



# 3D Image Fusion Technology-mediated Robot Application Research in Elderly Bone Joint Soft Tissue Diseases



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## Background

### Elderly bone and joint diseases

- High incidence: Occur in the elderly population, great harm, affecting the quality of life.
- Low satisfaction rate of medical treatment: Early senile bone and joint disease is only 19%.
- Low acceptance of surgical treatment: Only 9% of advanced severe bone and joint disease.
- Minimally invasive treatment is difficult to accurately locate: Various images have their own merits and cannot be combined.

### Patients

- High number of patients. 70-80% of the elderly in my country suffer from orthopedic diseases of varying severity, which seriously affect the quality of life of patients and social productivity.
- Conservative treatment is not effective. Through oral medication, physical therapy and other methods, the curative effect is not good.
- Surgery is risky. Once it fails or does not work well, it will cause serious consequences.

### Doctors

- Insufficient medical resources. The number of people suffering from these diseases in Beijing each year accounts for more than half of the outpatient resources of orthopedics clinics.
- The precision of puncture is high. The anatomy of paravertebral tissues is complicated, the risk is Once it fails, the consequences are serious.
- The professional requirements of the operating doctor are high. Most of the joint puncture techniques are based on the experience of orthopedic doctors.

## Technical solutions

### Fusion of intraoperative 2D ultrasound and preoperative CT/MRI/three-dimensional ultrasound 3D reconstruction images

In this project, the local structure direction descriptor of the image is constructed, the pixel/voxel neighborhood elements are used to describe the gray change direction of the local structure in the multi-mode image, and the automatic multi-mode image is realized based on the similarity criterion of the local structure direction descriptor vector. The registration framework realizes the registration and fusion of intraoperative 2D ultrasound and preoperative CT/MRI/3D ultrasound images.

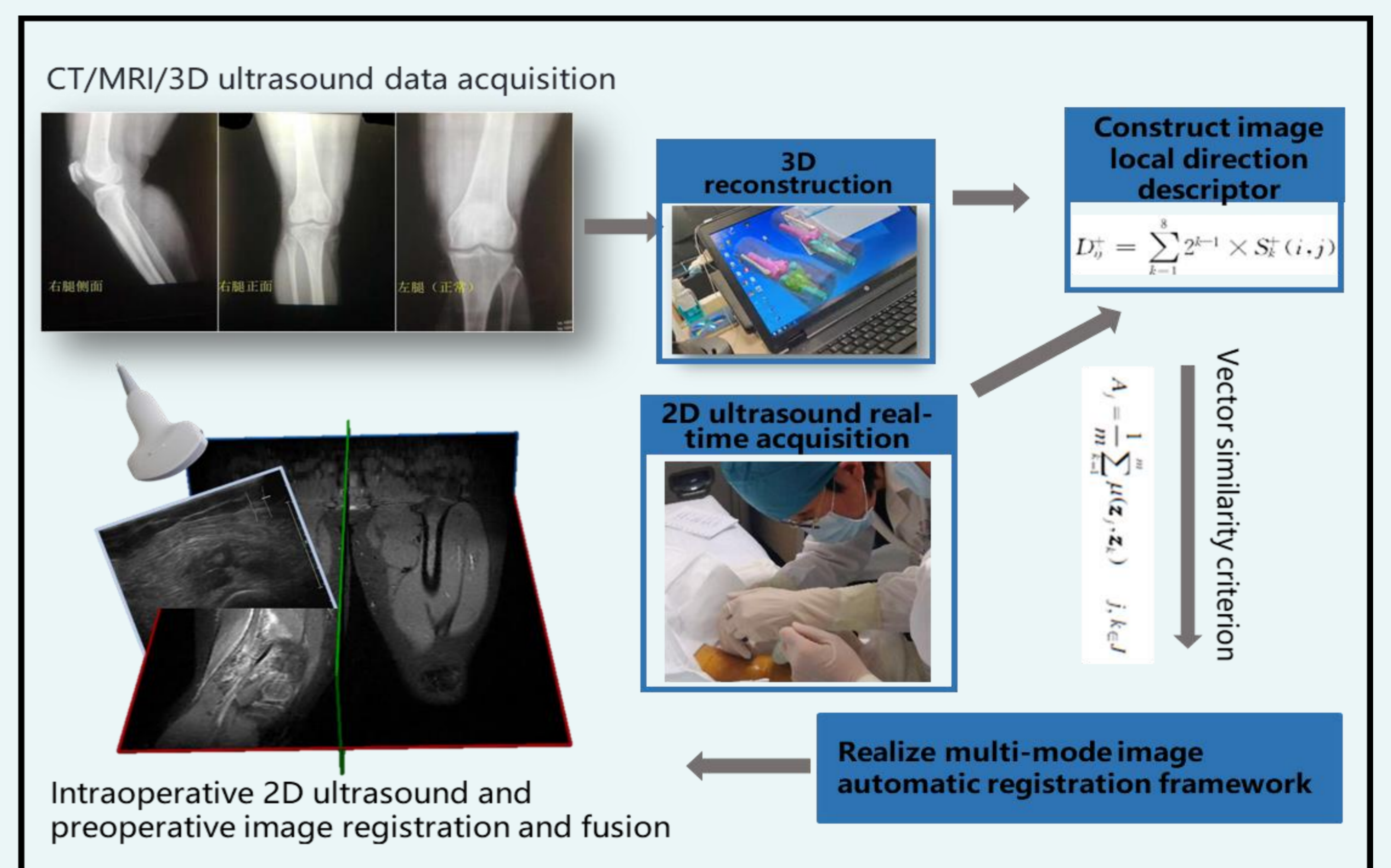
### Visualization of virtual and real fusion in mixed reality

Point matching registration method based on marker points to establish the mapping relationship between the positioning coordinate system and the image coordinate system.

The occlusion method based on model reconstruction is used to fuse the segmented bones and blood vessels. In the process of fusion, the real object is covered with a three-dimensional model, and then the depth values of the virtual and real object models are compared of the two sets of points in space.

### Path planning based on ultrasound-mediated robot arm guidance

A spherical coordinate system is established from the target position, and rays are radiated to the surrounding space with a certain density. Model the physiological anatomy and optimize the multi-objective optimization of the path length target, the minimum distance target between the puncture path and the obstacle, comprehensive distance target between the needle tip and obstacle.



## Main Innovation

- Through image analysis and processing, real-time registration and fusion of intraoperative 2D ultrasound images and preoperative 3D CT/MRI/ultrasound images
- Through the medical mixed reality visualization technology, the virtual and real fusion presentation of the operation
- Automatically implement preoperative planning routes through ultrasound-mediated robotic arm guidance

## Application

- ✓ **doctor-patient communication**
- ✓ **clinical treatment**
  - Preoperative discussion
  - Intraoperative guidance
- ✓ **expand the treatment field**

## Project Progress

We have completed the technical research of the project, are integrating product prototypes, and have been clinically verified for each module, and the test results are good.

## Potential Challenge

Multi-modal data fusion is a difficult point. For the multi-modal fusion of different patients, it is our goal to ensure high-precision fusion

## Future Directions

Expand the indications of interventional therapy in the field of musculoskeletal