

Manipulator Arm for Robot SCORPIO

Ondrej Juruš^{1,*}, Marek Sukop¹, Michal Špak¹, Miroslav Štofa²

¹Department of robotics, Technical university of Kosice, Kosice, Slovakia

²Department of manufacturing technology, Technical university of Kosice, Kosice, Slovakia

*Corresponding author: ondrej.jurus@tuke.sk

Abstract Availability of service robots designated to disposal of improvised explosive devices are a new trend in recent years, robots with manipulating arm. Company ZTS VVU a.s. Košice decided to upgrade their mobil robot Scorpio and equip it manipulating arm. On the market for service robots designated for the disposal of improvised explosive devices are a new trend in recent years, robots manipulating arm. The company ZTS VVU a.s. Košice decided to upgrade your teleoperator robot Scorpio and equip him manipulating arm. The prospecting market supply and detailed considering were selected and provided overall basic parameters. The basic parameters required handling robot trucks are moving speed, load capacity and reach into the vehicle through a window in the door of the vehicle.

Keywords: mobil servis robot, pyrotechnical robot, manipulating arm

Cite This Article: Ondrej Juruš, Marek Sukop, Michal Špak, and Miroslav Štofa, "Manipulator Arm for Robot SCORPIO." *American Journal of Mechanical Engineering*, vol. 4, no. 7 (2016): 349-352. doi: 10.12691/ajme-4-7-20.

1. Introduction

Analysis of the market and selected considering the detailed and comprehensive set basic parameters. Based on the required parameters of the robot handling trucks are moving at a speed 5 ms⁻¹, load capacity 5 kg and reach into the vehicle through a window in the door of the vehicle. To address this structural problem have been proposed many variants. There are four final designs of which is selected and elaborated by the best option as the company ZTS VVU Košice. After preliminary calculations, the draft was elaborated in greater depth. Using calculations were determined parameters of individual parts. While maintaining the company's design were selected engine and transmission in order to achieve the desired appearance of the shoulders. Visualization overall solution is given at the end of the work and its design is in the colors of the company.

2. Servis Robot

There is another group of robots. It is defined as "service robots understand autonomous or integrated computer-controlled system capable of goal-oriented interaction the real environment following the instructions from the man." From the theorem shows that it is a robot, which purpose is to serve. It is in human nature to let them operate and adapt your surroundings. It is They had to adapt and service robots. Service robots slowly penetrate into daily life man. Variations of these types of robots are limited only by the imagination and technical capabilities time. It is the wealth of a share may be under different parameters. They are divided into:

A) according to the environment in which they work:

- to work in the interior
- the exterior work
- to work in a mixed environment

B) according to the principle of motion:

- wheels
- tracks
- wheel-track
- walking
- flying.

Even these divisions have other subgroups. A number of other parameters that affect cutting service robots such as the power, capacity, throughput, performed operations on which is dedicated robot.

3. Pyrotechnic Service Robot

This is a special service oriented robots. Their role is to help security components such as the army and police for the destruction and disposal of improvised explosive devices. The role of these robots is to keep the members of such components outside of the danger zone thereby saving lives.

For the vast imagination of the people responsible for the planted explosive devices are used different design. The main objective of such construction work is to combine the speed of motion, size the operating space, accuracy and Ground clearance operations carried out.

By determining the robot depends on its structure. For exploration robots designed to control and search suspected places are chosen as small size and very good Ground clearance. For robots designed to remove booby traps, the use of stronger construction of more resistant materials.



Figure 1. Little pyrotechnic robot iRobot

4. Robot SCORPIO

Scorpio is a remotely controlled tracked robot field of small dimensions equipped with a water cannon or manipulating arm. It consists of a tracked vehicle, control panel / CASE and optional equipment. The robot is designed to:

- Destruction of improvised explosive devices
- pyrotechnical and chemical reconnaissance
- visual inspection of hazardous areas.

The advantages of the robot SCORPIO include:

- Height of only 130 mm - can be used under all types of cars - integrated water cannon also up to 130 mm. - explosives can be detected and disposed of in the same device.

Scorpio is a mobile operator with low body side profiles. Taking into account the shape of the base robot, which is similar to the shape of the letter "U". For this shape is not properly shoot sideways. For relatively narrow width of the robot is a robot swivel sideways risk. Threatens to overturn the robot. For that the arm rotation around the vertical axis robot provided by belts.

5. Pyrotechnic Service Robot

One of the main requirements of the load arm 5 kg. In the category of small robots, in which Nearest Scout robot with the same payload and have comparable effects shoulders. Another an essential requirement was to achieve the speed of movement of arm a minimum speed of 0.5 ms^{-1} , with an acceleration $0,35 \text{ ms}^{-2}$.



