CLAIMS

What is claimed is:

1. A method for processing a lost frame, wherein the method comprises:

determining an initial high-band signal of a current lost frame, wherein the current lost frame is a frame of an audio signal;

determining a gain of the current lost frame according to a gain of a previous frame of the current lost frame;

determining gain adjustment information of the current lost frame, wherein the gain adjustment information comprises at least one of the following:

a class of a frame, a low-band signal spectral tilt of a frame and a low-band signal energy of a frame;

if the gain adjustment information meets a corresponding preset condition, adjusting the gain of the current lost frame according to the gain adjustment information with an adjustment method corresponding to the preset condition, to obtain an adjusted gain of the current lost frame; and

adjusting the initial high-band signal according to the adjusted gain, to obtain a high-band signal of the current lost frame.

2. The method according to claim 1, wherein the gain adjustment information comprises a low-band signal energy of a frame, and the adjusting the gain of the current lost frame according to the gain adjustment information, to obtain an adjusted gain of the current lost frame comprises:

obtaining an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of a previous frame of the current lost frame according to the low-band signal energy of the current lost frame; and

adjusting the gain of the current lost frame according to the energy ratio of the low-band signal energy of the current lost frame to the low-band signal energy of the previous frame of the current lost frame, to obtain the adjusted gain of the current lost frame.

3. The method according to claim 1, wherein the gain adjustment information comprises a class of a frame, a low-band signal spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the gain of the current lost frame according to the gain adjustment information, to obtain an adjusted gain of the current lost frame comprises:

when the quantity of consecutive lost frames is equal to 1, and

a class of the current lost frame is not unvoiced, the class of the current lost frame is not unvoiced transition, a low-band signal spectral tilt of a previous frame of the current lost frame is less than a first threshold, and an energy ratio of a low-band signal energy of the current lost frame

to a low-band signal energy of the previous frame of the current lost frame is within a preset interval,

obtaining an energy ratio of a high frequency excitation energy of the previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to the low-band signal energy of the current lost frame; and

adjusting the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the adjusted gain of the current lost frame.

4. The method according to claim 1, wherein the gain adjustment information comprises a class of a frame, a low-band signal spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the gain of the current lost frame according to the gain adjustment information, to obtain an adjusted gain of the current lost frame comprises:

when the quantity of consecutive lost frames is equal to 1,

a class of the current lost frame is not unvoiced, the class of the current lost frame is not unvoiced transition, a low-band signal spectral tilt of a previous frame of the current lost frame is less than a first threshold, and an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and

a low-band signal spectral tilt of the current lost frame is greater than the low-band signal spectral tilt of the previous frame of the lost frame,

adjusting the gain of the current lost frame according to a preset adjustment factor, to obtain the adjusted gain of the current lost frame.

5. The method according to claim 1, wherein the gain adjustment information comprises a class of a frame, a low-band signal spectral tilt of a frame, and a quantity of consecutive lost frames, and the adjusting the gain of the current lost frame according to the gain adjustment information, to obtain an adjusted gain of the current lost frame comprises:

when the quantity of consecutive lost frames is equal to 1, and

a class of the current lost frame is not unvoiced, a low-band signal spectral tilt of a previous frame of the current lost frame is greater than a first threshold, and an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval,

obtaining an energy ratio of a high frequency excitation energy of the previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to the low-band signal energy of the current lost frame; and

adjusting the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the adjusted gain of the current lost frame.

6. The method according to claim 1, wherein the gain adjustment information comprises a quantity of consecutive lost frames, and the adjusting the gain of the current lost frame according to the gain adjustment information, to obtain an adjusted gain of the current lost frame comprises:

obtaining an energy ratio of a high frequency excitation energy of a previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to a low-band signal energy of the current lost frame; and

when the quantity of consecutive lost frames is greater than 1 and the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame is greater than the gain of the current lost frame,

adjusting the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the adjusted gain of the current lost frame.

7. The method according to claim 1, wherein the gain adjustment information comprises a quantity of consecutive lost frames, and a low-band signal spectral tilt of a frame, and the adjusting the gain of the current lost frame according to the gain adjustment information, to obtain an adjusted gain of the current lost frame comprises:

obtaining an energy ratio of a high frequency excitation energy of a previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to a low-band signal energy of the current lost frame; and

when the quantity of consecutive lost frames is greater than 1, the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame is greater than the gain of the current lost frame, and a low-band signal spectral tilt of the current lost frame and a low-band signal spectral tilt of the previous frame of the current lost frame are both greater than a second threshold,

adjusting the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the adjusted gain of the current lost frame.

