Claims

1. An apparatus for collecting seabed resources (100), ~~the apparatus~~ comprising~~:~~

a main module (110) and

a plurality of seabed resources collecting devices (120) releasably attached to the main module (110),

wherein the main module and the plurality of collecting devices are configured to be launched from a surface vessel (10) towards a seabed;

wherein the main module includes a control module (111) which is configured to determine a mining path for each of the collecting devices (120) based on characteristics of the seabed, control each of the collecting devices (120) to collect seabed resources along the determined mining path and control transfer of the seabed resources collected by the collecting devices,

wherein each collecting device (120) is configured to be released from the main module (100) after the apparatus is launched, and configured to collect seabed resources along the mining path determined by the main module after being released.

2. The apparatus according to claim 1, wherein each of the collecting devices is provided with at least one sensor (120b) configured to collect information relating to characteristics of the seabed; and

wherein the control module of the main module is further configured to determine the mining path for each collecting device based on the information collected by the at least one sensor of the collecting devices.

3. The apparatus according to claim 2, wherein the control module of the main module is further configured to determine whether there is overlap between the mining paths for the collecting devices based on the information collected by the collecting devices, and adjust the mining path for at least one of the collecting devices if there is overlap.

4. The apparatus according to claim 3, wherein the characteristics of the seabed are selected from the group consisting of: bathymetry, geographical features of the seabed, intensity distribution and volume of seabed resources on the seabed, and soil strength of the seabed.

5. The apparatus according to any preceding claim, wherein the main module further includes a filtering module (112, 312) which is configured to at least partially remove sand particles and/or slurry from the seabed resources collected by the collecting devices.

6. The apparatus according to claim 5, wherein the filtering module (112, 312) includes

a centrifugal system (2a) and a chamber defined by a wall with mesh filters, wherein the centrifugal system is arranged to drive sand particles and/or slurry out of the chamber through the mesh filters; and/or

a perforated structure (2b) arranged to separate the seabed resources from the sand particles and/or slurry; and/or

a jet/water sprinkler system (2c) arranged to wash the sand particles and/or slurry off the seabed resources.

7. The apparatus according to claim 5 or claim 6, wherein the main module further includes a storage module (114, 314) which is configured to temporarily store the filtered seabed resources transferred from the filtering module.

8. The apparatus according to any preceding claim, wherein the main module further includes a latching system which is configured to control release of the collecting devices from the main module after the apparatus is launched; and to reattach the collecting devices to the main module before the apparatus is returned to the surface vessel.

9. The apparatus according to claim 8, wherein the latching system includes a pneumatic piston or hydraulic system.

10. The apparatus according to any preceding claim, further comprising a conveying system fluidly connected to the main module and configured to receive seabed resources from the main module and transfer the received seabed resources to the surface vessel; wherein the main module is further configured to control transfer of the seabed resources from the main module to the conveying system.

11. The apparatus according to any preceding claim, wherein the conveying system comprises a thruster assisted Vertical Transport System (VTS) (140) which is connected to the surface vessel by an umbilical for power transfer and communication therebetween and configured to be launched from the surface vessel, receive seabed resources from the main module after being fluidly connected to the main module and be lifted up to the surface vessel after being at least partially filled with seabed resources;

wherein the main module is further configured to control transfer of seabed resources from the main module to the VTS (140).

12. The apparatus according to claim 11, wherein the VTS (140) includes

a vectored thruster (140a) configured to counteract drag forces from seabed current and move the VTS along a substantially vertical path;

a container (140b) configured to store seabed resources which is to be transferred to the surface vessel; and

a connecting means (140c) configured to fluidly connect the VTS to the main module and enable transfer of seabed resources from the main module to the VTS.

13. The apparatus according to any preceding claim, wherein the main module and the plurality of collecting devices are configured to be positioned at a predetermined height above the seabed after being launched from the surface vessel.

14. The apparatus according to claim 13, further comprising a buoyancy module and frame (117) and at least one vector thruster (118) which are configured to counteract drag forces from seabed current and maintain the main module and the plurality of collecting devices at the predetermined height above the seabed.

15. The apparatus according to any preceding claim, wherein each collecting device is movably and communicably connected to the main module by a hybrid flow hose (121, 321) for power, resource and information/data transfer therebetween after being released from the main module.

16. The apparatus according to any one of claim 1 to claim 14, wherein each collecting device is configured to communicate with the main module in a wireless manner after being released from the main module and return to the main module after being at least partially filled with seabed resources;

wherein the main module is further configured to control transfer of the seabed resources from the collecting device to the main module after the at least partially filled collecting device is reattached to the main module.

17. The apparatus according to claim 10, wherein the main module and the plurality of collecting devices are configured to be positioned on the seabed after being launched from the surface vessel,

wherein the conveying system comprises a seabed sitting frame (350) and a container (380),

wherein the seabed sitting frame is configured to be launched from the surface vessel and landed on the seabed,

wherein the container is configured to be launched from the surface vessel and positioned on the seabed sitting frame where the container is fluidly connected to the main module to receive seabed resources transferred from the main module; and configured to be lifted up to the surface vessel by winches to transfer the received seabed resources to the surface vessel.

18. The apparatus according to claim 17, wherein the seabed sitting frame (350) is arranged to be launched from the surface vessel by an A-shaped frame using launching ropes and guide rails, and lowered to the seabed due to its own weight; and

wherein the container (380) is arranged to be launched from the surface vessel along a guide system formed by the seabed sitting frame and the launching ropes.

19. The apparatus according to claim 16 or claim 17, further comprising an intervention Remotely Operated Vehicle (ROV) (330) which is configured to assist with launching and landing of the seabed sitting frame on the seabed, and control the connection between the container and the main module.

