireless sensor

modules, such as the data acquisition module to obtain the information necessary for processing and storage, control the wireless communication module and power supply module mode. The processor module provides information processing energy, the wireless sensor node intelligent [3]. The wireless communication module: wireless communication module is composed of short distance wireless transceiver circuit, wireless communication and wireless sensors for his neighbor node or base station. The wireless communication module provides the ability to transmit information, the wireless sensor nodes are connected into a network of individual.

$$u'(x_1, x_2) = \sum_{s=-n}^n \sum_{t=-n}^n w(s, t) u(x_1 + s, x_2 + t) \quad (3)$$

Wireless sensor network is wired or wireless network composed of a set of sensors to Ad Hoc, its purpose is to perceive the object geographic area covered cooperative sensing, collecting and processing of sensor network information, and transfer to the observer. This kind of sensor network sensor technology, embedded technology and wireless communication technology, the objects of perception cooperative sensing, monitoring and collecting all kinds of information environment, the information of collaborative information processing, obtaining accurate information, the perception of object and then, users who need the information is transmitted by Ad Hoc. Sensor for sensor network with the general concept of different, in addition it can sense the measured physical quantity change and change information corresponding to the output, but also with remote communication function, the sensor must be an intelligent.

Automatic network and it is network capacity. Zigbee network can accommodate up to 65000 nodes, any node in the network can carry out data communication. Network with stellate, sheet and mesh network structure. In the modular addition and withdrawal, the network has the automatic repair function.

A highly dynamic and uncertain application of wireless sensor network, including the change of network topology, node removal or addition, face a variety of threats, therefore, wireless sensor network has strong adaptability and survivability of various security attacks, even if an attack succeeds, the characteristics of its impact is minimized, a single node is threatened and will not lead to paralysis of the entire network.

$$\lambda \begin{cases} \geq 0, & f(u) = 0 \\ = 0, & f(u) < 0 \end{cases} \quad (4)$$

Wireless sensor network has a required performance characteristics and technology different from the traditional wireless network, the traditional wireless network MAC protocol cannot be used in a sensor network, all of the characteristics of the specific sensor network MAC protocols have been proposed. The design principle of MAC protocol of wireless sensor network and classification methods, the main mechanism analysis of all kinds of typical MAC protocols, and it is performance differences and range of application characteristics, detailed comparison of these protocols.

Neural network is composed of a large number of processing units (neurons) are connected to the network. In order to simulate the basic characteristics of the brain, in basic neuroscience research, and puts forward a neural network model. But, in fact, the neural network does not reflect the function of the brain; just on the biological neural network is a kind of abstract, simplification and simulation. Information processing of neural network to realize through the interaction of neurons, the knowledge and information storage is a physical connection network element is distributed [4]. The dynamic evolution process of learning and recognition based neural network connection weights of the neurons in various.

The addressing mode can be used to add other search function to find the routing and ZigBee protocol, a network. The ZigBee protocol of broadcast packets is to achieve a passive response mode. That is when a device or forwarding a broadcast packet and it forwards the situation and listen to all neighbors. If all the neighbors are not duplicated packets in response within the time limit, the equipment will be repeated to forward packets, until it listens to the packet has been all neighbors forwarding, or broadcast transmission time is exhausted.

The basic characteristics of the wireless sensor network MAC layer protocol is energy limited, as much as possible to save energy, such as reducing the conflict and crosstalk, reduce the duty cycle and avoid long distance communication. The agreement should also include compromise mechanism, the use of fire can be used in energy saving and increase throughput, reduce the delay between choice. In addition, should design the protocol when the attention of energy is not readily available, because a node may sleep or because the cause of death was not known.

The design goal of traditional MAC protocol is to maximize throughput, minimize the delay and fairness.

