Scanner imitators

1

1. What is it?

Imitators of *IM* and *SLM* are intended for imitation of the scanner type *MDL SLM Stockpile Scanner (MDA082)*. Even if there are no at all scanner imitators allow to organize process of debugging and testing of calculation program *volume.exe* and to check up its performance.

Scanner imitation is carried out by means of two imitators *IM* and *SLM*, because there are two sensors in scanner: *SLM* – simulates the rotating range and angle finder scanning a cross-section cut of calculation area; *IM* – simulates the range finder defining longitudinal position of the scanner.

2. Installation

The Distribution kit *Java Development Kit (JDK)* is needed for imitators work and one can download it by the link: http://java.sun.com/download.

Installation of imitators take place together with installation of the calculation program *volume.exe* when one unpacks an archive *volume_installer.exe* (imitators included into subdirectory *java_imitators*).

Run a file volume_installer.exe.

In the field «a purpose folder» choose the directory which is necessary for installation. Click the button unpack. Open a folder of installation and run one of the following executable files:

- *start_GUI.bat* – to run the program of management (it is recommended);
- *start_console.bat* – to run consol version of the program of management, thus only simulators *IM* and *SLM* are run, and then to run the program *volume.exe* independently;
- *start_IM.bat* – to run *IM* imitator as console application;
- *start_SLM.bat* – to run *SLM* imitator as console application.

IM и SLM imitators communicate with each other through network port UDP. These imitators can be run by one process as well as by different processes, and even on different computers in a local network.

3. Setup

All setup parameters of imitators are located in two configurable files: *lm_im.properties* (parameters for *IM* imitator) и *slm_im.properties* (parameters for *SLM* imitator).

Let's consider setup parameters presented in a file *lm_im.properties*:

- **output properties –** section contains outputs parameters of *IM* imitator, namely:
  - **udpport –** a number of UDP port which *SLM* imitator should listen for receiving readings from *IM* imitator;
  - **outputFile** – a name of output file in which records of points from *IM* imitator will be collected;
  - **outputToConsole** – to enable output of readings from *IM* imitator on the console;
  - **logSpeedPeriod** – a time in milliseconds between output of the debugging information.
- **imitation properties** – section contains parameters of imitation, namely:
  - **speed** – speed in m/sec of longitudinal motion of the scanner, that is imitated by *IM* imitator;
  - **minDistance** – a distance in meters to the end of imitated calculation area (should correspond to program setups *volume.exe*), having been reached when *IM* imitator set speed of longitudinal motion of the scanner equal to zero, and continues to send current constant value of a longitudinal distance;
  - **maxDistance** – a distance in meters from the beginning of a imitated calculation area (should correspond to program setups *volume.exe*) from which *IM* imitator begins its movement up to **minDistance**;
  - **errorVariance** – an *IM* error dispersion (an error by Gaussian distribution);
  - **errorMean** – mathematical expectation of *IM* errors in meters.

Let's consider setup parameters presented in a file s*lm_im.properties*:

- **network options** – section contains network options of *SLM* imitator, namely:
  - **slmport** – a number of UDP port which the program *volume.exe* should listen for receiving meterings from *SLM* imitator;
  - **lmip** – IP address of *IM* imitator;
  - **lmport** – a number of UDP port for linking with *IM* (should be coordinated with a field **udpport** in setups of *IM* imitator).
- **surface options** – section contains parameters of imitated surfaces:
  - **surface** – type of imitated surface: **surface**=const – a surface of cylindrical form (pipe); **surface**=parabolic – a surface consisting of parabolas in a cross-section cut of kind like $z_i(x,y)=a_ix^2+b_ix+c_i$; **surface**=parabolic3D – a three-dimensional parabola of kind like $z(x,y) = \sum_{i=0}^{2} \sum_{j=0}^{2} c_{ij} x^i y^j$, where coefficients c_{ij} are also set in setup file.

