CLAIMS

1. An image depth estimation method, comprising:

obtaining a reference frame corresponding to a current frame and an inverse depth space range of the current frame;

performing pyramid downsampling processing on the current frame and the reference frame respectively to obtain k layers of current images corresponding to the current frame and k layers of reference images corresponding to the reference frame, wherein k is a natural number greater than or equal to 2; and

performing inverse depth estimation iteration processing on the k layers of current images based on the k layers of reference images and the inverse depth space range to obtain inverse depth estimation results of the current frame.

2. The image depth estimation method according to claim 1, wherein obtaining the reference frame corresponding to the current frame comprises:

obtaining at least two frames to be screened; and

selecting at least one frame from the at least two frames to be screened and taking the at least one frame as the reference frame, wherein the at least one frame and the current frame meet a preset angle constraint condition.

3. The image depth estimation method according to claim 2, wherein the preset angle constraint condition comprises that:

an included angle, formed by a connection line between a pose center corresponding to the current frame and a target point and a connection line between a pose center corresponding to the reference frame and the target point, falls within a first preset angle range, wherein the target point is a midpoint of a connection line between an average depth point corresponding to the current frame and an average depth point corresponding to the reference frame;

an included angle between an optical axis corresponding to the current frame and an optical axis corresponding to the reference frame falls within a second preset angle range; and

an included angle between a vertical axis corresponding to the current frame and a

vertical axis corresponding to the reference frame falls within a third preset angle range.

4. The image depth estimation method according to any one of claims 1 to 3, wherein performing inverse depth estimation iteration processing on the k layers of current images based on the k layers of reference images and the inverse depth space range to obtain inverse depth estimation results of the current frame comprises:

determining inverse depth candidate values corresponding to each sampling point in i^{th}-layer sampling points based on the k layers of current images and the inverse depth space range, wherein the ith-layer sampling points are pixel points obtained by performing sampling on an ith-layer current image in the k layers of current images, and i is a natural number greater than or equal to 1 and less than or equal to k;

determining inverse depth values of each sampling point in the ith-layer sampling points according to the inverse depth candidate values corresponding to each sampling point in the ith-layer sampling points and the ith-layer reference image in the k layers of reference images to obtain i^{th}-layer inverse depth values;

letting i be equal to i+1 and continuing performing inverse depth estimation on the $(i+1)^{th}$-layer current image, in the k layers of current images, having a resolution greater than that of the ith-layer current image until i=k to obtain k^{th}-layer inverse depth values; and

determining the kth-layer inverse depth values as the inverse depth estimation results.

5. The image depth estimation method according to claim 4, wherein determining inverse depth candidate values corresponding to each sampling point in i^{th}-layer sampling points based on the k layers of current images and the inverse depth space range comprises:

performing interval division on the inverse depth space range and selecting an inverse depth value from each divided interval to obtain a plurality of initial inverse depth values;

determining the plurality of initial inverse depth values as inverse depth candidate values corresponding to each sampling point in the first-layer sampling points;

if i is not equal to 1, obtaining $(i-1)^{th}$-layer sampling points from the k layers of current images and $(i-1)^{th}$-layer inverse depth values; and

determining, based on the $(i-1)^{th}$-layer inverse depth values, the $(i-1)^{th}$-layer sampling points, and the plurality of initial inverse depth values, the inverse depth candidate values

corresponding to each sampling point in the ith-layer sampling points.

6. The image depth estimation method according to claim 5, wherein determining, based on the $(i-1)^{th}$ layer inverse depth estimation values, the $(i-1)^{th}$-layer sampling points, and the plurality of initial inverse depth values, the inverse depth candidate values corresponding to each sampling point in the ith-layer sampling points comprises:

determining, from the $(i-1)^{th}$-layer sampling points, a second sampling point closest to a first sampling point and at least two third sampling points adjacent to the second sampling point, wherein the first sampling point is any sampling point in the ith-layer sampling points;

obtaining an inverse depth value of each sampling point in the at least two third sampling points and an inverse depth value of the second sampling point according to the $(i-1)^{th}$-layer inverse depth values to obtain at least three inverse depth values;

determining a maximum inverse depth value and a minimum inverse depth value from the at least three inverse depth values;

selecting, from the plurality of initial inverse depth values, inverse depth values falling within a range between the maximum inverse depth value and the minimum inverse depth value, and determining the selected inverse depth values as the inverse depth candidate values corresponding to the first sampling point; and

continuing determining inverse depth candidate values corresponding to the sampling points, other than the first sampling point, in the ith-layer sampling points until the inverse depth candidate values corresponding to each sampling point in the ith-layer sampling points are determined.