3. The Novel Model of ZigBee in Wireless Sensor Network based on CMOS Image Sensor

Both the CCD color image sensor and CMOS color image sensor, all need to color image processor to complete the automatic white balance, automatic gain control, automatic exposure control, image processing and RGB to YUV image format conversion. Usually DSP is used as a color image processor. Real time color image data rate is very high, so the processing speed of DSP is very high. High speed DSP high power, heat generation will affect the stability of CMOS image sensor matrix. High speed DSP will cause a lot of noise, serious interference of CMOS image sensor matrix work.

Based on the IEEE802.15.4 standard and it is in thousands of tiny sensors to achieve mutual coordination and communication. In addition, the relay way through radio waves to move data from one sensor to another, which makes the communication efficiency, is very high. Compared with the various existing wireless communications technology and it is ZigBee technology, low power, and low rate of the most suitable for wireless sensor networks.

$$E[\tilde{X}\tilde{X}^T] = (H^T R^{-1} H)^{-1} \quad (5)$$

CMOS sensor each pixel ratio CCD sensor is complex, the pixel size is difficult to achieve the CCD sensor level, therefore, when we compare the same size of CCD and CMOS sensor, CCD sensor resolution is usually better than the CMOS sensor level. The noise differences: because CMOS sensor each photosensitive diode are paired with an amplifier, and amplifier belongs to the analog circuit, it is difficult to make each amplifier results remained consistent, and therefore only one amplifier in the CCD sensor chip edge compared to CMOS sensor, noise will increase a lot, affect the image quality.

Wireless channel with random competitive mode MAC protocol uses on-demand channel based approach, the main idea is that when a node has data to send the request, occupy wireless channel through competition, when a conflict occurs when transmitting data, according to some strategy (DCF mode of coordination of distributed IEEE802.11 MAC protocol is used in binary backoff retransmission mechanism) data retransmission, until the data transmission success or abandon sends data. Because the IEEE802.11 protocol based on MAC, the researchers put forward more suitable for wireless sensor network MAC protocol based on the competition [5]. The main IEEE 802.11 MAC layer protocol, S-MAC protocol and S-MAC based on improved T-MAC protocol.

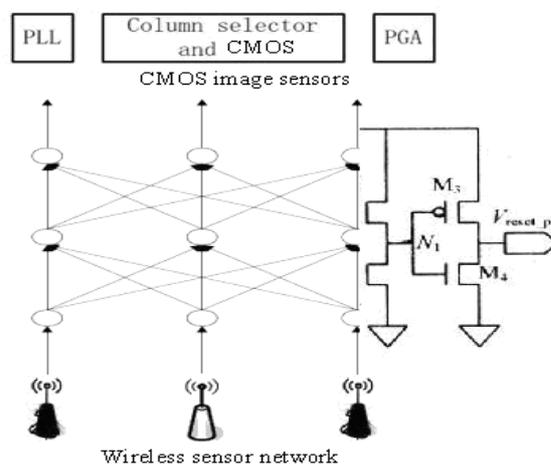


Fig. 2. Model of ZigBee in Wireless Sensor Network based on CMOS Image Sensor

CMOS image sensors provide only small amounts of a power converter can work normally; this is because the CMOS image sensor power is very small, only 5V voltage by USB bus provides can drive its normal work. In addition CMOS image sensor chip only needs several external a few control signals to complete the image acquisition (control signal of the system provided by the CPLD chip USB data transmission board), and the output of the amplifier is integrated in the chip, digital to analog conversion module, only need to modify the value of the special register chip bias voltage to change the output amplifier, gain parameter, thus greatly reducing complexity and finished the hardware design of the volume, has the very high application value.

A ZigBee based WPAN (wireless personal area network) can support up to 254 nodes, and a full function device,

can realize the bidirectional communication completely protocol for a direct connection to the 4 kB node of a device or as a coordinator or router Hub 32 kB. Each coordinator can connect up to 255 nodes, and several coordinators can form a network, the number of routing is not restricted.