- o **surface.leftwall** – distance in meters to the left border of calculating area (should correspond to program setups volume.exe);
- o **surface.rightwall** – distance in meters to the right border of calculating area (should correspond to program setups volume.exe);
- o **surface.floor** – distance in meters to the bottom border of calculating area (should correspond to program setups volume.exe);
- o **surface.const.r** – pipe radius in meters, in a case if the parameter **surface**=const.
- o **parabolic surface params** – section contains definitions of coefficients of parabolic surface, namely:
- o **surface.parabolic.n** – quantity of parabolas in a cross-section cut; surface.parabolic.a_i, surface.parabolic.b_i, surface.parabolic.c_i – coefficients of the equation $z_i(x,y)=a_i x^2+b_i x+c_i$;
- o **surface.parabolic.W$_i$** – width of 'i' area in meters in a cross-section cut.
- o **parabolic3D surface params** – section contains definitions of coefficients of parabolic surface, namely:
- o **surface.parabolic.c$_{ij}$** – coefficients of the equation $z(x, y) = \sum_{i=0}^{2} \sum_{j=0}^{2} c_{ij} x^i y^j$.

- **fault options –** section contains imitation of errors *SLM*, namely:
  - o **errorMean** – mathematical expectation of errors SLM in meters;
  - o **errorVariance** – the *SLM* error dispersion (the error by Gaussian distribution);
  - o **zeroPerCircle** – mathematical expectation of zero points quantity (errors when the signal does not come back) during one round of *SLM*.

4. Description

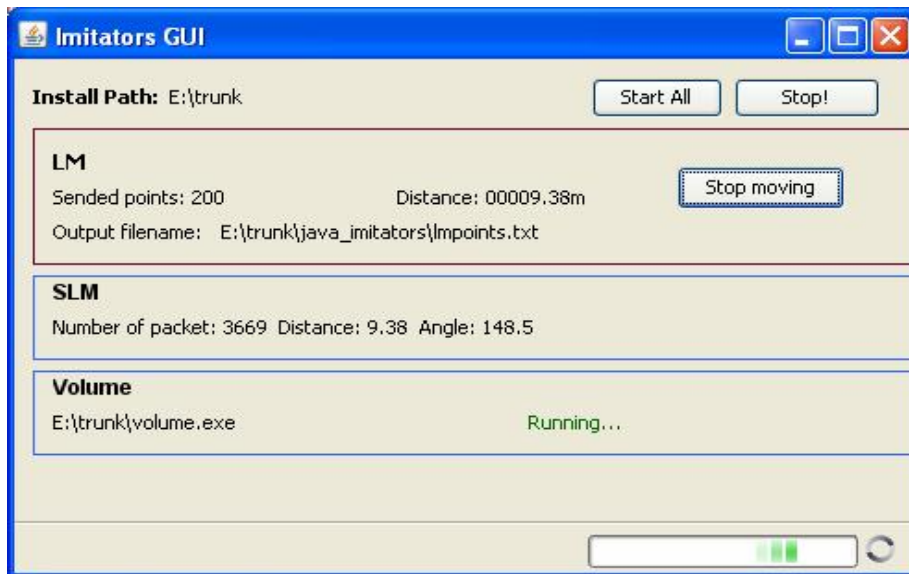After running *start_GUI.bat* the main window appears as:

Fig.1. View of the window of the management program

Set of the operating elements:

- **Start All** – starts an imitation process for *IM* imitator, SLM imitator and enables the program *volume.exe*;

- **Stop** – stops all three working processes: IM imitator, *SLM* imitator and program *volume.exe*;

- **Start moving/Stop moving** - start/stop of *IM* imitation of longitudinal movement.

Set of information data fields:

- **Install Path** – a full path of installation catalogue;

- **Volume** – a section of parameters of calculation program *volume.exe*, which contains a full name of an executable program's file, and also diagnostic results of the program activity;

- **LM** – a section of parameters of *IM* imitator, namely:
    - **Sent points** – quantity of the generated readings for imitated longitudinal distance of the scanner;
    - **Distance** – a current imitated longitudinal distance of the scanner in meters;
    - **Output filename** – a full name of a file for output generated readings for imitated longitudinal distance of the scanner.

- **SLM** – a section of *SLM* imitator parameters, namely:
    - **Number of packet –** quantity of network packets with information of generated readings from *SLM* imitator;
    - **Distance –** a current imitated distance in meters to a point of imitated surface of stuff in a cross-section cut with current angle of *SLM* head turn;
    - **Angle –** a current angle of *SLM* head turn in degrees.

