REAL TIME SEARCH OF AGRICULTURAL MACHINERY BASED ON MATRIX SEQUENCE SENSOR
/
基于矩阵序列传感器的农业机械实时搜索

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ABSTRACT
Omni-directional vision sensor can provide information within the sensor range, and the directional angle of an object can be accurately obtained through omni-directional images. Based on this characteristic, an automatic navigation and positioning system for agricultural machinery is developed, and a three-dimensional positioning algorithm for agricultural wireless sensor networks based on cross particle swarm optimization is proposed. The method mainly includes three stages: convergence node selection, measurement distance correction and node location. Using the idea of crossover operation of genetic algorithm for reference, the diversity of particles is increased, and the influence of ranging error and the number of anchor nodes on positioning results is effectively improved. The location algorithm has the ability of global search. On the positioning node, the symmetric bidirectional ranging algorithm based on LFM (Linear frequency modulation) spread spectrum technology is used to calculate the distance between the positioning node and each beacon node, and the trilateral centroid positioning algorithm is used to calculate the coordinate position information of unknown nodes. Finally, the Kalman filter algorithm is used to superimpose the observed values of the target state to solve the influence of measurement noise on the positioning accuracy.

摘要
全向视觉传感器可以提供传感器范围内的信息，通过全向图像可以准确获得物体的方向角。研究基于这一特点，开发了农业机械自动导航定位系统，并提出一种基于交叉粒子群优化的农业无线传感器网络三维定位算法。该方法主要包括收敛节点选择、测量距离校正和节点定位三个阶段。研究借鉴遗传算法交叉运算的思想，增加了粒子的多样性，有效地改善了测距误差和锚节点数目对定位结果的影响。定位算法具有全局搜索能力。在定位节点上，采用基于LFM（线性调频）扩频技术的对称双向测距算法计算定位节点与各信标节点之间的距离，采用三边质心定位算法计算未知节点的坐标位置信息。最后，利用卡尔曼滤波算法对目标状态的观测值进行叠加，解决测量噪声对定位精度的影响。

INTRODUCTION
In recent years, the automation and intelligence of agricultural machinery is a hot spot in the field of agricultural engineering in the world *(Hu Z. et al., 2020)*. Agricultural machinery automation is one of the key technologies to realize modern precision agriculture, improve productivity and reduce fertilization and pesticide application *(Gao L. et al., 2020)*. Data fusion needs to reason based on these uncertain information to achieve target identification and attribute determination. This kind of uncertain reasoning constitutes the basis of sensor data fusion *(Mugandani R. et al., 2020)*. An evidence theory is a typical method in solving this uncertainty reasoning method. Location information plays an important role in the monitoring activities of agricultural wireless sensor networks. Location or access information node location is important information that must be included in the sensor node monitoring message *(Butts T.R. et al., 2019)*. Monitoring information without location information is often meaningless, and limited by resources, cost and application environment. Facility agriculture is the growing demand for people's lives *(Qin J. et al., 2020; Yudao L. et al., 2020; Joppa M. et al., 2018)*. Developed at the same time. Facility agriculture is a new mode of production to obtain fast-growing, high-yielding, high-quality and high-efficiency agricultural products, and is the main technical measure to provide fresh agricultural products in the world *(Li Y. et al., 2020)*.

Wireless sensor network extends people's information acquisition capability, links physical information of the objective world with network transmission, provides people with the most direct, effective and real information, has a very broad application prospects, and can be widely used in military defense, industrial and agricultural control, urban management, biomedical treatment. Environmental monitoring, disaster relief, anti-terrorism, remote control of dangerous areas and many other areas *(Wang B. et al., 2020).*

