Report

The application study of robot dog (quadruped robot) in the transport of critically ill patients

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ABSTRACT

The application of robot dog (quadruped robot) in the transport of critically ill patients is an interdisciplinary field that combines robotic technology, medical needs and emergency scenarios. The following is an analysis of the application scenarios, technical challenges, potential advantages, research status and future direction.

PREFACE

With the increasing aging of the global population and the frequent occurrence of public emergencies, the rapid and safe transport of critically ill patients has become a major challenge facing the modern medical system. In emergency medicine, the concept of "prime time" is particularly important, and any delay or improper operation in the transport process may directly threaten the patient's life and even lead to irreversible secondary injury. Traditional transport methods rely on manual operation or simple mechanical tools (such as stretchers, carts, etc.), due to human fatigue, environmental complexity and insufficient equipment flexibility, it is difficult to achieve efficient rescue in narrow space, post-disaster ruins or extreme terrain. In recent years, breakthroughs in UAV, intelligent robots and other technologies have provided new ideas for medical emergency, but its application in the field of critical illness transport still has limitations such as functional fragmentation and insufficient human-machine collaboration [1,2].

This paper focuses on the technological innovation and application potential of robot dogs in the transport of critically ill patients, systematically analyzes their design principles, key technical bottlenecks and clinical adaptation paths, aiming to provide theoretical reference and practical inspiration for the development of intelligent first aid equipment, and promote the deep integration of robot technology and emergency medical rescue [3].

1. APPLICATION SCENARIO

1.1 Short-distance in-hospital transport

Between the emergency department, the operating room and the ICU, robotic dogs can assist medical staff in the rapid and stable transport of critically ill patients, especially in narrow corridors or crowded environments.

1.2 Disaster or dangerous environment

In dangerous scenarios such as earthquakes, fires, and nuclear radiation, robotic dogs can enter areas that are difficult for humans to reach, perform initial patient positioning, emergency drug / equipment transportation, and even assist in stretcher handling.

1.3 Remote or remote areas

In areas with scarce medical resources, robotic dogs can be used as temporary transport tools, equipped with life support devices (such as portable ventilators), in conjunction with drones or autonomous vehicles.

2. TECHNICAL CHALLENGES

2.1 Mechanical design and load capacity

The transport of critically ill patients requires stable load-bearing (stretcher + patient + equipment, usually 100kg), which puts forward extremely high requirements for the structural strength, joint driving ability and balance control algorithm of the quadrupedal robot [4,5].

2.2 Dynamic environmental adaptability

Complex terrain (such as rubble, stairs) and dynamic obstacles (e. g., crowds) require real-time path planning, multi-modal movement (walking / climbing), and anti-interference ability.

2.3 Medical equipment integration and security

The vital sign monitor, infusion pump and other equipment should be seamlessly integrated to ensure the stable power supply and real-time data transmission of the equipment during the transfer process, and to avoid the secondary injury caused by vibration to patients.

2.4 Human-computer interaction and ethical compliance

Need should design intuitive operation interface (such as remote control or voice command) and solve problems such as patient psychological acceptance, medical responsibility division and privacy protection.

3. POTENTIAL ADVANTAGES

3.1 Flexibility and scene coverage

Compared to wheeled or tracked robots, quadruped robots are more mobile in complex terrain and are suitable for unstructured environments [6,7].

3.2 Reduce the risk of healthcare workers

Reduce direct contact and reduce the risk of infection or injury in infectious areas or dangerous environments.

3.3 Efficiency improvement

Through automated navigation and collaborative scheduling, shorten the transit time and optimize the first aid process.

4. STUDY THE STATUS QUO AND CASES

4.1 Technical Progress

Boston Power Spot: It has been trialled for industrial inspection, and its load capacity (14kg) and dynamic balancing technology provide reference for medical applications, but require further reinforcement.

ANYmal (ETH Zurich): Capability to walk in complex terrain, the research team is exploring its application in rescue missions.

Medical robot research: For example, Panasonic's HOSPI series (logistics robot) has been used for the transportation of hospital supplies, but it is not yet involved for patient transport.

4.2 Experimental applications

During the COVID-19 period in 2020, some hospitals tried to transport drugs with wheeled robots, but the quadruped robots were still in the laboratory verification stage in the field of transport for critically ill patients [8,9].

5. FUTURE RESEARCH DIRECTION

5.1 Development of a high-load quadruped platform

Optimize drive systems (e. g., hydraulic joints), lightweight materials (carbon fiber / titanium alloy), and energy management (high-density battery or hybrid).

5.2 Intelligent collaboration system

Develop multi-robot cooperative handling strategies (such as multiple robotic dogs joint transport stretchers), and combine 5G / edge computing to achieve low latdelay remote control.

5.3 Medical-grade safety certification

Ensure system reliability by ISO 13485 and other medical equipment standards; study damping stretcher, emergency braking mechanism and fault redundancy design.

5.4 Clinical validation and ethical framework

Conduct simulated clinical trials to assess transport efficiency and patient safety; develop ethical guidelines and liability regulations for robotic medical applications.

6. CONCLUSION

Robots show their potential in the transport of critically ill patients, but their landing needs to break through

bottlenecks such as load, environmental adaptability and medical compliance. In this context, robotic dogs (Legged Robots) with high mobility, strong environmental adaptability and intelligent decision-making ability have gradually entered the research field [10,11]. Compared with wheeled or tracked devices, robot dogs can cross complex obstacles such as stairs and rubble with bionic gait and multi-freedom joints, combined with multi-sensor fusion and AI algorithm, and can realize autonomous navigation, real-time vital signs monitoring and smooth load control. Its application is not only expected to solve the contradiction between efficiency and safety in traditional transport, but also to reduce the burden of medical staff through remote operation and automatic process, so as to obtain critical treatment time for critically ill patients. However, how to realize the precise control, human-computer interaction reliability and ethical compliance of robot dogs in dynamic medical scenarios still needs interdisciplinary collaboration and clinical verification.

Future research should focus on "technology-medical-society" collaborative innovation to drive translation from laboratory to clinic through interdisciplinary collaboration.

7. REFERENCES

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