Министерство науки и высшего образования РФ
Федеральное государственное автономное образовательное учреждение высшего образования "Национальный исследовательский Томский государственный университет"

ИНТЕЛЛЕКТУАЛЬНЫЕ СИСТЕМЫ 4-й ПРОМЫШЛЕННОЙ РЕВОЛЮЦИИ

Сборник материалов III Международного форума
г. Томск, 26–27 ноября 2019 г.

Под ред. В.И. Сырямкина

Scientific & Technical Translations
STT
ИЗДАТЕЛЬСТВО
Томск – 2020

EFFICIENCY OF 3D PRINTING IN EDUCATIONAL ROBOTICS

Fokin A.O., Syryamkin V.I.
National Research Tomsk State university
fokinao88@gmail.com

At the moment, robotics is used at all stages of the educational process from elementary school to higher professional education. However, robotic kits are very expensive and they limit the user because of a specific theme of a robotics kit set and a specific number of parts. Therefore, in this article I will talk about the effectiveness of the application of additive technologies in robotics, namely 3D printing by the fused deposition modeling. (FDM) [1].

The comparison of the cost of the most popular robotic kits:

Controller	Cost of controller	Cost of kit with controller	Cost of other components (difference between columns 3 and 2)
TXT	21 550 ₽	30 990 ₽	9 440 ₽
myRIO	96 280 ₽	142 160 ₽	45 880 ₽
Arduino UNO	582 ₽	35 938 ₽	35 356 ₽
Raspberry Pi 3 B	2 948 ₽	9 303 ₽	6 355 ₽

The first, second and third columns contain information about the controller and its cost, as well as the price of robotic kit with this controller. The fourth column shows the cost of the remaining components; it also includes additional electronics. For example, a servo controller is 2000 p, a motor driver is 1000p, two servos are 1000p, and two electric motors are 1000p. Total cost of electronic components is 5000 rub (I took prices from the Internet and rounded them up). Thus, the minimum and maximum cost of main parts and accessories that can be replaced with 3D-printed products is 1 355 and 40 880 rubles respectively. The cost of one gram of plastic in the finished product for ABS the is 0.56 rubles; HIPS, is 0.43 rubles; PLA is 0.74 rubles; SBS is 0.67 rubles; FLEX is 2.98 rubles; NYLON is 2.6 rubles.

Therefore, we can conclude that we can replace all plastic and aluminum parts that should not be deformed by parts printed from PLA or HIPS plastic. We can print flexible and resiliently deformable parts from SBS plastic, and we can print soft and resilient elastomeric details from FLEX and NYLON materials.

To print the Rover platform (Fig. 1), you will need 407g of HIPS plastic for the body and 149g of FLEX for the tracks. Total cost of this product is 619.03 rubles ($407 \times 0.43 + 149 \times 2.98 = 619.03$ rubles).

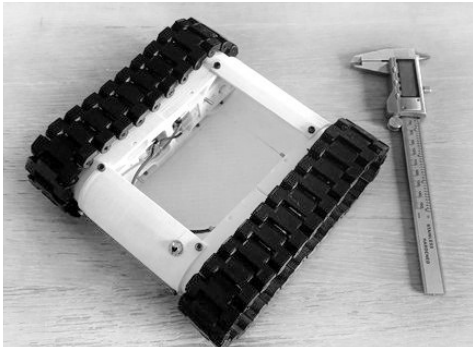

Fig.1. Rover platforf

To print Robot ARM CLAW (Fig. 2) you will need 116g of HIPS plastic, and the cost of thisproduct will be 49.88 rubles (116 × 0.61 = 49.88 rubles).

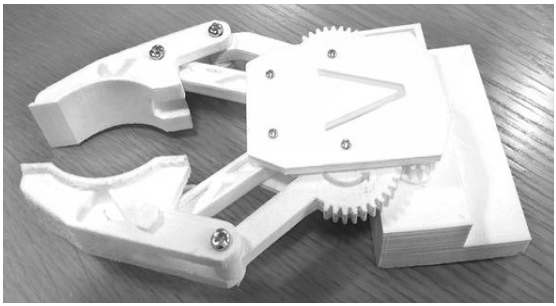

Fig. 2. Robot ARM CLAW

This platform and hand manipulator are distributed freely on the Internet and they are compatible with Arduino and Raspberry Pi boards.

The total cost of printing a robot is 668.91 rubles (49.88 + 619.03 = = 668.91 rubles). This solution is 9.5 times more profitable than the cheapest kit, even taking into account the fact that I calculated the cost for printing with 100% filling but such a large fill is almost never used.

And in conclusion I would like to say that We can replace all non-electrical elements with elements printed on a 3D printer. The cost of a printed robot is cheaper; we can also conclude that 3D printing makes robot-

ics much more accessible and the degree of involvement in the process increases [2].

References

1. Дресвянников В.А., Страхов Е.П. Аддитивные технологии как технологическая инновация: понятие, содержание, анализ развития // Экономика и менеджмент инновационных технологий. – 2018. – № 1.
2. Фокин А.О. Эффективность применения 3D-печати в образовательной робототехнике // Когнитивная Робототехника. – 2017. – 82 с.