6

5. Preparation

Before the start of *IM* and *SLM* imitators it is necessary to set required parameters in setup files into subdirectory *java_imitators*, for example:

File *lm_im.properties*:

```
#LM imitator properties file - lm_im.properties
#--- output properties
#port to recieve queries to get points
udpport = 3095
#file to write points
outputFile = lmpoints.txt
outputToConsole = false
logSpeedPeriod = 2000
#--- imitation properties
speed = 0.1
minDistance = 5
maxDistance = 10
errorVariance = 0.01
errorMean = 0
```

File *slm_im.properties*:

```
#SLM imitator properties file - slm_im.properties
#-- network options –
#Receive packets on port
slmport = 30
#LM imitator ip-address and port
lmip = 127.0.0.1
lmport = 3095
#-- surface options –
#surface type: const, parabolic, parabolic3D
surface = parabolic
surface.leftwall = 15.0
surface.rightwall = 15.0
surface.floor = 12.
#-- parabolic surface params –
# parabolic functions
surface.parabolic.n = 1
surface.parabolic.a1 = 0.01
surface.parabolic.b1 = 0.0
surface.parabolic.c1 = 5.0
surface.parabolic.W1 = 30.0
#-- parabolic3D surface params --
#-- fault options --
#Accidental error of range parameters, error distributed normally
errorMean = 0
errorVariance = 0
#Zero range per circle
zeroPerCircle = 0
```

6. Working process and control of results

Working process for the volume calculation program *volume.exe* and *IM и SLM* imitators can be considered through an example of inserted above parameters that are simulated by parabolas in cross-section cut of stuff surface. In this case by means of simple preliminary analytical calculations we will find required stuff volume in a calculation area.

The size of a calculation area (the size of a storehouse) is set as:

- **Left** = 15 meters;
- **Right** = 15 meters;
- **Height** = 12 meters;
- **First** = 10 meters;
- **Last** = 5 meters.

Imitated by parabolas in cross-section cut (**surface**=parabolic) the elements of surface are setup as:

- **surface.parabolic.n**=1 (one parabola);
- **surface.parabolic.a1**=0.01;
- **surface.parabolic.b1**=0;
- **surface.parabolic.c1**=5.0;
- **surface.parabolic.W1**=30 meters.

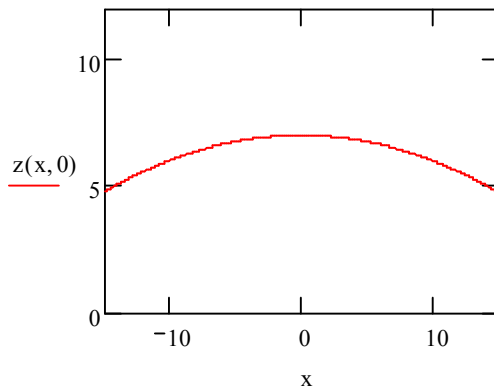There is the set parabola in cross-section cut on fig. 2.

Fig. 2. Parabola in a cross-section cut.

Let's get volume which the program *volume.exe* should calculate by analytical method:

$$\int_{Last}^{First} \left(\int_{-Left}^{Right} (Height - (ax^2 + bx + c))\,dx \right) dy =$$

$$= \int_{5}^{10} (12x - (0.01\frac{x^3}{3} + 5x))\Big|_{-15}^{15}\,dy = 2 \cdot (12 \cdot 15 - (0.01\frac{15^3}{3} + 15 \cdot 5)) \cdot (10 - 5) =$$

$$= 937.5\,м^3$$

1) That to start process of simulated lime volume measuring it is necessary to run a file *start_GUI.bat* and to click the button **Start All.** Then the *IM, SLM* imitators as well as the calculation program *volume.exe* will be started in absence of an error messages.

2) For enabling connection with *SLM* imitator and to be able to give commands to start the process of imitation of lime surface it is necessary to click the button **Scanning** in a window of calculation program *volume.exe*.

3) For starting process of *IM* imitation of longitudinal movement of the scanner it is necessary to click the button **Start moving** in a window of the management program.

