•Motivation: (Ⅰ)

Most ships in the world today need to anchor off the coast for operations and replenishment (including refueling, equipment replacement, and supplies). This will cause two serious problems: 1. Many of them are easy to run aground when landing, which will cause damage to ship/dock facilities and bring huge economic losses; 2. During this period, in order to maintain the needs of production and life, the ship at anchor needs to start the auxiliary generators on board to generate electricity to provide necessary power, which will result in a large amount of harmful substances emissions. According to statistics, the carbon emission generated by the auxiliary generators during the berthing period of ships accounts for 40% to 70% of the total carbon emission in the port, which is an important factor affecting the air quality of the port and the city where it is located. Therefore, I want to design a ship-borne robotic arm, which can transport the oil pipeline to a position near the coast, and then use the robotic arm to dock automatically to supply energy to the ship, so as to solve the above problems.

当今世界上，绝大部分船只需要在海岸边停泊作业与补充物资（包括燃料补给、设备更换与生活用品）。这样子会造成两个比较严重的问题：1. 许多穿在靠岸时容易搁浅，造成船/码头设施的损坏，带来巨大的经济损失；2. 在此期间，为了维持生产生活需要，停泊的船就需要开动船上的辅助发电机发电以提供必要的动力，由此会产生大量的有害物质排放。根据统计，船舶靠港停泊期间由其辅助发电机所产生的碳排量占港口总排碳量的40%至70%，是影响港口及所在城市空气质量的重要因素。因此，我想设计一个船载机械臂，可以将输油管输送到近海岸的位置，然后用机械臂自动对接，为船只补给能源，解决以上问题。

把文章列出来；OK

•Refine the Research Question: (Ⅱ)

Q1: Is my motivation reasonable?

A1: -❗调研收集Motivation相关的文献！！！ (OK√) For details, see the 111\_Ⅰ~

Q2: Which type of manipulator should I choose: Linear manipulator（线性）? Rope-driven manipulator（绳驱）? Tendon-driven manipulator（肌腱）? Serial manipulator（串联式）?

A2:

|  |  |
| --- | --- |
|  | Characteristic |
| Linear Manipulator | A linear manipulator consists of a linear motion mechanism that moves along a single axis. It provides straight-line motion and is often used in applications where precise linear movement is required. However, it may not be the most suitable choice for a ship-borne robotic arm as it may not offer the required flexibility and range of motion for docking with ships of different sizes and configurations.  线性机械臂由沿单轴运动的直线运动机构组成。它提供直线运动，通常用于需要精确直线运动的应用中。然而，对于舰载机械臂来说，它可能不是最合适的选择，因为它可能无法提供与不同大小和配置的船舶对接所需的灵活性和运动范围。 |
| Rope-Driven Manipulator | Rope-driven manipulators, also known as cable-driven manipulators, use cables or ropes to transmit forces and control the movement of the arm. They are known for their lightweight design and flexibility. Rope-driven manipulators can offer greater reach and dexterity compared to linear manipulators, making them potentially suitable for a ship-borne robotic arm. They can accommodate complex movements and reach various points of the ship for docking.  绳驱动式机械手，又称缆绳驱动式机械手，利用缆绳或绳索传递力，控制手臂的运动。它们以轻巧的设计和灵活性而闻名。与线性机械臂相比，绳驱动的机械臂可以提供更大的范围和灵活性，使其潜在地适用于舰载机械臂。它们可以适应复杂的运动，并到达船舶的各个点进行停靠。 |
| Tendon-Driven Manipulator | Tendon-driven manipulators use flexible cables or tendons to control the movement of the arm. They offer similar advantages as rope-driven manipulators in terms of lightweight design and flexibility. Tendon-driven manipulators can provide improved dexterity and range of motion, enabling better adaptability to the ship's structure and various docking scenarios.  肌腱驱动的机械手使用柔性电缆或肌腱来控制手臂的运动。它们在轻量化设计和灵活性方面具有与绳驱动机械手相似的优势。肌腱驱动的机械手可以提供更好的灵活性和运动范围，使其能够更好地适应船舶结构和各种对接场景。 |
| Serial Manipulator | Serial manipulators, also known as articulated manipulators, consist of a series of connected links and joints. They are widely used in robotic applications and offer excellent versatility and maneuverability. Serial manipulators can provide multiple degrees of freedom, allowing them to reach different positions and orientations. They are commonly used in industrial settings, but they can also be adapted for specific maritime applications, including ship docking.  串联机械手，也称为铰接机械手，由一系列连接的连杆和关节组成。它们广泛用于机器人应用，并提供出色的多功能性和可操作性。串行机械手可以提供多个自由度，使它们能够达到不同的位置和方向。它们通常用于工业环境，但它们也可以适用于特定的海事应用，包括船舶停靠。 |