Wireless sensor network is composed of a large number of small volumes, low power consumption, with wireless communication, sensing and data processing function of the sensor nodes; therefore, node design will directly affect the quality of the whole network. In this paper the structure and characteristics of wireless sensor based on the independent design, a design scheme for ZigBee protocol, using CC2430 chip as the core of the node based on wireless sensor network.

The CCD sensor data in charge for each pixel in each row will be transmitted to the next pixel, the bottom end portion of the output, and then through the edge sensor amplifier for amplifying the output; while in the CMOS sensors, each pixel is adjacent to an amplifier and A/D conversion circuit, with a similar memory the data output circuit.

Through the I2C bus programming to the internal CMOS image sensors registers can change the following parameters: (1) the brightness, hue, saturation, white balance, electronic shutter, automatic gain control; (2) the window size, position. Use this function, can easily realize the electronic zoom and electronic camera shake; (3) the digital image sensor field, from 0.5 per second to 60 fields per second; (4) scan mode (select interlaced or progressive scan mode); (5) the software reset. Through the I2C bus, reset the image sensor; (6) power saving mode.

$$WT_f(a,b) = \int_{-\infty}^{\infty} f(t) \psi\left(\frac{t-b}{a}\right) dt, \quad a \neq 0 \quad (6)$$

The Zigbee module in 2.4G global free band, so only need module cost in advance, no need to pay the continued use of cost. If you use the Zigbee module Feng agent of DIGI company, can again without development, through the TTL RX, TX is used for data transmitting and receiving, greatly reduce the product development cycle, to get the better of the market opportunities.

In order to provide location information effectively, randomly deployed sensor nodes must be able to determine their position in the layout after. Since the sensor nodes are deployed randomly, limited resources, communication, vulnerable to environmental interference and node failure, positioning mechanism must satisfy the self-organization, robustness, energy efficient, distributed computing and other requirements. According to the node location is determined, sensor nodes are divided into anchor nodes and unknown nodes. The beacon node location is known, unknown nodes to the beacon nodes, in accordance with a positioning mechanism to determine the self position. In sensor network localization process, usually use three sided measurement, triangulation or very high likelihood estimation method to determine the position of the node.

ZigBee coordinator must know each sensor node of the network address, this requires each sensor in the network after the addition, to the network address is sent to the coordinator; the coordinator receives sensor network address, can build the address table and stored up. So that the user needs to collect temperature data, on the basis of data address table acquisition of each sensor.

CMOS imaging sensor with high quality can provide a series of technical advantages, including low noise, large dynamic range, high frame rate and small size, and the latest progress of the digital image processing technology can help the surveillance camera system to improve image quality and increase more intelligent functions. These improvements not only promote civil security and surveillance applications, but also promoted the commercial security and surveillance applications, in stimulating the market growth at the same time, also created new product opportunities.

4. Novel Model of ZigBee in Wireless Sensor Network based on CMOS Image Sensor and BP Neural Network

Wireless sensor network is integration of sensor, micro electro mechanical system and network technologies, is a novel technology about acquiring and processing information. It can be a variety of environmental or monitoring collaborate in real-time monitoring of perception and acquisition network of regional distribution of information, and the information processing, information transmission and detailed and accurate to the users who need the information. Sensor networks will enable people at any time, and any place access to a lot of detailed and reliable information.

Time spent with each channel is detection equipment to channel energy of the network through the ScanDuration

scan to determine the continuous parameters, general equipment to spend 1 minute to perform a scan request, for a Zigbee router and terminal equipment, only need to perform a scan can determine the join network [6]. The coordinator is scanned two times, sampling channel energy; another is used to determine the presence of network.

$$fresp(x, y) = Det(Z) - kTrace^2(Z) \quad (7)$$

Information processing method of BP neural network has the following characteristics: information distributed storage. Characteristics of human information storage is to adjust the stored content using changes in synaptic efficacy, distribution of connection strength between neurons that information is stored in the BP neural network to simulate the human this characteristic, the information in the form of connection weights are distributed in the entire network. Information parallel processing. The neurons pass between the pulse rates is far lower than the von Neumann computer operating speed, but on many issues can make quick judgment, decision making and processing, this is because the brain is a massively parallel processing system and the serial combination. The basic structure of BP neural network to imitate human brain, has the characteristics of parallel processing, greatly improves the network function.