Traditional agricultural production can no longer meet people's growing demand for the quantity and quality of various agricultural products. Node localization in wireless sensor networks refers to the process that sensor nodes determine the location information of other nodes in the network through certain positioning technology according to the location information of a few known nodes in the network. Node positioning technology is one of the important supporting technologies in agricultural wireless sensor network applications *(Wang J. et al., 2019)*. The so-called node location problem is to use the nodes of known locations to obtain the location information of other nodes, that is, to use the position information of the reference nodes to establish a coordinate system, and to determine the position information of the pending nodes in the coordinate system by different methods *(Musiu E.M. et al., 2019).* There are certain restrictions depending on the application of GPS in agricultural machinery navigation. In farmland operation, especially in mountainous areas, GPS can not be used in greenhouses, and greenhouse agriculture is an important part of modern agriculture. In practical applications, a sensor network is composed of several sensors, and the sensor network constructs the corresponding basic credibility assignment of propositions by using these evidences. However, as the amount of data increases, the amount of calculation flips exponentially, resulting in huge data flow and increasing the pressure of sensor networks *(Kooij S. et al., 2018).* Wireless sensor networks involve many research fields, including network routing, data fusion, positioning technology, time synchronization, security management and so on. The research and development of wireless sensor networks is driven by practical application requirements, and has become a research hotspot of the next generation network.

Sensor is a knowledge-intensive, technology-intensive, interdisciplinary, very complex Mechatronics system. Besides rich image information, omnidirectional vision sensor has another characteristic: when acquiring omnidirectional image, the direction angle of space object relative to sensor is fixed and unchanged *(Geng L. et al., 2020)*. Farmland or greenhouse varies with seasons. Different colored crops are planted, but the same kind of crops are often planted in the same area, which is not conducive to the use of natural markers to extract image features *(Naveeninder K. S. et al., 2019)*.

The research of point localization mainly focuses on two-dimensional plane, but the environmental factors of three-dimensional space are more complex. The computational complexity of refinement problem increases greatly, so it is difficult to apply two-dimensional localization algorithm directly to three-dimensional space. Space position, based on the development of safety management technology, must be three-dimensional positioning of nodes. Machine vision can provide all or part of the image information for relative positioning *(Soponpongpipat N. et al., 2020)*. The positioning accuracy is high, but the positioning accuracy and stability of machine vision are greatly affected by environmental factors such as weather and light, and its edges. Image processing methods such as edge sharpening and feature extraction are computations with large amount and poor real-time performance *(Muzylyov D. et al., 2020).* The academician's research team has been working on the research of agricultural machinery automatic navigation system for many years, and developed a GPS-based agricultural machinery automatic navigation system that can reach the centimeter accuracy level. The initial basic reliability distribution of the target, data fusion, and the goal of advanced basic Credibility is assigned to obtain target identification and attribute determination *(Zheng Y. et al., 2020)*. The sensor and agricultural machinery are closely combined to facilitate the discovery and treatment of potential problems in agricultural machinery, promote the development of agricultural machinery automation, and the application of sensors in agricultural machinery is very extensive. The transformation of traditional agricultural machinery is inseparable from sensors.

MATERIALS AND METHODS

According to the different reflective surfaces, the omnidirectional vision sensor is mainly divided into three kinds of surfaces: spherical, parabolic and hyperbolic; its main features are: low price, single viewpoint, wide viewing angle, 360° information, and the image does not rotate with the sensor. Change the relative angle between the image and the two objects on the ground.

Even in the case of convergence, since all the particles fly in the direction of the optimal solution, the particles in the latter stage tend to be the same, which makes the convergence speed slower.

When the number of anchor nodes in agricultural wireless sensor networks is small and the search range is large, the problem of locating unknown nodes using this algorithm is more prominent, which will limit the improvement of location accuracy.

CSS technology (Cascading Style Sheets) has the characteristics of reliable communication, good stability, long transmission distance and low power consumption, so CSS technology is very suitable for indoor positioning by a large number of resource-constrained sensor nodes composed of Ad hoe mode of self-organizing multi-hop wireless communication network, a combination of sensor technology, embedded computing technology, sub-system Distributed processing technology and communication technology', through collaborative operation, real-time monitoring, perception and collection of various monitoring object information and processing and transmission to the destination node.