8. The method according to any one of claims 1 to 7, wherein after the determining gain adjustment information of the current lost frame, the method further comprises:

determining an initial excitation adjustment factor;

adjusting the initial excitation adjustment factor according to the gain adjustment information,

to obtain an adjusted excitation adjustment factor; and

the adjusting the initial high-band signal according to the adjusted gain, to obtain a high-band signal of the current lost frame comprises:

adjusting the initial high-band signal according to the adjusted gain and the adjusted excitation adjustment factor, to obtain the high-band signal of the current lost frame.

9. The method according to claim 8, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy of the current lost frame is greater than a high frequency excitation energy of a previous frame of the current lost frame, and

a class of the current lost frame is not unvoiced and a class of a last normally received frame before the current lost frame is not unvoiced,

adjusting the initial excitation adjustment factor according to a low-band signal energy of the previous frame of the current lost frame and a low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

10. The method according to claim 8, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of the low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of the previous frame of the current lost frame is unvoiced,

adjusting the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

11. The method according to claim 8, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy

of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of a last normally received frame before the current lost frame is unvoiced,

adjusting the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

12. The method according to claim 8, wherein the gain adjustment information comprises a low-band spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a low-band signal spectral tilt of the previous frame of the current lost frame is greater than a third threshold,

adjusting the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

13. The method according to claim 8, wherein the gain adjustment information comprises a low-band signal energy of a frame and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is greater than 1, the high frequency excitation energy of the current lost frame is greater than a high frequency excitation energy of a previous frame of the current lost frame,

adjusting the initial excitation adjustment factor according to a low-band signal energy of the previous frame of the current lost frame and a low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

14. The method according to claim 8, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is greater than 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of the previous frame of the current lost frame is unvoiced,

adjusting the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

15. The method according to claim 8, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is greater than 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of a last normally received frame before the current lost frame is unvoiced,

adjusting the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

16. The method according to claim 8, wherein the gain adjustment information comprises a low-band spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjusting the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor comprises:

when the quantity of consecutive lost frames is greater than 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a low-band signal spectral tilt of the previous frame of the current lost frame is greater than a third threshold,

adjusting the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

17. An apparatus for processing a lost frame, wherein the apparatus for processing a lost frame

comprises:

a determining module, configured to determine an initial high-band signal of a current lost frame, wherein the current lost frame is a frame of an audio signal; determine a gain of the current lost frame according to a gain of a previous frame of the current lost frame; and determine gain adjustment information of the current lost frame, wherein the gain adjustment information comprises at least one of the following: a class of a frame, a low-band signal spectral tilt of a frame, and a low-band signal energy of a frame; and

an adjustment module, configured to adjust the gain of the current lost frame according to the gain adjustment information if the gain adjustment information meets a corresponding preset condition, to obtain an adjusted gain of the current lost frame; and adjust the initial high-band signal according to the adjusted gain with an adjustment method corresponding to the preset condition, to obtain a high-band signal of the current lost frame.

18. The apparatus for processing a lost frame according to claim 17, wherein the gain adjustment information comprises a low-band signal energy of a frame, and the adjustment module is specifically configured to obtain an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of a previous frame of the current lost frame according to the low-band signal energy of the current lost frame; and adjust the gain of the current lost frame according to the energy ratio of the low-band signal energy of the current lost frame to the low-band signal energy of the previous frame of the current lost frame, to obtain the adjusted gain of the current lost frame.

19. The apparatus for processing a lost frame according to claim 17, wherein the gain adjustment information comprises a class of a frame, a low-band signal spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is equal to 1, a class of the current lost frame is not unvoiced, the class of the current lost frame is not unvoiced transition, a low-band signal spectral tilt of a previous frame of the current lost frame is less than a first threshold, and an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, obtain an energy ratio of a high frequency excitation energy of the previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to the low-band signal energy of the current lost frame; and adjust the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the adjusted gain of the current lost frame.