4) The *IM* imitator after getting out from the calculation sets speed of longitudinal movement of the scanner equal to zero, and continues to send current constant value of longitudinal distance.

5) To disconnect the *SLM* imitator it is necessary to click the button **Stop** in a calculation program window *volume.exe*.

In case of turning on a rendering mode 2D in program setups *volume.exe* the graphic top view of a surface imitated by parabolas in a cross-section cut should be the same as on fig. 3.
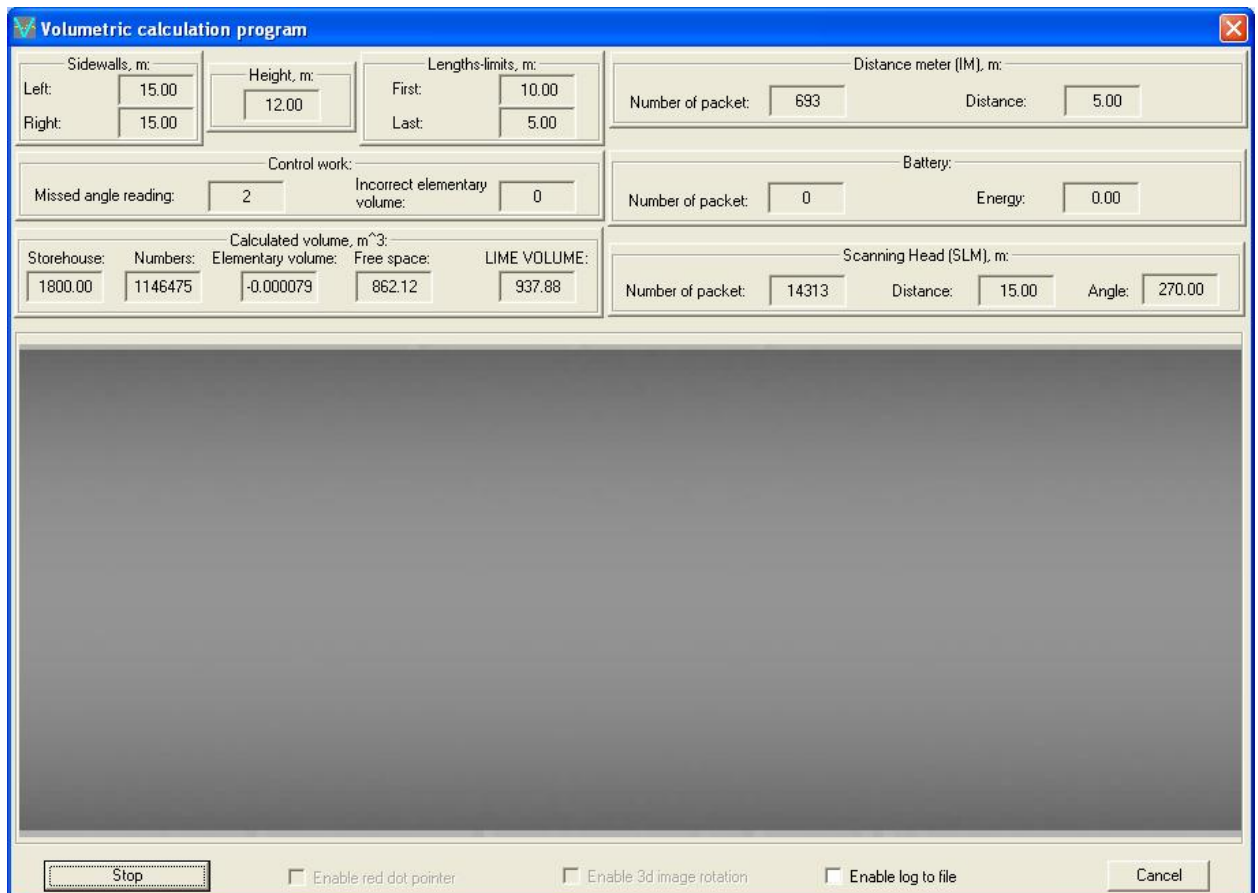

Fig. 3. An example of rendering 2D of surface imitated by parabolas in cross-section cut (top view).