7. The image depth estimation method according to claim 4, wherein determining inverse depth values of each sampling point in the ith-layer sampling points according to the inverse depth candidate values corresponding to each sampling point in the ith-layer sampling points and the ith-layer reference image in the k layers of reference images to obtain i^{th}-layer inverse depth values comprises:

for each sampling point in the ith-layer sampling points, projecting each sampling point in the ith-layer sampling points to the ith-layer reference image according to each inverse depth value in the corresponding inverse depth candidate values respectively to obtain i^{th}-layer projection

points corresponding to each sampling point in the ith-layer sampling points;

performing block matching according to the ith-layer sampling points and the ith-layer projection points to obtain i^{th}-layer matching results corresponding to each sampling point in the ith-layer sampling points; and

determining, according to the ith-layer matching results, the inverse depth values of each sampling point in the ith-layer sampling points to obtain the ith-layer inverse depth values.

8. The image depth estimation method according to claim 7, wherein performing block matching according to the ith-layer sampling points and the ith-layer projection points to obtain i^{th}-layer matching results corresponding to each sampling point in the ith-layer sampling points comprises:

by using a preset window, selecting, from the ith-layer current image, a first image block with a sampling point to be matched as a center, and selecting, from the ith-layer reference image, a plurality of second image blocks respectively with each projection point in the ith-layer projection points corresponding to the sampling point to be matched as a center, wherein the sampling to be matched is any sampling point in the ith-layer sampling points;

respectively comparing the first image block with each image block in the plurality of second image blocks to obtain a plurality of matching results, and determining the plurality of matching results as i^{th}-layer matching results corresponding to the sampling point to be matched; and

continuing determining the ith-layer matching results corresponding to the sampling points, in the ith-layer sampling points, different from the sampling point to be matched, until the ith-layer matching results corresponding to each sampling point in the ith-layer sampling points are obtained.

9. The image depth estimation method according to claim 7, wherein determining, according to the ith-layer matching results, the inverse depth values of each sampling point in the ith-layer sampling points to obtain the ith-layer inverse depth values comprises:

selecting a target matching result from i^{th}-layer matching results corresponding to a target sampling point, wherein the target sampling point is any sampling point in the ith-layer sampling points;

determining the projection point, in i^{th}-layer projection points corresponding to the target

sampling point, corresponding to the target matching result as a target projection point;

determining inverse depth values, in the inverse depth candidate values, corresponding to the target projection point as inverse depth values of the target sampling point; and

continuing determining the inverse depth values of the sampling points, in the ith-layer sampling points, different from the target sampling point until the inverse depth values of each sampling point in the ith-layer sampling points are determined to obtain the ith-layer inverse depth values.

10. The image depth estimation method according to any one of claims 4 to 9, after obtaining the kth-layer inverse depth values, further comprising:

performing interpolation optimization on the kth-layer inverse depth values to obtain optimized k^{th}-layer inverse depth values; and

determining the optimized k^{th}-layer inverse depth values as the inverse depth estimation results.

11. The image depth estimation method according to claim 10, wherein performing interpolation optimization on the kth-layer inverse depth values to obtain optimized k^{th}-layer inverse depth values comprises:

for each inverse depth value in the kth-layer inverse depth values, respectively selecting adjacent inverse depth values of the inverse depth value from candidate inverse depth values of a corresponding sampling point in the kth-layer sampling points, wherein the kth-layer sampling points are pixel points obtained by performing sampling on the kth-layer current image in the k layers of current images;

obtaining matching results corresponding to the adjacent inverse depth values; and

performing interpolation optimization on each inverse depth value in the kth-layer inverse depth values based on the adjacent inverse depth values and the matching results corresponding to the adjacent inverse depth values to obtain the optimized k^{th}-layer inverse depth values.