•Considering the need for flexibility, reach, and adaptability in a ship-borne robotic arm, both rope-driven manipulators and tendon-driven manipulators are worth considering. These manipulator types can offer the necessary dexterity and range of motion to navigate the ship's structure and perform docking operations effectively. Serial manipulators can also be suitable if they are designed to accommodate the specific requirements of ship docking.

考虑到船载机械臂对灵活性、可及性和适应性的需求，绳驱动机械臂和肌腱驱动机械臂都值得考虑。这些机械臂类型可以提供必要的灵活性和运动范围，以导航船舶结构并有效地执行对接操作。如果设计适应船舶对接的特殊要求，也可以采用串行机械手。

•Review existing literature & Learning by modifying exiting models: (Ⅲ)

for details, see the document ‘Ship-borne Manipulator database.xlsx’.

Tip:•❗不仅要看论文，还要看开源网站，模仿现有机械臂；

•Design: (Ⅳ)

Designing a ship-borne robotic arm/manipulator to transport an oil pipeline and automatically dock to supply energy to ships near the coast is an interesting concept that could potentially address the problems you mentioned. Such a system could help reduce the risk of ships running aground during the landing process and minimize the emissions caused by auxiliary generators. While I can provide you with a general outline of how such a system might work, please note that specific engineering details would require further analysis and expertise.

设计一种舰载机械臂/操纵器来运输石油管道，并自动停靠为海岸附近的船只提供能源，这是一个有趣的概念，可能会解决你提到的问题。这样一个系统可以帮助减少船舶在着陆过程中搁浅的风险，并最大限度地减少辅助发电机造成的排放。虽然我可以为您提供这样一个系统如何工作的一般大纲，但请注意，具体的工程细节将需要进一步的分析和专业知识。

--Robotic Arm Design:

-The robotic arm should be designed to have sufficient reach and flexibility to handle the oil pipeline and dock with the ship securely.

-机械臂的设计应具有足够的可及性和灵活性，以处理石油管道并安全地与船舶对接。

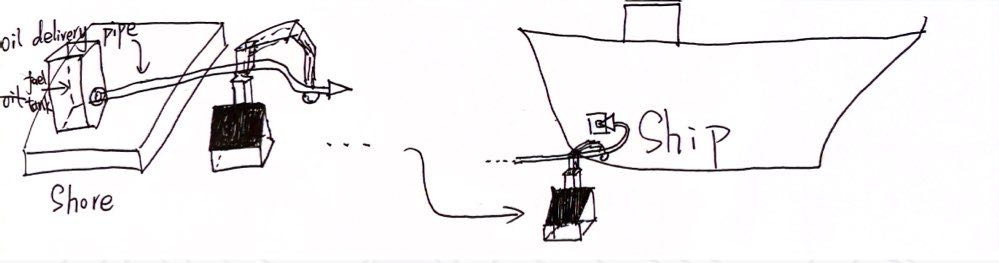
-It should be equipped with sensors and cameras to ensure accurate positioning and alignment during the docking process.

