Technology Status and Development Trend of Modular Moving System

Youshan Hou*, Yong Yang and Zhongtian Xie
China north vehicle research institute Beijing 100072, China
*Corresponding author email: houyoushan2008@126.com

Abstract. With the development of technology, modular independent suspension technology has been widely applied on high-movement off-road platforms in the developed world because of the characteristics of offline assembly and full-body lifting. At the same time, after the breakthrough of key techniques such as the stiffness spiral springs, the high dissipation of the shock absorbers, the lightweight of double-wishbone steering mechanism and the non-maintenance bearing, the ability to carry the off-road mobility and armor protection of the military vehicles have been significantly increased. In this case, the application of the modular independent suspension and its current state around the world was explained, that the development of this technology is of great significance to the off-road maneuvering of our military equipment was also represented in this paper.

1. Introduction
High mobility platform operation system is the "legs and feet" of the platform, the quality of moving system directly affects the mobility of the platform, the rapid development of high manned/unmanned movement platform technology requires high performance system to support the movement, movement system modular design is feasible to improve the performance of platform high mobility. At present, the movement system components of wheeled or tracked high movement platforms are scattered and cannot be integrated by themselves. The layout and installation of movement components should be attached to the vehicle body, and the quality of the movement system should be judged based on the vehicle body. There is no exclusive performance evaluation index for the movement system. Modular movement system is easy to realize the integrated design of movement system, and plays an important role in realizing the lightweight design of movement system and improving the reliability of equipment. At present, there have been visible applications of modular movement system in foreign high mobility platforms, but there is no visible application of modular movement system in the field of heavy duty platform in China. The gap between domestic and foreign technologies is quite obvious, so it is necessary to promote the modular design of high mobility platform movement system as soon as possible[1-6].

2. Development Status of Modular Moving System At Home and Abroad
2.1. The Development Status of Modularized Moving System Abroad
At present, the modular movement system has been applied in foreign countries. In the wheeled platform field, the most representative ones are the integrated modular double winearm independent suspension, which are mainly the products of AxleTech, Oshkosh, Timoney; In the field of tracked platforms, the most representative ones are heavy-duty platforms such as the German "Pumas" fighting vehicle and the Swedish "BV206" armored vehicle, and light and small platforms such as the
Themis from Estonia Milrem.

AxleTech has become the world’s leading manufacturer of modular double-wishbone independent suspension in wheeled vehicle field. The 2000, 3000, 4000, 5000 series modular independent suspension of the company is the world’s leading suspension put into production at the beginning of this century. Figure 1 shows the electric independent suspension axle provided by AxleTech for "Scorpion II" electric armored vehicle.

Figure 1. AxleTech electric independent suspension axle

Oshkosh is a major supplier of tactical vehicles to the U.S. army. The TAK-4 modular independent suspension, with a 406mm travel range, is highly versatile and is currently installed in several types of military equipment. Timmoney is a leading design supplier of independent suspension for military and commercial heavy lift vehicles. The company’s modular independent suspension is currently used in the US Air Force 8x8 High Mobility Airfield Rescue Truck, the UK Defense Research Agency's 6x6 High Mobility Vehicle (HMLC).

Figure 2. Oshkosh TAK-4 modular suspension
In the field of heavy-duty tracked vehicles, German "Puma" unmanned fighting vehicle and Swedish "BV206" armored vehicle series are typical representatives.

In the field of light and small vehicles, Estonia's MILREM's THEMIS tracked modular platform is a highly modular, universal platform that allows different upper mission loads to be mounted on intermediate platforms to perform different battlefield missions. THEMIS tracked modular platform biggest feature is that two identical crawler walking assembly, crawler walking assembly internal integration have not only the regular movement part, also the integrated design of hybrid diesel engine, battery, motor and related electronic control parts, such as crawler walking walking assembly is a highly modular units. It can also be seen as a self-driven walking robot, which realizes the high-density integrated design with high technical content and is easy to realize the interchangeability, versatility and combination of the vehicle platform.
A small unmanned tank from BAE Systems, codenamed 'Ironclad'. Ironclad is modular and can be combined to carry different payloads in a short period of time, depending on the mission. Ironclad will be used for a variety of missions, including vigilance, reconnaissance, attack, and transportation, providing support on both sides of the attack and defense.

