Research on Positioning Technology Based on the Mobile Phone Imaging Equipment

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Keywords: Imaging location, Genetic algorithm, Precisi.

Abstract. The complexity of indoor environment has become the bottleneck of the relying on satellite navigation and mobile network positioning technology. With the development of the city, the demand of indoor positioning service is increasing day by day. In this paper, based on the principle of mobile phone image localization, indoor precision positioning is studied. For the adaptive problem of imaging positioning technology, genetic algorithm is used to realize the intelligent calculation of positioning algorithm. The image points identified by the image are involved in the iterative process as constraints and the error correction Ability to reduce the computational complexity of the target solution to achieve fast and accurate positioning.

Introduction

With the development of Internet of Things technology, location information services have become more and more in-depth in all aspects of people's daily life. In addition, location information services in some special areas are also widely used, such as military, medical and other fields. Relying on satellite navigation and mobile network outdoor positioning technology research started early, the popularity of applications, however, the complexity of the indoor environment to mature positioning technology stretched, indoor positioning technology is not yet mature.

Indoor positioning mainly through continuous access to the target (people or items) hot spots precise location information, fusion of target data or user points of interest, indoor precision navigation, big data analysis, personnel management, article management and other basic functions. As a result, it has expanded to include military, public safety, business analysis, healthcare, interior navigation, warehouse management, social networking, advertising and marketing and other related fields, generating enormous social and economic value. In this paper, based on the mobile phone imaging positioning technology to carry out indoor precise positioning.

Domestic and foreign research institutions rely on different technical standards developed indoor positioning technology based on ultrasound, infrared, Bluetooth, radio frequency, Wi-Fi and visible light, but each technology has its limitations, for example, infrared positioning technology uses directional sending and receiving infrared In the process, there can be no other obstacles. If infrared transmitters and receivers are deployed in each room and corridor, the positioning cost will be increased. In this paper, the mobile phone imaging technology is researched. According to the adaptive problem of imaging location technology, the intelligent algorithm of positioning algorithm is realized based on genetic algorithm. The image points recognized as the constraints participate in the iterative process, improve the error correction ability of the algorithm and reduce the target Calculate the amount of computation.
Based on the Basic Principles of Mobile Phone Imaging Equipment Positioning Technology

Imaging Positioning Principle

The use of pinhole camera imaging mathematical model, the equivalent of thin lens, the camera lens and thin lens aperture tends to 0, the imaging equivalent of camera, camera positioning, the camera imaging target conversion process can be expressed as an object space Point of the projection space, usually using central projection method to achieve photogrammetry space projection mapping transformation. Here is a commonly used projection video photography shadow. Shown in Figure 1, Sa, Sb projection line, such as points A, B, C, D and points projected onto a plane pA, pB, pC, pD convergence in the shadow.

![Figure 1. Central projection model.](image)

Like the space coordinate system: Set the position of the image empty coordinate point is like the coordinate system, regardless of the punctuation in the shadow is positive z-axis direction, photography. The x and y axes passing through the point parallel to the image plane are the image space coordinates x and y axes. In Figure 2, each plot point coordinates equal to the camera's main distance.

![Figure 2. Coordinate transformation model.](image)

\[
\begin{align*}
\begin{vmatrix}
    a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0) \\
    a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0) \\
    a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0) \\
    a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0) \\
\end{vmatrix}
\end{align*}
\]

Coordinate rotation matrix R is defined as follows:

\[
\begin{align*}
\begin{vmatrix}
    u-u_0 = -f \frac{a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0)}{a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0)} \\
    v-v_0 = -f \frac{a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0)}{a_x(x-x_0) + b_y(y-y_0) + c_z(z-z_0)} \\
\end{vmatrix}
\end{align*}
\]
\[
R = \begin{bmatrix}
  a_1 & a_2 & a_3 \\
  b_1 & b_2 & b_3 \\
  c_1 & c_2 & c_3
\end{bmatrix}
\]

Transform the equation into a matrix form

\[
m = MX = K[R \ | \ t]X
\]  

Matrix $K$ describes the internal structure of the camera, the camera's internal reference matrix, where the parameters are referred to as the camera's internal parameters, and $R$, $t$ is the rotation matrix and translation vector describing the camera's position and orientation. Known as the projection matrix, and implicit camera external parameters. Called the projection matrix, while implicitly the camera's internal and external parameters. The central projection tectonic equation expresses the relationship between the object point and the simple projection mapping image point. Therefore, the sensitivity of the analysis method and improve the imaging effect factor in the process, the interaction between the imaging model is very complex and difficult to be resolved.