The trend prediction method is carried out and compared with the actual data according to the data of the past years. The results show that the prediction accuracy is high. It is the primary task of the sensor to accurately convert the seed flow signal of the seed guide tube into the signal accepted by the single chip microcomputer. The performance of the method directly affects the whole system. The overall performance. The photoelectric sensor has the advantages of simple structure, low price, strong anti-electromagnetic interference ability, and has no effect on the movement of seeds. Therefore, at present, the application is the most extensive and mature.

A new matrix can be obtained by multiplying the transposition of one row in the matrix with another row. First, the omnidirectional vision sensor is corrected to obtain the inner and outer parameters of the vision system and the projection center of the USB camera. Second, the input image, Extracting the identification feature, estimating the position of the center of gravity of the feature pixel as the position in the image; and then calculating the angle between the four directions of the marker relative to the projection center, according to the circumferential theorem, if the arc is formed by the direction angle, if there is no error, 4 arcs should intersect at the same intersection, but in general, due to the existence of errors such as measurement and identification, the probability of this situation is small and no positioning is required. Only rely on information such as network connectivity for positioning. Generally, there are centroid algorithm, approximate trigonometric point test method, vector jump moment, convex plan and so on.

Compared with the positioning algorithm without ranging, the positioning algorithm based on ranging has the disadvantages of high energy consumption, large amount of calculation and large amount of communication, but the positioning accuracy of the former is generally higher than that of the latter; The latter is less affected by environmental factors, but the positioning error is larger, and the density of anchor nodes is required higher. infrared has relatively high indoor positioning accuracy, but its linear sight distance and transmission distance are shorter these two major drawbacks make the indoor positioning effect is very poor. The overall positioning accuracy of ultrasonic positioning is higher and the structure is simple, but the ultrasonic is greatly affected by multipath effect and non-line-of-sight propagation, and the cost is higher. Modern control theories and methods, such as optimal estimation, optimal control, adaptive control and fuzzy control, are adopted. Prospects for the future development of agricultural machinery navigation technology are made. Communication security is an important part of this technology. Privacy protection is becoming more and more important, while authorization is becoming less important. It needs to be based on wireless. According to the characteristics of sensor networks, a new type of security protocol and security strategy are studied in view of its unique security threats.

Table 1 shows the static positioning coordinates and error data of indoor nodes. Figure 1 shows the static positioning coordinates and errors of indoor nodes.

Table 1

Static positioning coordinates and error of the indoor node

Numbering	Actual coordinates	Positioning coordinates	Error
1	(2,3.1)	(2.7,2.6)	0.1
2	(2,3.1)	(3,2.5)	0.1
3	(2,3.1)	(3.1,2.8)	0.1
4	(2,3.5)	(3.9,4,6)	0.2