-应配备传感器和摄像头，以确保对接过程中准确定位和对准。

-The arm should be robust, capable of withstanding challenging weather conditions and sea movements.

-臂应该是坚固的，能够承受恶劣的天气条件和海上运动。

-Sketch diagram for all procedure:



-Sketch diagram:

Tips:

•❗只考虑运动控制，其他能量传输可以不用考虑；

•用Mahincapture模拟软件，不需要传感器；

•能量传递也不需要，有输电线揽；

•小磁铁，模型船；

•简化模型，装在现有的船上； (后面一些部分不用考虑！)

--Oil Pipeline Transportation System:

-Develop a specialized mechanism, such as a conveyor belt or a series of rollers, to transport the oil pipeline from a storage area on the ship to the robotic arm.

-开发一种专门的机构，如传送带或一系列滚筒，将石油管道从船上的储存区输送到机械臂上。

-Implement an automated system to control the pipeline's movement, ensuring its safe and smooth transfer.

-实施自动化系统来控制管道的移动，确保其安全顺利地转移。

--Docking and Energy Supply Process:

-Develop an interface on the ship's side where the robotic arm can securely connect to receive energy.

-在船的一侧开发一个接口，机器人手臂可以安全地连接以接收能量。

-Implement an automated docking mechanism that allows the robotic arm to align with the ship's interface accurately.

-实现自动对接机制，使机械臂能够准确地与舰船界面对齐。

-Design a secure coupling mechanism to establish a connection between the ship and the robotic arm for energy transfer.

-设计安全耦合机构，建立舰船与机械臂之间的连接，实现能量传递。

-Implement a power transfer system that can efficiently supply electricity to the ship from the onshore power source through the robotic arm and the oil pipeline.

-实现电力传输系统，可以通过机械臂和输油管道从陆上电源高效地为船舶供电。

--Safety and Monitoring:

-Incorporate safety measures to detect and prevent any hazards during the docking process, such as collision sensors and emergency shutdown mechanisms.

-纳入安全措施，以侦测和防止对接过程中的任何危险，例如碰撞传感器和紧急关闭机制。

-Install monitoring systems, including cameras and sensors, to ensure proper alignment and prevent accidents or damage to the ship, the robotic arm, and the oil pipeline.

-安装监控系统，包括摄像头和传感器，以确保正确对准，防止事故或损坏船舶、机械臂和输油管道。

--Automation and Control:

-Develop an intelligent control system to automate the entire docking and energy supply process, minimizing the need for human intervention.

-开发智能控制系统，实现整个对接和供能过程自动化，最大限度减少人为干预。

-Implement algorithms and software to handle the precise movements and alignment required during the docking process.

-实现算法和软件，以处理对接过程中所需的精确运动和对齐。

--Integration and Compatibility:

-Ensure the design and specifications of the robotic arm and the ship's interface are compatible with different types of ships and energy systems.

-确保机械臂和船舶接口的设计和规格与不同类型的船舶和能源系统兼容。

-Consider the variations in ship sizes, shapes, and energy requirements when designing the system.

-在设计系统时考虑船舶尺寸、形状和能源需求的变化。

-Tips: It is important to note that implementing such a system would require a collaborative effort involving ship manufacturers, port authorities, energy providers, and robotics experts. Additionally, extensive testing and validation would be necessary to ensure the system's reliability, safety, and efficiency.

提示:需要注意的是，实施这样一个系统需要船舶制造商、港口当局、能源供应商和机器人专家的共同努力。此外，为了确保系统的可靠性、安全性和效率，广泛的测试和验证是必要的。

•Develop a research plan: (Ⅴ)

Q

•Collect data: (Ⅵ)

Q

•Analyze data: (Ⅶ)

Q

•Interpret and evaluate findings:(Ⅸ)

Q

•Draw conclusions: (Ⅹ)

Q

•Generate the paper: (X1)

Q