Figure 2. Robot SCORPIO

The dimensions of arm was set only one parameter and it reaches into the vehicle through a car door window. After prolonged comparison of available vehicles on the market, and the comparison was determined height arm to which it is necessary to reach a value of 1.10 meters from the ground.

The last and the most relevant parameters superstructure robot design prize. The robot must consist of readily available parts with a minimum of special components manufactured to order. While achieving all the mentioned parameters with the lowest number of articles shoulders. Reduce the weight of the body to the minimum value so that the structure or undersized. Since this is a pyrotechnic robot, all components used in action superstructure work to be the most reliable and the entire plant must be susceptible to disorders.

Table 1. Competitive solutions pyrotechnical robots

ROBOT	Parameters
 <p>PIAP Scout</p>	<ul style="list-style-type: none"> - Dimensions: 670x540x570 (length x width x height) - Total weight: 27.5 kg - Speed: 7 km / h - Max. The weight of the object: 5 kg - Max. outreach arm: 1.17 m - Degrees of freedom: 2 - Number of cameras: 4 - Battery life: 2 hours - Style Chassis wheel – track
 <p>PIAP Grief</p>	<ul style="list-style-type: none"> - Dimensions: 864x572x427 (length x width x height) - Total weight: 52 kg - Speed: 8.37 km / h - Max. The weight of the object: 9lbs - Max. outreach arm: 1.029 m - Number of cameras: 5 - Battery life: 3 hours - Style chassis Crawler
 <p>Telmax Explosive Ordnance</p>	<ul style="list-style-type: none"> - Dimensions: 800x400x750 (length x width x height) - Total weight: 52 kg - Speed: 4 km / h - Max. the manipulated object weight: 3-20 kg - Max. outreach arm: 1.955 m - Number of cameras: according to customer - Battery life: 2-4 hours - Style chassis Crawler
 <p>Talon Brochure</p>	<ul style="list-style-type: none"> - Dimensions: 864x572x427 (length x width x height) - Total weight: 52 kg - Speed: 8.37 km / h - Max. The weight of the object: 9lbs - Max. outreach arm: 1.029 m - Number of cameras: 5 - Battery life: 3 hours - Style chassis Crawler

6. Competitive Robots

Over the last few years, the market appeared a large number of new pyrotechnical robots equipped manipulating arm. By robots with legs made of tubular profiles of small after an average of robots with big shoulders. Most of the robots are designed to handle with booby traps. Each manufacturer chooses its own parameters that are trying to promote. Major competitors in this market is PIAP company that offers several versions of robots that cover a wide spectrum of the market. Table 1 shows the most similar to our two robots the robot and parameters that we set.

7. Preliminary Conceptual Solutions Action Superstructure

Simple design with three rotating pairs. This structure is easy to management. With fewer powertrain weight is applied to the smallest robot against all other designs. Removal of the third arm members reduced torque acting on the first engine. It narrowing the robustness of the drive consumption. As the mass of the arm shrinking the end of the robot requires a stable and strong parts such variations 3. While the variant provides many advantages, including its disadvantages include less maneuverability.

8. Calculation Arm

Clubs forces are at the center of the body. From this base, we start in the calculation. In view of the ideal state, the center of gravity is in the center of arm, whereas the individual Articles I chose a circular profile. The preliminary result I felt the weight of individual cells arm of the same weight as the desired mass of the manipulated object. Weight of effector assume 0.5 kg.

9. Design issues

Calculated values were applied to the selected design arm. Taking into account all possible impacts. The overall design of the robot, we slightly over provision, so that He is safe and reliable to fulfill its functions. They will be based on designs of the entire entry. It is ideologically simple but its implementation requires a creative approach. It is therefore necessary to define the what principle will be the nodes (joints of the robot) to work.

