# *Pallas Project specification*

Stakeholders : Anna Solovyova (Manager of the project), Igor Solovyov (scientific advisor)

## *Section 1. Project Purpose and Scope*

The aim of the project is to create a Computer-Aided Detection (CAD) System that will allow detecting the bone fractures on the X-ray with the minimum level of false-negative outcomes. Current problem is that some kinds of bone fractures are difficult to detect by the human eyes, thus, not all of the cases are detected in-time and treated accordingly.

Timeline:

Stage 1 - 4-6 weeks

Stage 2 - n/d

Stage 3 - n/d

This algorithm will be used as an additional tool for practical specialists.

Link to the project on GitHub https://github.com/users/solomesolo/projects/1

Here is the summary of previous works in this field
https://docs.google.com/spreadsheets/d/1uJlCeyC51gVoQecKA_s9buN3714H3ArfvfgE6hyOYDM/edit#gid=0

## *Section 2. Technical challenges*

Develop the solution that will be reliable enough to use it on the clinics. Majority of the works that have been done in this field have not been applied to real life because of the system limitation in the practical work.

***Section 3. Functionality requirements***

1. User interface: Minimalistic, there should be no UX/UI, but must be a simple way for the specialist to download the photo and then to read the results (Stage 1-2)
2. Recommendation system for Stage 3
3. Integration with in-clinics system (Stage 3)
4. Personal data protection (Stage 2-3)

***Section 4. Purpose and Need***

The purpose of the project is to create Computer Aided Diagnosis System, that will be able to:

- Detect the region with abnormalities on the Xray image (first stage);
- Detect the complicated bone fractures (second stage);
- Detect complicated bone fractures and find the appropriate same-look past cases in the database (third stage).

*Baseline for the work:*

One of the main traits that the medical sector faces now is the lack of the high-skilled specialist who will be able to detect abnormalities on the Xray images right after the accident, thus, preventing the complications when the correct diagnosis has not been detected at an early stage. Beside this, even the more experienced specialists tend to make more mistakes in the trauma diagnoses at the second half of the day - there was a peak in errors in fracture diagnosis between 8 pm and 2 am (47% against 20% in controls, $p < 0.005$).

The most critical localization of the missed fractures are: ankle or foot (28%, n = 11), lower arm (22%, n = 9), hand and fingers (22%, n = 9), hip (10%, n = 4) and misc. (18%, n = 7).

***Section 5. Development of the product***

Development of the solution for CAD fracture detection consists of three main stages:

***Stage 1.*** Development of the prototype of the working solution aimed to detect the region on the Xray image with the abnormalities. On this stage the system should not classify the type of abnormality, rather just to indicate its presence. For the need of this stage the Stanford Xray Dataset and the real-life Xray images should be used.


*Indexes that should be used to measure the performance* - AUC, sensitivity, selectivity

**Indicator of the successful accomplishment of the project** - working prototype (basic user functionality, user can upload the image and see the result) with the accuracy is not less than 80%, sensitivity - 90%, selectivity - 80% (on the validation set).

*Questions to this stage:*
Data augmentation?
Quality of the images?
Number of samples (real life samples for validation)?
Visualisation of the detected area (heat map?)

***Stage 2.*** Development of the tool for complicated bone fractures detection (only within hand). On this stage the system should recognize the area of the fracture and label the fracture image as a positive. For the need of this stage the real-life data set will be added.

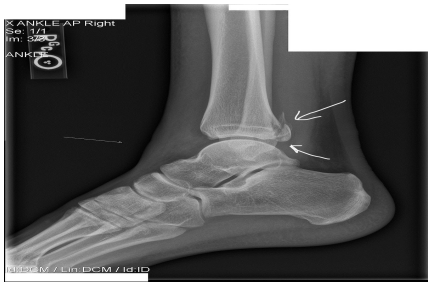
*Indexes that should be used to measure the performance* - AUC, sensitivity, selectivity.

**Indicator of the successful accomplishment of the project** - algorithm is able to operate with the accuracy is not less than 80%, sensitivity - 90%, selectivity - 80% (on the validation set).

Pic.1 - Normal Xray image (bone without fracture)

Pic. 2 Examples of the fractures

(easy fracture)





(not easy to find fractures, our goal)

***The pictures above are the demonstration one, the pics from the data set will be more quality with less noise***

*Questions to this stage:*

Size of the dataset (positive and negative cases)?
Quality of the images (issue with the different quality from the different clinics)?

***Stage 3.*** The system is able to indicate the complicated fractures on the images (whole body) and after the case classification the system is able to find the similar cases in the hospital/external database and propose them for a clinical specialist as the additional tool for diagnoses.

*Indexes that should be used to measure the performance - n/d.*

**Indicator of the successful accomplishment of the project** - n/d.

***Section 6. Benefits and Costs***

Current situation in the healthcare sector during COVID-19 crisis showed the importance of the Computer Aided Systems for eliminating human-biased mistakes connected with burnout of the practical specialists and lack of the time for the detailed diagnosys.

The main benefit of the Pallas solution is decreasing the rate of the false positive and false negative diagnoses of the trauma cases made by the young specialists and the experienced specialists in the second half of the day. Besides this, it is expected that it will decrease the need for additional X-ray examinations, thus our solution will eliminate the additional X-ray irradiation on doctors and patients.

Developed algorithm will serve as the support tool for the radiologists and trauma specialists, however, the final diagnoses will be made by the human-doctor. Successful criteria of the solution implementation will be decreasing of the number of the miss-diagnosed cases for 3%.

***Cost sheet will be attached.***

***Section 7. Project Constraints***

***Time constraints:*** we have no strict time frames as for now, but ideal timing for the Stage 2 is the end of 2020

***Budget constraints:*** First stage (prototype) is paid by stakeholders and thus should be made without additional features. Stage 2 and 3 will be paid from the external resources and will be re-estimated after Stage 1.

***Scope constraints:*** Limitation of the clinics database, need to develop agreements with Institutes (ideally in 2-3 countries to get the deverce dataset of the different images).