**Error Correction**

**Camera Parameters Correction.** Ideally, the camera model meets the requirements of the measurement system. However, in practical applications, due to camera factors, assembly errors inevitably introduce measurement errors and calculation errors in the image acquisition process, the imaging plane center of the image will deviate from the ideal geometrical center of projection. Camera parameter calibration and calibration are first to be solved The key issue.

**Light Imaging Center Positioning.** In imaging positioning, the light source as an important input data, the center positioning accuracy directly affects the calibration accuracy. In other conditions remain unchanged, the high positioning accuracy of the light source is the most direct factor in increasing the camera resolution. However, the cost of relying on hardware upgrades to improve is high, and dual resolution can result in multiples of the price if the camera itself has high resolution. For this reason, improving the accuracy of sub-pixel positioning through software improvements, such as image processing algorithms, is a more cost-effective way to improve positioning accuracy.

Positioning techniques require high accuracy, and the need for positional accuracy is now higher and higher. The error correction described in this section for imaging positioning is a key technique. Camera calibration and calibration of the parameters is the first to solve the problem, only to improve the positioning accuracy in order to achieve the accuracy of imaging positioning, genetic algorithms can improve the positioning accuracy.
Genetic Algorithm Solution

The Basic Principles of Genetic Algorithms

Genetic algorithm is a random search algorithm based on biological natural selection and natural genetic mechanism, which generates a new population based on the principle of evolution and based on genetic operations and the existing population. Search for the optimal solution at the same time, the solution to the problem of evolution, the result is to meet the requirements of the optimal solution. Genetic algorithm uses the function group of genetic operators to get a new generation group \( P(t + 1) \) according to genetic operation.

- **Choice**: Select some good individuals from the first generation \( t \) \( P(t) \) to the next generation \( P(t + 1) \) as specified or somehow.
- **Crossover**: Individuals are paired randomly in group \( P(t) \), with each pair having a certain probability (called crossover probability, part of the chromosomal exchange between them).
- **Variation**: Each individual in a population has a chance (called a mutation probability) to change the genome of one or more genes.

The Application of Genetic Algorithms

Use the following method to solve the function optimization problem, that is, the maximum and minimum problems

\[
\begin{align*}
\text{max} & \quad f(x) \\
\text{s.t.} & \quad x \in R \\
& \quad R \subseteq U
\end{align*}
\]

(4)

In the above, is the decision variable, \( f(X) \) is the objective function, \( RX \) and \( UR \) are constraints, \( U \) is the basic space, \( R \) is a subset of \( U \). \( R \) set represents a set of solutions that satisfy all the constraints, called a set of feasible solutions.

The genetic algorithm flow chart shown in Figure 4.

```
Problems to be optimized

| Determination of the solution of the objective function and the problem variable |
| Generation of initial groups |
| Calculating the adaptive value of an individual |
```

```
Whether convergence conditions or evolutionary algebras are satisfied?

| Generation of new groups by operation of genetic operators |
```

```
Output optimal solution
```

Figure 4. Flow chart.

MATLAB Simulation Program

Assuming that the ceiling has four light sources, which are located at four vertex angles respectively, the light source projects four points on the photographic paper through the image points. Under the object space coordinate system, as shown in FIG. 2-3, when the image space coordinate system is Reference, as shown in Figure 5-6 shows the rotation process. In the process of positioning, the coordinates of the light source in the object space are known, and the position of the image point in the
image coordinate system is known. Through the above imaging and transformation principle, the rotation angle of the coordinate system of the image coordinate system is traversed, Transform to the image space coordinate system.

Figure 5. Object space coordinate system.

Figure 6. Positioning space positioning schematic.

**Summary**

Based on the basic principle of mobile phone imaging equipment positioning technology, this paper analyzes the typical mathematical model of pinhole camera imaging, and then describes the basic principles of GA and its application. In order to solve the problem of adaptive imaging positioning technology, this paper uses genetic algorithm to realize the intelligent calculation of positioning algorithm, and takes the image points identified as constraints in the iterative process to improve the error correction capability of the algorithm and reduce the computational complexity of the target solution. In the positioning algorithm, the positioning accuracy of the algorithm is improved by the error correction of imaging positioning and the calculation of the optimal imaging point of the light source.

**References**