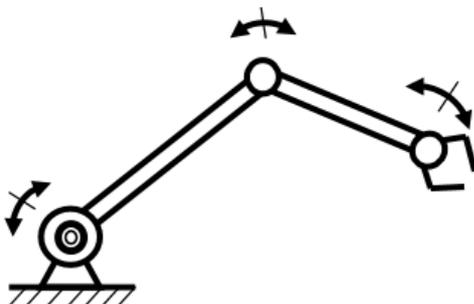


Figure 3. Design arm

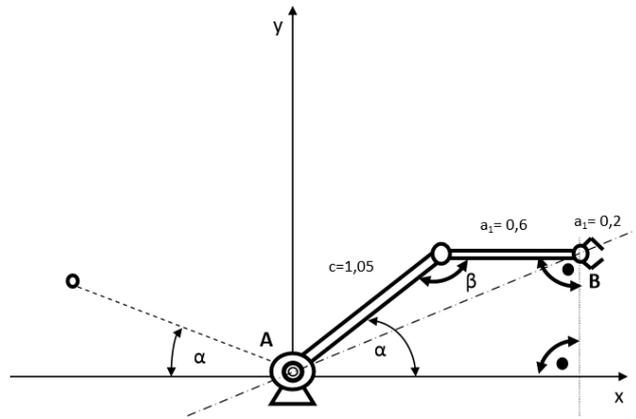


Figure 4. Drawing for calculating drives

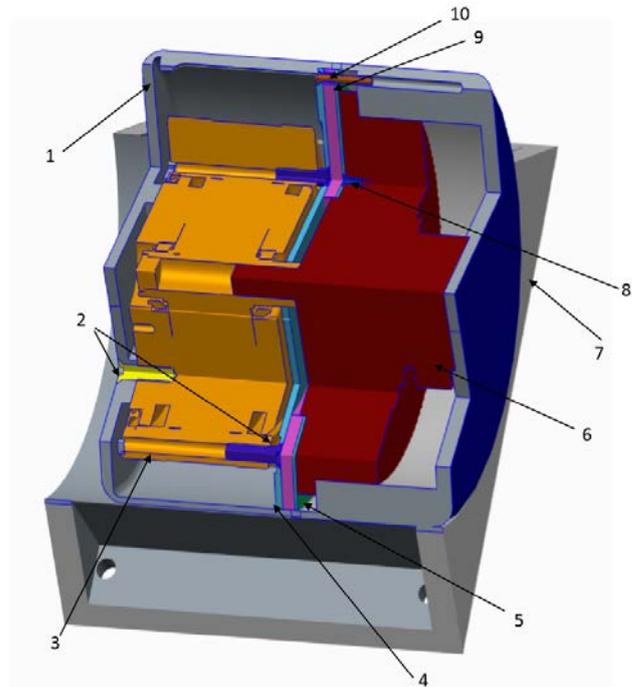


Figure 5. Cut joint robot 1) First Leg, 2) screw M12, 3) transmission TS240 4) flange gearbox, 5) motor flange, 6) engine, 7) base 8) M4 screws, 9) sealing rubber, 10) screw M6

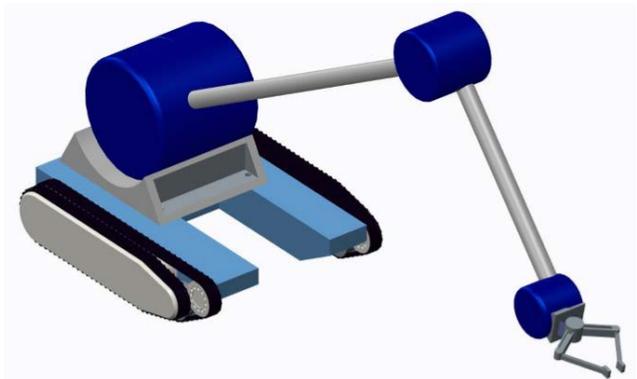


Figure 6. Final design

Each node is rotated at the connection of the motor shaft with a hole in the gearbox. Motor shaft fits into the hole transmission. The joint is covered by grooves on the shaft that fit into pre-milled groove in the gearbox. We voted engine with the shaft so as to fit exactly without insuring with the stylus or pin.

Structural articulation of purpose and shaped line is shown on the final draft Figure 6. This is a symmetric cylindrical sleeves. The base is aluminum shoes with the motor housing. Everyone from the tube contains the same elements. The proposal is based on fractal. therefore each element, in our case the node resembles the previous at a certain reduction ratio. Here represents the gear reduction from a high of decreasing size. The aim of the work is not the proposal leaves. The arm is designed to carry the minimum of 5.5 kg when fully the forward projection.

Acknowledgements

The proposal is entirely based on manipulating arm of a draft drawn up in cooperation with holding workers ZTS

VVU Košice a.s. and my consultant work. With simple construction and easy installation solution is beneficial for future users. The stock for the can make an adjustment in external conditions.

References

- [1] Proposal for a mobile manipulator arm robot SCORPIO, Bc. Ondrej Juruš, 2015
- [2] <http://www.antyterrorizmus.com/product/en/scout>
- [3] <http://www.ztsvvu.eu>
- [4] <https://www.qinetiq-na.com/products/unmanned-systems/talon/>.