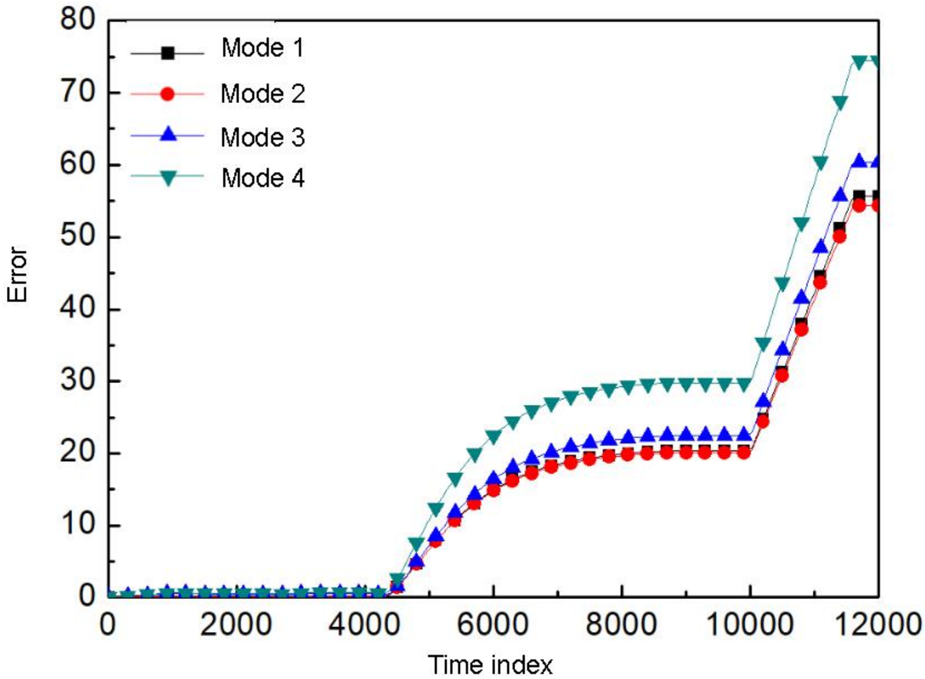

Fig. 1 - Static positioning coordinates and error of the indoor node

RESULTS

The development of modern agricultural machinery requires more sensors. It can be seen that modern agricultural machinery is equipped with various sensors, which improves trilateral localization he automation control performance, thereby reducing the mechanical power loss and saving energy. Reduce energy consumption and save investment in human and material resources. Therefore, sensors have a very important position and role in agricultural machinery. Figure 2 is a modern agricultural sensor.

Fig. 2 - Modern agricultural sensors

The study of single-component force sensors focuses on improving the accuracy of measurement. The research of multi-component force sensor includes various structural forms. The main problems to be solved by different structural forms are to improve the mutual interference between the natural frequency and the component force.

Positioning technology is a low-cost, low-power, short-distance wireless communication technology, but it is very sensitive to environmental impacts and easily deviates from the computational model. In the identification process, there is a certain error between the average value of the extracted pixels and the actual center of the identification. The transmission range of the RF positioning technology is large, the cost is relatively low, and the positioning accuracy is high, but its action distance is short and communication capability is not available.

Originally used primarily for Internet network multicast authentication. It solves the problem of high information load in asymmetric MAC protocol (Multiple Access Control Protocol) by introducing time synchronization mechanism. But this agreement needs another agreement to ensure the authenticity of time synchronization.

As a big agricultural country, one of the magic weapons to solve people's livelihood problems is the popularization of scientific modernization. Selecting suitable pressure sensors can significantly improve the reliability and life of agricultural machinery and equipment. Location technology based on wireless sensor network has the characteristics of non-contact and non-line-of-sight, and has become one of the preferred indoor positioning methods. It can be used not only in navigation and positioning system, but also in sensor information transmission and automatic monitoring system of facility agricultural environment. A cross-Particle swarm optimization based three-dimensional localization method for agricultural wireless sensor networks is proposed. By introducing cross-factor into the algorithm searching process, a new population is generated through cross-operation, and the diversity of particles is increased.

This method not only enhances the global searching ability of particles, but also speeds up the convergence speed of particle swarm optimization and effectively improves the efficiency of particle swarm optimization. Positioning accuracy. The automatically enhanced autonomous key scheme mainly includes two pairs of asymmetric key protocols and group key protocols. Both are based on asymmetric public key technology, which combines the security information of a group of nodes to determine the key, independent of trusted third parties. However, the computational overhead of such schemes is too high and is not applicable in most wireless sensor networks. Like most sensors, the force sensor needs to be calibrated. If the sensor is designed and manufactured, the interference coefficient can be made small, negligible, and only six calibration coefficients can be used. This method is called direct decoupling.