12. An image depth estimation apparatus, comprising:

an obtaining section, configured to obtain a reference frame corresponding to a current frame and an inverse depth space range of the current frame;

a downsampling section, configured to perform pyramid downsampling processing on the current frame and the reference frame respectively to obtain k layers of current images corresponding to the current frame and k layers of reference images corresponding to the reference frame, wherein k is a natural number greater than or equal to 2; and

an estimating section, configured to perform inverse depth estimation iteration processing on the k layers of current images based on the k layers of reference images and the inverse depth space range to obtain inverse depth estimation results of the current frame.

13. The image depth estimation apparatus according to claim 12, wherein

the obtaining section is specifically configured to: obtain at least two frames to be screened; and select at least one frame from the at least two frames to be screened and take the at least one frame as the reference frame, wherein the at least one frame and the current frame meet a preset angle constraint condition.

14. The image depth estimation apparatus according to claim 13, wherein the preset angle constraint condition comprises that:

an included angle, formed by a connection line between a pose center corresponding to the current frame and a target point and a connection line between a pose center corresponding to the reference frame and the target point, falls within a first preset angle range, wherein the target point is a midpoint of a connection line between an average depth point corresponding to the current frame and an average depth point corresponding to the reference frame;

an included angle between an optical axis corresponding to the current frame and an optical axis corresponding to the reference frame falls within a second preset angle range; and

an included angle between vertical axis corresponding to the current frame and a vertical axis corresponding to the reference frame falls within a third preset angle range.

15. The image depth estimation apparatus according to any one of claims 12 to 14, wherein

the estimating section is specifically configured to: determine inverse depth candidate values of each sampling point in i^{th}-layer sampling points based on the k layers of current images and the inverse depth space range, wherein the ith-layer sampling points are pixel points obtained by performing sampling on an ith-layer current image in the k layers of current images, and i is a

natural number greater than or equal to 1 and less than or equal to k; determine inverse depth values of each sampling point in the ith-layer sampling points according to the inverse depth candidate values corresponding to each sampling point in the ith-layer sampling points and the ith-layer reference image in the k layers of reference images to obtain i^{th}-layer inverse depth values; let i to be equal to i+1 and continue performing inverse depth estimation on the (i+1)th-layer current image, in the k layers of current images, having a resolution greater than that of the ith-layer current image until i=k to obtain k^{th}-layer inverse depth values; and determine the kth-layer inverse depth values as the inverse depth estimation results.

16. The image depth estimation apparatus according to claim 15, wherein

the estimating section is specifically configured to: perform interval division on the inverse depth space range and select an inverse depth value from each divided interval to obtain a plurality of initial inverse depth values; determine the plurality of initial inverse depth values as inverse depth candidate values corresponding to each sampling point in the first-layer sampling points; if i is not equal to 1, obtain $(i-1)^{th}$-layer sampling points from the k layers of current images and $(i-1)^{th}$-layer inverse depth values; and determine, based on the $(i-1)^{th}$ layer inverse depth estimation values, the $(i-1)^{th}$-layer sampling points, and the plurality of initial inverse depth values, the inverse depth candidate values corresponding to each sampling point in the ith-layer sampling points.

~~17. The image depth estimation apparatus according to claim 16, wherein~~

~~the estimating section is specifically configured to: determine a second sampling point closest to a first sampling point and at least two third sampling points adjacent to the second sampling point from the $(i-1)^{th}$-layer sampling points, wherein the first sampling point is any sampling point in the ith-layer sampling points; obtain an inverse depth value of each sampling point in the at least two third sampling points and an inverse depth value of the second sampling point according to the $(i-1)^{th}$-layer inverse depth values to obtain at least three inverse depth values; determine a maximum inverse depth value and a minimum inverse depth value from the at least three inverse depth values; select, from the plurality of initial inverse depth values, inverse depth values falling within a range between the maximum inverse depth value and the minimum inverse depth value, and determine the selected inverse depth values as inverse depth~~

candidate values corresponding to the first sampling point; and continue determining inverse depth candidate values corresponding to the sampling points, other than the first sampling point, in the ith-layer sampling points until the inverse depth candidate values corresponding to each sampling point in the ith-layer sampling points are determined.