Based on an important difference between the surveillance cameras CMOS imaging sensor with previous product is its ability to provide the certain function of artificial intelligence for end users. For example, in many monitoring applications, motion detection and tracking is the focus of attention, therefore, motion detection accuracy is a very valuable. When monitoring the scene movement is detected, the alarm signal at the same time, and it is video function start. Motion detection is implemented by digital control chip built-in microprocessor and digital image processing, rather than the previously used by external monitoring camera motion detection unit.

Temperature acquisition system ZigBee technology can simultaneously monitor multiple regions based on, and the development of low cost, high performance price ratio, easy installation and maintenance, and only need to install a monitoring can be performed over a long period of time, thus has the advantages of traditional temperature monitoring system do not have, can better solve the problem of wiring, relocation the traditional temperature monitoring in the system.

Sensor nodes scattered in the perception of the designated area, each node can collect data, and transmit data to the sink node through the "multi hop routing mode", and the sink node can send information to each node in the same way. The sink node is directly connected with the Internet or a communications satellite, task management node by Internet or a communications satellite (the observer) communications and sensor.

Types and application market of high-speed CMOS image sensor. High speed camera speed sensor suitable for general, high-end or custom, which can be used for scientific research, car camera for collision detection, high speed scanning, machine vision and military research high frame rate motion capture field. Sensor resolution ranging from the VGA level until 15000 pixels, some can be up to 10000 times a second full frame rate. The sensor architecture may be composed of two fractions, four fractions or an array of pixels. The paper presents a novel model of ZigBee in wireless sensor network based on CMOS image sensor and BP neural network, as is shown by figure3.

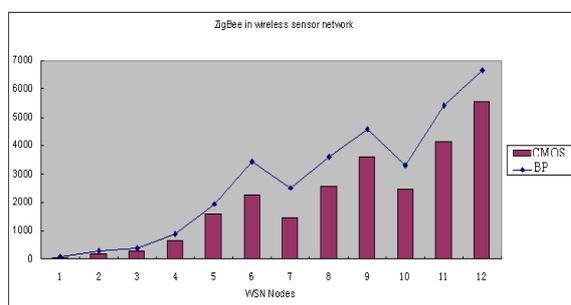


Fig. 3. Comparison results of ZigBee in wireless sensor network based on CMOS with BP neural network

BP neural network has the preliminary adaptive and self-organizing ability, learning or training in the change of synaptic weights so as to adapt to the environment, can be used in continuous learning and improve their function, and the same network because of the different study style can have different functions, it even has the innovation ability, can the development of knowledge, even more than the original knowledge level designer. If the control and system function is integrated in the CMOS sensor, the overall performance and will be better, this is because in the save the external interconnect cables to other semiconductor devices at the same time, the power consumption of

high drive also exempted.

CONCLUSION

Location in wireless sensor networks including a variety of classification, the absolute and relative positioning, physical location and symbolic location, centralized computing and distributed computing, tight coupling and loose coupling, location technology and range free localization based on etc.. Sensor network node locating system refers to a node to access our locations. The paper presents a novel model of ZigBee in wireless sensor network based on CMOS image sensor and BP neural network. By the price, volume, power consumption and scalability constraints, most sensor network localization systems have node localization scheme using beacon assisted. BP neural network is a nonlinear optimization problem, it can be in the constraint conditions known, find a set of parameters, the objective function so that the combination to determine the minimum. Multi slope CMOS image sensor makes the dynamic range can be kept unchanged significantly increased in SNR.

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