20. The apparatus for processing a lost frame according to claim 17, wherein the gain adjustment information comprises a class of a frame, a low-band signal spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is equal to 1, a class of the current lost frame is not unvoiced, the class of the current lost frame is not unvoiced transition, a low-band signal spectral tilt of a previous frame of the current lost frame is less than a first threshold, and an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a low-band signal spectral tilt of the current lost frame is greater than the low-band signal spectral tilt of the previous frame of the lost frame, adjust the gain of the current lost frame according to a preset adjustment factor, to obtain the adjusted gain of the current lost frame.

21. The apparatus for processing a lost frame according to claim 17, wherein the gain adjustment information comprises a class of a frame, a low-band signal spectral tilt of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is equal to 1, and a class of the current lost frame is not unvoiced, a low-band signal spectral tilt of a previous frame of the current lost frame is greater than a first threshold, and an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, obtain an energy ratio of a high frequency excitation energy of the previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to the low-band signal energy of the current lost frame; and adjust the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the adjusted gain of the current lost frame.

22. The apparatus for processing a lost frame according to claim 17, wherein the gain adjustment information comprises a quantity of consecutive lost frames, and the adjustment module is specifically configured to: obtain an energy ratio of a high frequency excitation energy of a previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to a low-band signal energy of the current lost frame; and when the quantity of consecutive lost frames is greater than 1 and the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame is greater than the gain of the current lost frame, adjust the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the

adjusted gain of the current lost frame.

23. The apparatus for processing a lost frame according to claim 17, wherein the gain adjustment information comprises a quantity of consecutive lost frames, and a low-band signal spectral tilt of a frame, and the adjustment module is specifically configured to obtain an energy ratio of a high frequency excitation energy of a previous frame of the current lost frame to a high frequency excitation energy of the current lost frame according to a low-band signal energy of the current lost frame; and when the quantity of consecutive lost frames is greater than 1, the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame is greater than the gain of the current lost frame, and a low-band signal spectral tilt of the current lost frame and a low-band signal spectral tilt of the previous frame of the current lost frame are both greater than a second threshold, adjust the gain of the current lost frame according to the energy ratio of the high frequency excitation energy of the previous frame of the current lost frame to the high frequency excitation energy of the current lost frame, to obtain the adjusted gain of the current lost frame.

24. The apparatus for processing a lost frame according to any one of claims 17 to 23, wherein the determining module is further configured to determine an initial excitation adjustment factor; and

the adjustment module is further configured to adjust the initial excitation adjustment factor according to the gain adjustment information, to obtain an adjusted excitation adjustment factor; and adjust the initial high-band signal according to the adjusted gain and the adjusted excitation adjustment factor, to obtain the high-band signal of the current lost frame.

25. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy of the current lost frame is greater than a high frequency excitation energy of a previous frame of the current lost frame, a class of the current lost frame is not unvoiced, and a class of a last normally received frame before the current lost frame is not unvoiced, adjust the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

26. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when

the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of the previous frame of the current lost frame is unvoiced, adjust the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

27. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of a last normally received frame before the current lost frame is unvoiced, adjust the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

28. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a low-band spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is equal to 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a low-band signal spectral tilt of the previous frame of the current lost frame is greater than a third threshold, adjust the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

29. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a low-band signal energy of a frame and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is greater than 1, and high frequency excitation energy of the current lost

frame is greater than a high frequency excitation energy of a previous frame of the current lost frame, adjust the initial excitation adjustment factor according to a low-band signal energy of the previous frame of the current lost frame and a low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

30. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is greater than 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of the previous frame of the current lost frame is unvoiced, adjust the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

31. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a class of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is greater than 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a class of a last normally received frame before the current lost frame is unvoiced, adjust the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.

32. The apparatus for processing a lost frame according to claim 24, wherein the gain adjustment information comprises a low-band spectral tilt of a frame, a low-band signal energy of a frame, and a quantity of consecutive lost frames, and the adjustment module is specifically configured to: when the quantity of consecutive lost frames is greater than 1, a high frequency excitation energy of the current lost frame is less than half a high frequency excitation energy of a previous frame of the current lost frame, an energy ratio of a low-band signal energy of the current lost frame to a low-band signal energy of the previous frame of the current lost frame is within a preset interval, and a low-band signal spectral tilt of the previous frame of the current lost frame is

greater than a third threshold, adjust the initial excitation adjustment factor according to the low-band signal energy of the previous frame of the current lost frame and the low-band signal energy of the current lost frame, to obtain the adjusted excitation adjustment factor.