18. The image depth estimation apparatus according to claim 15, wherein

the estimating section is specifically configured to: for each sampling point in the ith-layer sampling points, project each sampling point in the ith-layer sampling points to the ith-layer reference image according to each inverse depth value in the corresponding inverse depth candidate values respectively to obtain i^{th}-layer projection points corresponding to each sampling point in the ith-layer sampling points; perform block matching according to the ith-layer sampling points and the ith-layer projection points to obtain i^{th}-layer matching results corresponding to each sampling point in the ith-layer sampling points; and determine, according to the ith-layer matching results, the inverse depth values of each sampling point in the ith-layer sampling points to obtain the ith-layer inverse depth values.

19. The image depth estimation apparatus according to claim 18, wherein

the estimating section is specifically configured to: by using a preset window, select, from the ith-layer current image, a first image block with a sampling point to be matched as a center, and select, from the ith-layer reference image, a plurality of second image blocks respectively with each projection point in the ith-layer projection points corresponding to the sampling point to be matched as a center, wherein the sampling to be matched is any sampling point in the ith-layer sampling points; respectively compare the first image block with each image block in the plurality of second image blocks to obtain a plurality of matching results, and determine the plurality of matching results as i^{th}-layer matching results corresponding to the sampling point to be matched; and continue determining the ith-layer matching results corresponding to the sampling points, in the ith-layer sampling points, different from the sampling point to be matched, until the ith-layer matching results corresponding to each sampling point in the ith-layer sampling points are obtained.

20. The image depth estimation apparatus according to claim 18, wherein

~~the estimating section is specifically configured to: select a target matching result from i^{th}-layer matching results corresponding to a target sampling point, wherein the target sampling point is any sampling point in the ith-layer sampling points; determine the projection point, in the ith-layer projection points corresponding to the target sampling point, corresponding to the target matching result as a target projection point; determine inverse depth values, in the inverse depth candidate values, corresponding to the target projection point as inverse depth values of the target sampling point; and continue determining the inverse depth values of the sampling points, in the ith-layer sampling points, different from the target sampling point until the inverse depth values of each sampling point in the ith-layer sampling points are determined to obtain the ith-layer inverse depth values.~~

~~21. The image depth estimation apparatus according to any one of claims 15 to 20, wherein~~

~~the estimating section is further configured to: perform interpolation optimization on the kth-layer inverse depth values to obtain optimized k^{th}-layer inverse depth values; and determine the optimized k^{th}-layer inverse depth values as the inverse depth estimation results.~~

~~22. The image depth estimation apparatus according to claim 21, wherein~~

~~the estimating section is specifically configured to: for each inverse depth value in the kth-layer inverse depth values, respectively select adjacent inverse depth values from candidate inverse depth values of a corresponding sampling point in the kth-layer sampling points, wherein the kth-layer sampling points are pixel points obtained by performing sampling on the kth-layer current image in the k layers of current images; obtain matching results corresponding to the adjacent inverse depth values; and perform interpolation optimization on each inverse depth value in the kth-layer inverse depth values based on the adjacent inverse depth values and the matching results corresponding to the adjacent inverse depth values to obtain the optimized k^{th}-layer inverse depth values.~~

~~23~~17. An electronic device, comprising: a processor, a memory, and a communication bus, wherein

the communication bus is configured to implement connection communication between the processor and the memory; and

the processor is configured to execute an image depth estimation program stored in the

memory to implement the image depth estimation method according to any one of claims 1 to 11.

~~24~~18. The electronic device according to claim ~~23~~17, wherein the electronic device is a mobile phone or a tablet computer.

~~25~~19. A computer-readable storage medium, having one or more programs stored thereon, wherein the one or more programs are executable by one or more processors to implement the image depth estimation method according to any one of claims 1 to 11.

~~26~~20. A computer program, comprising computer-readable codes, wherein when the computer-readable codes are executed by a processor, the steps corresponding to the image depth estimation method according to any one of claims 1 to 11 are implemented.