**1.1. Название проекта** *(на английском языке)*

***Development of a model of a flexible control object***

**1.2. Фамилия, имя руководителя коллектива** *(заполняется*

*автоматически)*

**1.3. Ключевые слова** *(на английском языке) (приводится не более 15*

*слов) brachytherapy, robotic system, injection needle, needle deflection, model of a flexible control object*

**1.4. Аннотация проекта на английском языке** *(кратко, в том числе*

*- актуальность, уровень фундаментальности и научная новизна;*

*ожидаемые результаты и их значимость)*

New research is that, in contrast to the known, in the presentation of a medical injection needle, like points with a pinched end at the puncture site. In this case, the calculations of the forces acting on the needle tip are different types of effects.

A physical and mathematical model will be developed that describes the deviation of the medical injection needle during movements in human tissues. Parametric calculations will be performed. The simulation results will be compared with experimental data. There will also be conducted virtual experiments using models of manipulators.

The developed physical and mathematical model will improve the efficiency of operations, reduce the number of punctures, reduce the trauma of the patient.

The results of this project can be used in various control systems in medical robotics where control and precise needle tip positioning will be necessary. In this project, we will consider a minimally invasive brachytherapy operation, which is carried out to treat prostate cancer (PCa) by introducing micro-sources of radio emission into the prostate gland as close as possible to the tumor.

The difficulty of this operation lies in bringing the needle tip to the target point. Since the needle tip is asymmetrical, when moving in the tissues, the needle will be deformed, which will lead to the deviation of the needle from the rectilinear movement. Thus, introducing and turning the needle around its axis, you can hold the needle tip along a predetermined path.

In this project, a physico-mathematical model will be developed that describes the deviation of a medical steel injection needle as it moves in a soft tissue phantom (imitation of human tissues). This model is necessary to ensure the correction of the work of the robotic system during brachytherapy or similar operations where high-precision positioning of the needle tip is necessary, as well as prediction of optimal puncture sites.

The use of this model is assumed directly in the performance of operations or for use in regulators based on the “Model predictive control” approach (MPC). To do this, the model will be subject to restrictions on the resources that it can use in the calculation. It is necessary to apply such approaches to the implementation of the model in order to maintain accuracy and improve performance.