2.2. Domestic Development Status of Modular Moving System
At present, modular double-wishbone independent suspension is also being promoted and applied in wheeled vehicles in China, and there are also successful application cases in the field of light and small tracked platforms. Figure 6 shows a civil explosion-proof vehicle platform for firefighting, in which the modular tracked movement system is applied. Figure 8 shows the integrated modular vehicle axle developed by Shandong Pengxiang
3. Application Trend of Modular Mobile System Technology

3.1. The Modular Movement System Reduces the Complex Interface with the Vehicle Hull
After the modular design of the movement system, it becomes an integral whole. The interface connecting the movement system assembly and the car body will be simplified and unified, and there is no need to install and fix the parts on the car body one by one, which greatly reduces the number of connecting interfaces between the movement system and the car body and reduces the workload of coordination.

3.2. Convenient for the Movement System to Become an Independent Body and Form Its Own Exclusive Indicators
The stand or fall of for many years, the operation performance of the system has not been unified independent evaluation index, movement the merits of the system performance is generally based on the vehicle to judge, concrete is through the vehicle off-road riding comfort, cross-country speed and operating stability to judge operation system such as performance, movement system development greatly attached to the vehicle test together. After the modular design of the mobile system, the mobile system assembly becomes an integral whole and is separated from the subsidiary relationship with the vehicle body. The mobile system related tests can be carried out independently, and the performance of the mobile system can be fully verified and understood before the final assembly, which is conducive to the formation of exclusive technical indicators of the mobile system.
3.3. Helps with Fast Delivery and Super Maneuverability on the Battlefield

After the modular design of the movement system, the movement system and the vehicle body are connected through several unified interfaces to realize rapid disassembly and assembly. During the implementation of air delivery, the movement system can be separated from the vehicle body first, thus avoiding the overall size of the vehicle, which is helpful to improve the efficiency of air transportation and complete a variety of battlefield tasks.

3.4. Helpful to Improve Equipment Reliability, Maintainability and Support, and Enhance the Battlefield Survivability of the Platform

In the traditional unmanned platform with caterpillar, once the caterpillar is destroyed, the whole platform will lose the ability to move and be in a passive situation in the battlefield. This is mainly because it is difficult and almost impossible to replace the caterpillar on the battlefield. But the modular action system is an independent unit module, once the track failure, the whole action system unit module can be quickly replaced, quickly restore the combat effectiveness of the platform.

3.5. Helpful to Improve the "Three" Level of the Ground Unmanned Platform and Realize the Homification of the Unmanned Platform Vehicle Reference

The modular action system can quickly form a track platform with the vehicle body. In order to meet the different operational needs of the battlefield, different mission modules are only needed to be mounted on the common tracked platform, which can be used as a combat platform to reconstruct and assemble the vehicles that cannot be damaged in the battlefield and replace the damaged parts so as to restore a certain combat power. Especially in today's urban warfare environment, the battle loss rate of armor equipment is high, and reconfigurable reduces the battle loss and combat effectiveness to a large extent. In short, the modular action system technology greatly improves the "three" level of the ground unmanned platform, and makes the ground unmanned platform have the characteristics of vehicle family.

3.6. Quickly Combined to Greatly Improve the All-Region High Mobility and High Passability of the Ground Unmanned Platform

How to improve the whole regional high ground unmanned platform battlefield maneuver, high capacity has always been a hot research topic at home and abroad, the ground without stage successively appeared round the shoe range change, wheel track wheel shoe composite, deformation and so on various travel mechanism, a lot of walking agencies also did raise the platform of high mobility, high capacity, but in the trenches, vertical wall and other technical indicators are still insufficient. According to the investigation, articulated vehicles such as Swedish BV206 ATVs, Russian DT-30 ATVs, Swedish Oudes XX20 Articulated Tanks and civil articulated dump trucks all adopt articulated connection mechanisms, and the chief officer improves the cross-country high passability and high mobility of the vehicle platform. This modular action system technology can be used for reference to adopt articulated or rigid connection mode to realize modular assembly of crawler platform and further improve the platform's regional mobility index.

4. References

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