View planning for 3D modeling of outdoor environments by using a rangefinder

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3D Model of Outdoor Scenes

Useful for applications of ubiquitous networked media computing

- Virtual walk-through
- Site simulation
- Wearable AR
  (Human navigation)

These models are made manually with high cost

Virtual walk-through

Automatic 3D modeling of outdoor scenes by using a laser rangefinder has been widely investigated.

Modeling by using a rangefinder

A rangefinder can acquire 3D shape of object.

Acquired partial shape

Integrated model (10 data)

The whole model is generated by registering partial shapes

The modeling problem

- It is difficult to measure whole shape of the object by one measurement.
  - Necessity for registration of multiple range data
- Unobserved portions which have not irradiated laser beam become lack of model.

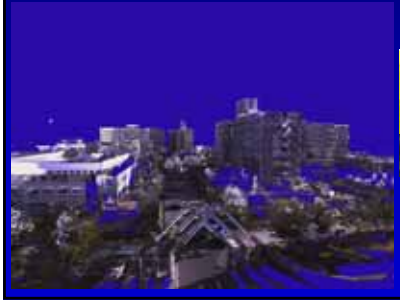
White portions are unobserved portions.

3D modeling cycle

1. Planning of data acquisition positions
   - Reduction of unobserved portions
   - Success of Registration process
2. Data acquisition
   - Range and color images are acquired at multiple positions.
3. Registration of multiple range data
4. Integration of range and color data

Generated model by our method

Data acquisition points are decided by a operator which has knowledge about the registration algorithm.



Sensor system mounted on a vehicle

Objective

3D modeling of urban environments without unobserved portions

Approach

- Simultaneously registration of range data using planar portions (already proposed)
- Applying view planning method
  - Indication of data acquisition points
    - Efficient reduction of unobserved portions
    - Registration to acquired range data is successful

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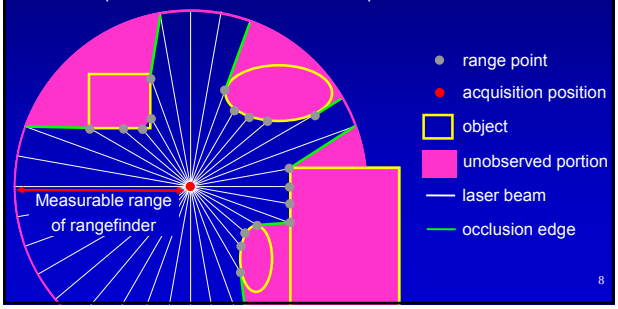
The definition of unobserved portion

The portions which could not acquire range data

- The portions which laser beam has not passed.



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Conventional view planning method

- Volumetric method
  - Encoding space occupancy by a voxel occupancy grid
    - Compact method
    - Large memory requirement
- Surface-based method
  - Using occlusion edges
    - The premise that the occlusion edges represent the boundary of the unobserved portions.

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Applying view planning method

- Motivation
  - Unobserved portions of generated model are reduced efficiently.
- Premises
  - Outdoor environments are complex.
  - An omnidirectional rangefinder is used.
  - The work area of rangefinder is limited.
  - Our registration method require overlapped planar portions among different range data.

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Outline of view planning

- Input (known information)
  - GIS (map)
    - Work area of sensor system
    - Modeling area (given by the sensor operator)
  - Generated model
- Output
  - The positions in which registration succeeds.
  - Reduction rate of unobserved portion in the work area.

Next acquisition position is decided by the sensor operator

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Procedure of data acquisition

1. Calculation of reduction rate on work area from generated model
2. Acquisition of range data
3. Registration of range data, update of the model

   (On site) successive registration
   - low processing cost, low accuracy

   (Off site) simultaneous registration
   - high processing cost, high accuracy
4. Return to 1

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Conclusion

3D modeling of urban environments without unobserved portions

- Applying view planning method
  - Efficient reduction of unobserved portions
  - Registration to acquired data is successful

Future work

- Calculation of optimal acquisition position
- Gap between a planned and an actual acquisition position

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