The initial basic credibility of the target is assigned in the sensor network, and the high-level basic credibility of the target is assigned through data fusion, so as to get the target recognition and attribute determination. Particle swarm optimization algorithm has the characteristics of high positioning accuracy, few parameters and simple implementation, which is very suitable for agricultural wireless sensor. This paper proposes a clock synchronization algorithm to locate the time of bidirectional transmission and obtain the distance between nodes. The ranging process includes two symmetrical measurements. The first measurement sends a packet from node 1 to node 2 and receives an automatic response from node 2. Node 1 calculates the propagation delay time, and node 2 calculates its own processing delay.

It detects the shape, mechanical and optical characteristics of the tested objects in the process of robot work, and guides the robot to walk, classify and pick agricultural products automatically. This not only enhances the perception ability of the agricultural robot to the environment, but also directly improves the intelligent degree of the agricultural robot. After deployment, it can establish shared key with neighboring nodes independently. The scheme is based on a probability model, and its secure connection probability is related to the key pool and its proportion.

The model node coefficient table is shown in table 2 and figure 3.

Table 2

Model node coefficient table

	A->A	B->C	C->B
Model 1	1.02	0.21	0.85
Model 2	0.35	0.01	0.31
Model 3	0.4	0.01	0.64

Sensors are the core components of the whole engine and chassis control system. They can be used to realize steering lightly, improve response characteristics, reduce engine loss, increase output power, save fuel and so on.

After sorting the fitness of the particles, the first N/2 particles with good fitness enter the next generation directly. The latter N/2 particles are paired in the particle selection pool, and a crossover position is randomly generated (i.e. a crossover point is randomly set, and some structures of the two particles before or after the crossover point are interchanged, and two new particles are generated) to produce the same offspring as the parent number. Identification and location determination are extremely important for positioning.

People usually plant the same plants in the same field, which exhibit roughly the same color characteristics, which is very disadvantageous for positioning systems that are identified by natural environmental features. In addition, it is difficult to calibrate to get an accurate coefficient. It is in this situation that the study of multi-component force sensors has important practical significance for scientific research. This optimization of the sensor can be classified as virtual prototype technology. The biggest advantage is that the probability of secure connectivity is always 1, but usually the computation and communication overhead is large. Later, some people improved on this basis and proposed several improvements.

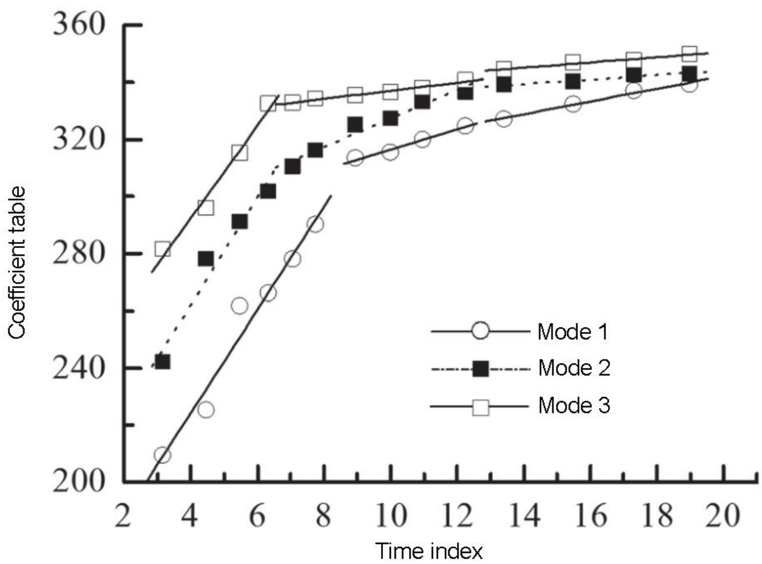

Fig. 3 - Model node coefficient table

The indoor dynamic positioning coordinates and node errors are shown in Table 3

Table 3

Indoor dynamic positioning coordinates and errors in nodes

Numbering	Actual coordinates	Positioning coordinates	Error
1	(1,1.5)	(1.2,2.5)	0.3
2	(1,1.2)	(1.8,2.8)	0.6
3	(1,2)	(0.7,1.7)	0.3
4	(1,3)	(1.8,2.8)	0.8

The indoor dynamic positioning coordinates and errors are shown in figure 4. Because wireless sensor networks may be deployed in hostile environments, in order to prevent malicious nodes from injecting illegal information, forging and tampering with data, information authentication technology must be used to confirm that information originates from legitimate nodes and ensure data integrity. Different authentication methods are different for different communication modes.