20. A method for collecting seabed resources, comprising:

launching an apparatus for collecting seabed resources from a surface vessel towards a seabed (101), wherein the apparatus includes a main module and a plurality of collecting devices releasably attached to the main module;

determining, by the main module, a mining path for each of the plurality of collecting devices based on characteristics of the seabed (104);

releasing the plurality of collecting devices from the main module (102);

controlling, by the main module, each of the collecting devices to collect seabed resources along the mining path determined by the main module (105); and

controlling, by the main module, transfer of the seabed resources collected by the collecting devices (108).

21. The method according to claim 20, further comprising:

collecting, by each of the collecting devices, information relating to characteristics of the seabed and sending the collected information to the main module;

wherein the step of determining the mining path comprises: determining, by the main module, the mining path for each of the collecting devices based on the information collected by the collecting devices.

22. The method according to claim 21, further comprising:

determining, by the main module, whether there is overlap between the mining paths for the collecting devices based on the information collected by the collecting devices, and

adjusting, by the main module, the mining path for at least one of the collecting device if there is overlap.

23. The method according to claim 22, wherein the characteristics of the seabed are selected from the group consisting of bathymetry, geographical features of the seabed, intensity distribution and volume of seabed resources on the seabed, and soil strength of the seabed.

24. The method according to any one of claim 20 to claim 23, further comprising:

filtering, by a filtering module provided in the main module, the seabed resources collected by the collecting devices to at least partially remove the sand particles and/or slurry from the seabed resources.

25. The method according to claim 24, wherein the filtering module includes a centrifugal system and a chamber defined by a wall with mesh filters and/or a perforated structure and/or a jet/water sprinkler system,

wherein the step of filtering the seabed resources comprises:

driving the sand particles and/or slurry out of the chamber through the mesh filters; and/or

separating, by the perforated structure, the seabed resources from the sand particles and/or slurry; and/or

washing by the jet/water sprinkler system, the sand particles and/or slurry off the seabed resources.

26. The method according to claim 24 or claim 25, further comprising:

temporarily storing the filtered seabed resources in a storage module provided in the main module.

27. The method according to any one of claim 20 to claim 26, wherein the step of releasing the collecting devices from the main module comprises:

controlling a latching system to release the collecting devices from the main module after launching the apparatus;

and the method further comprising:

controlling the latching system to reattach the collecting devices to the main module before the apparatus is returned back to the surface vessel.

28. The method according to claim 27, wherein the latching system includes a pneumatic piston or hydraulic system.

29. The method according to any one of claim 20 to claim 28, further comprising:

transferring, by a conveying system, the seabed resources from the main module to the surface vessel.

30. The method according to claim 29, wherein the conveying system includes a thruster assisted Vertical Transport System (VTS), and the method further comprises:

launching the thruster assisted Vertical Transport System (VTS) from the surface vessel to a predetermined location above the seabed;

connecting the VTS to the main module to enable transfer of the seabed resources from the main module to the VTS;

transferring the seabed resources from the main module to the VTS;

disconnecting the VTS from the main module after the VTS is at least partially filled with seabed resources; and

lifting up the at least partially filled VTS to the surface vessel.

31. The method according to any ~~preceding~~ one of claim 20 to claim 30, wherein the step of launching the apparatus from the surface vessel towards the seabed comprises:

lowering the main module and the plurality of collecting devices from the surface vessel and positioning the main module and the plurality of collecting devices at a predetermined height above the seabed.

32. The method according to claim 31, further comprising:

providing at least one vector thruster connected to the main module; and

using the at least vector thruster to counteract drag forces from seabed current to ensure the apparatus moves along a substantially vertical path and maintain the apparatus at the predetermined height above the seabed.

33. The method according to any one of claim 20 to claim 32, wherein each collecting device is movably and communicably connected to the main module by a hybrid flow hose for power, resource and information/data transfer therebetween.

34. The method according to any one of claim 20 to claim 32, wherein after releasing the collecting devices from the main module, the method further comprises:

transferring information/data between the main module and each of the collecting devices in a wireless manner;

reattaching, a collecting device, to the main module after the collecting device is at least partially filled with seabed resources and returns to the main module; and

transferring the collected seabed resources from a collecting device to the main module after the collecting device is reattached to the main module.

35. The method according to claim 29, wherein the conveying system includes a seabed sitting frame and a container, the method further comprising:

launching the seabed sitting frame from the surface vessel and landing the seabed sitting frame on the seabed;

launching the container from the surface vessel and positioning the container on the seabed sitting frame;

fluidly connecting the main module to the container to enable transfer of seabed resources from the main module to the container;

disconnecting the connection between the main module and the container after the container is at least partially filled with seabed resources; and

lifting up the at least partially filled container to the surface vessel by winches.

36. The method according to claim 35, wherein the step of launching the seabed sitting frame comprises: launching the seabed sitting frame from the surface vessel by an A-shaped frame using launching ropes and guide rails and lowering the seabed sitting frame due to its own weight;

wherein the step of launching the container comprises: launching the container from the surface vessel along a guide system formed by the seabed sitting frame and the launching ropes.

37. The method according to claim 35 or claim 36, wherein the conveying system further comprises an intervention ROV, wherein the method further comprises:

using the intervention ROV to assist with launching and landing of the seabed sitting frame on the seabed; and

using the intervention ROV to control the connection between the main module and the container.

38. The method according to claim 37, wherein the step of using the intervention ROV to control the connection between the main module and the container comprises:

enabling, by the ROV, the connection between the container and the main module before transferring seabed resources from the main module to the container; and

disabling, by the ROV, the connection between the container and the main module after the container is at least partially filled with the seabed resources.