In case of turning on a rendering mode 3D in program setups *volume.exe* the graphic kind of surface imitated parabolas in cross-section cut should be the same as on fig. 4.

Value in the field **LIME VOLUME** should accord to analytically calculated value. By difference between these values it is possible to judge a result's error.
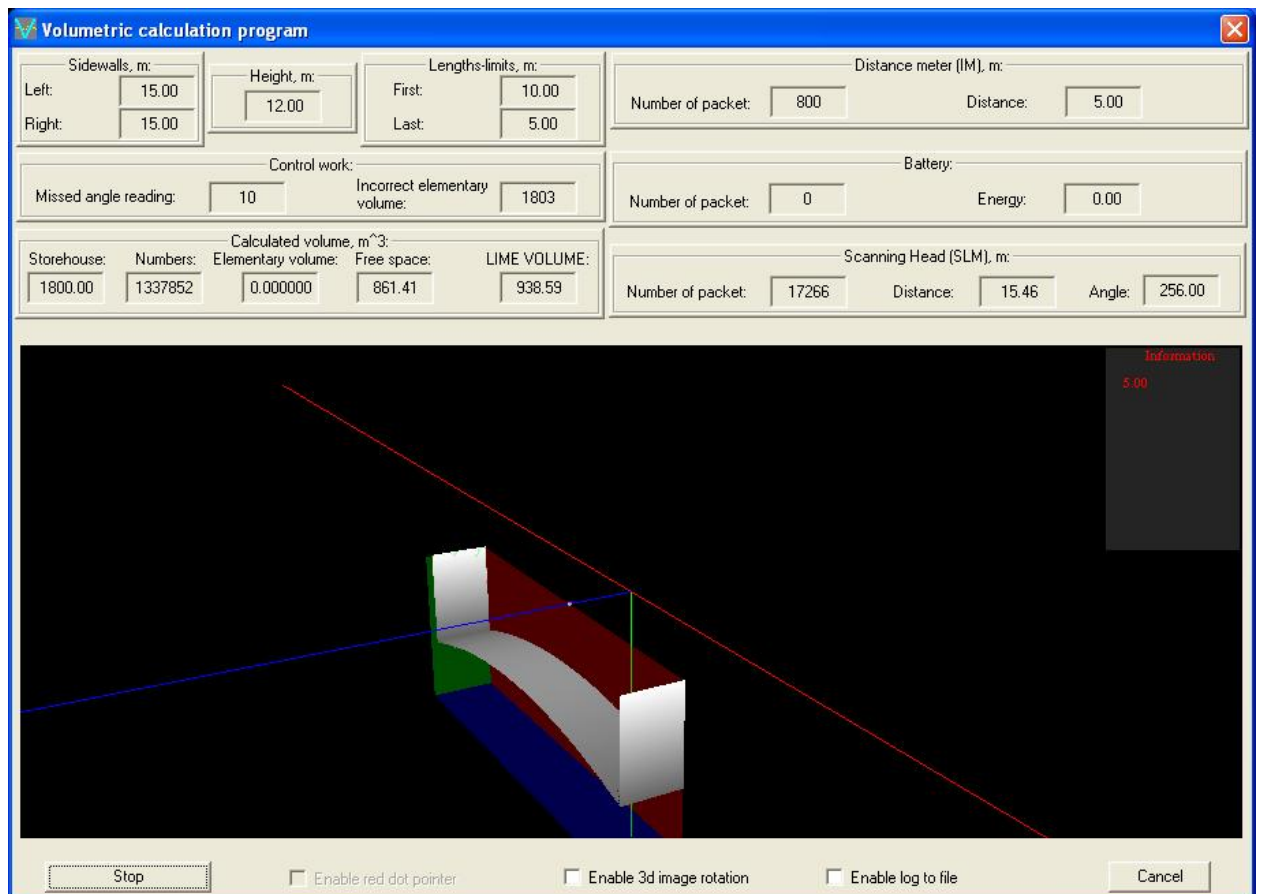
Fig. 4. An example of rendering 3D of surface imitated by parabolas in cross-section cut.

That to stop working with the volume calculation program *volume.exe,IM* and *SLM* imitators it is necessary to click the button **Stop** in a window of the management program and to close this window.