Multipoint data source broadcasting authentication and low energy consumption multi-hop authentication path are the focus of research. With the further development and integration technology of modern physics, such as nanotechnology, laser, infrared, ultrasound, microwave, optical fiber, strong magnet, radioisotope, etc., the integration of sensors has opened up a broad front.

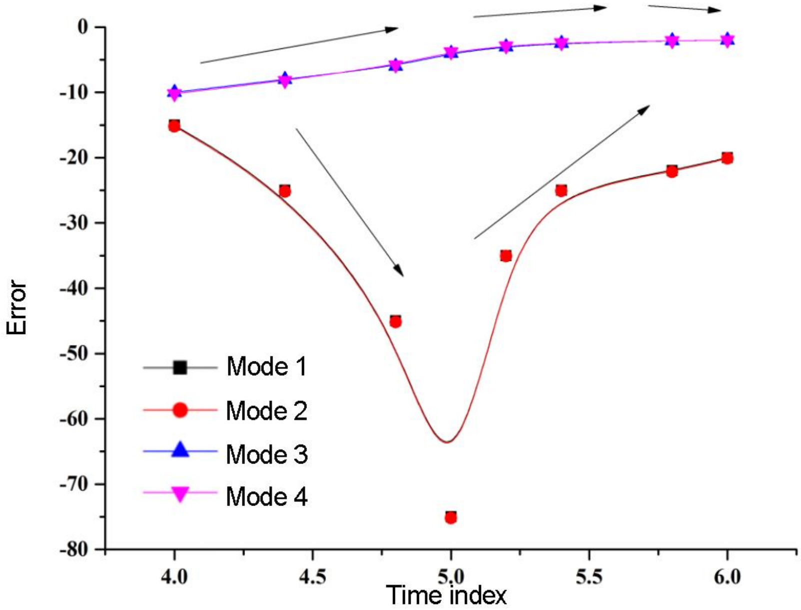

Fig. 4 - Indoor dynamic positioning coordinates and error

The development of sensors with small size, easy encapsulation, wider application range, high reliability, long service life and stronger function is also the trend of sensor development in facility agriculture. The material delivery vehicle and 3 beacon nodes are used to realize data communication and ranging and positioning functions. In the positioning node, the trilateral positioning algorithm in the common WSN positioning method is adopted and used in conjunction with the centroid estimation method. Finally, the Kalman filtering algorithm is used to improve the positioning accuracy. In the positioning calculation, the unknown node optimizes the calculation of the normal anchor node information and the corrected distance input cross particle swarm optimization algorithm. Therefore, whether it is outdoors or indoors, it is completely feasible to ensure that the location of the logo is appropriate. Then, since the visual range of the omnidirectional vision sensor currently used is about 120°, the height range of the marker setting position is large; and the setting of the height of each marker position can be arbitrary as long as the camera imaging requirements are satisfied. The node positioning effect is shown in figure 5.

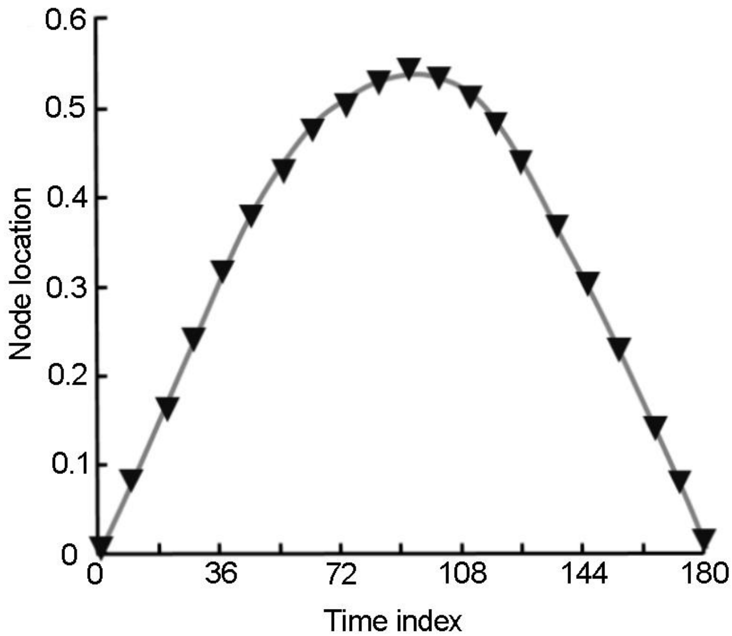

Fig. 5 - Node positioning effect diagram

When the size of network nodes is adjusted, when the dimensions of matrix M and VD are m, the formula is:

$$M(w) = \frac{w}{D} R_{ON} + (1 - \frac{w}{D}) R_{OFF} \tag{1}$$

$$v_D = \eta \frac{u_D R_{ON}}{D} i(t) \tag{2}$$

When the number of matrices is expanded, the following formula is established:

$$v_D = \frac{dw}{dt} \tag{3}$$

$$D_k(x,y) = \begin{cases} 255 & \left|P_k(x,y) - B_k(x,y)\right| > T_h \\ 0 & else \end{cases} \tag{4}$$

In contrast with the polynomial mentioned above, the directional quantity is:

$$D_k(x,y) = \left| f_{k-1}(x,y) - f_k(x,y) \right| \tag{5}$$

$$B_k(x,y) = \left| f_k(x,y) - B(x,y) \right| \tag{6}$$

Since Rk is the network capacity, the storage of this scheme has the following formula:

$$R_k(x,y) = \begin{cases} 1, \text{target}, & if\ T_k(x,y) > Th \\ 0, \text{background}, & if\ T_k(x,y) \le Th \end{cases} \tag{7}$$

Combining matrix decomposition and polynomial schemes:

$$P_d = N_i v_i \left(\frac{M_i v_i^2}{2} + Zeu(t) \right) \tag{8}$$

$$N_i = N_{i0} \exp(-\frac{t - t_0}{\tau})(\frac{D_{amp} l^2}{D_{gap}^2} + 1) \tag{9}$$

$$U_0 = \frac{M_i}{2e}(v_i + \frac{dl}{dt})^2 \tag{10}$$

$$i(t) = \frac{\pi D^2 Z N_i e}{4}(v_i + \frac{dl}{dt}) \tag{11}$$

$$R = \omega L + \frac{1}{\omega C} \tag{12}$$

CONCLUSIONS

Compared with the location results, the algorithm mainly calculates the direction angle formed by the mark and the projection center of the camera. It is very important to find the correct position of the mark in the image. Therefore, in the next step, we will focus on the feature extraction of the mark. If we want to further improve the location accuracy, we need to change the location node. The method based on multi-point three-dimensional space positioning can be studied, even if the best ultra-wide band sensor series products are used as positioning nodes. Although its price is very expensive, its positioning stability is good, the precision is very high, and the theoretical positioning accuracy can reach the centimeter level. It better overcomes the negative impact of the standard particle swarm optimization algorithm on the slow convergence, easy to fall into the local minimum point and premature convergence in the late stage of evolution. It not only improves the positioning accuracy, but also optimizes the performance.

The matrix scheme combines matrix multiplication and polynomial-based key pre-allocation schemes, and is extended on the multi-dimensional key space to meet the needs of larger network capacity with lower storage, communication, and computational overhead. Network positioning applications have certain value.

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