AutoCAD Interface:

– user input of parameters in a specialised window,

– 3D model visualisation with all parameters displayed.

Sharing files:

– `Piram_L.dxf` and `Piram_R.dxf` contain sweeps in the `cutting` (for cutting), `marking` and `attributes` (properties) layers.

– The LISP script `Piram.lsp` automatically loads the data into AutoCAD.

Integration with PM2000 :

– exporting DXF files to PM2000 allows for part layout on the sheet and plasma cutting.

Advantages over analogues of the developed CAD sweep

– versatility: support for AutoCAD and PM2000 makes the system available to companies with different levels of equipment;

– time saving: manual calculation took up to 2 hours, automation reduced the time to 2 minutes;

– accuracy: calculation errors are reduced to 0% due to parameter checking algorithms.

Limitations and perspectives

The current version has limitations as it only supports truncated tetrahedral pyramids.

Perspectives:

– extension of functionality for other geometrical figures (cylinders, cones);

– integration with cloud services for remote access.

**Conclusion.** The developed LISP-based CAD system in AutoCAD solves the key problems of automating the design of truncated pyramid sweeps. Integration with PM2000 and use of free technologies (Lazarus, LISP) make the system accessible for small and medium-sized enterprises. Implementation results confirm the system efficiency: reduction of design time, minimisation of errors and improvement of product quality.

## INTEGRATED SAPR FOR AREA AND PERIMETER

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In modern engineering and manufacturing systems, the accurate determination of geometric characteristics of objects (area, perimeter, volume) is a key step in design, analysis and optimisation. However, manual calculations for complex shapes with curved or non-standard boundaries are often error-prone, time-consuming and low scalability.

An integrated CAD system that combines design, analysis and calculation automation can solve these problems. Such a system provides not only accuracy, but also the ability to work with large amounts of data, which is especially important when creating complex technical drawings or engineering projects. The purpose of the article is to study the methods of implementation of such a system, description of algorithms and their practical efficiency.

Research Objective. To develop an integrated CAD system for automated calculation of area and perimeter of figures of complex geometric shape, combining the following functions:

**Material and мethods.** Gauss method for calculating the area of polygons was used in this work. Simpson's method for numerical integration of areas under curves. Bresenham's algorithm for boundary discretisation and perimeter calculation. Experimental studies with controlled conditions to verify the accuracy of the calculations. Statistical analysis of data to compare the results with manual calculations and existing programmes. Use of numerical methods and algorithms to handle complex geometric shapes, including curved objects and shapes with internal holes.

**Results and their discussion.** The study was carried out on the basis of the study:
– scientific and technical literature on geometric algorithms (Gauss formulae, numerical integration methods, triangulation of surfaces);
– work processes in CAD-systems (AutoCAD, SolidWorks, FreeCAD);
– software platforms for automation of calculations;
– requirements to accuracy and speed of calculations in industry (ISO standards, GOST).

The following algorithms were used in selecting the calculation methods to implement the system.

1) For polygons:
– Gauss's formula for calculating area:

$$S = \frac{1}{2}\left|\sum_{i=1}^{n}(x_i y_{i+1} - y_i x_{i+1})\right|, \tag{1}$$

where $(x_i, y_i)$ are the coordinates of the vertices.

– Sum the side lengths for the perimeter:

$$P = \sum_{i=1}^{n}\sqrt{(x_{i+1} - x_i)^2 + (y_{i+1} - y_i)^2} \tag{2}$$

2) For curved objects:
– Simpson's method for numerical integration of areas under curves
– Bresenham's algorithm for boundary discretisation and perimeter computation.

3) For Combination Forms:
– splitting an object into simple elements (polygons, arcs) with subsequent summation of their characteristics;
– automatic subtraction of internal hole areas.

Programme implementation includes the following steps:
– development of a module for importing/exporting data from CAD systems;
– creating algorithms for calculating area and perimeter for different types of figures;
– integration of visualisation to monitor results.

Testing and optimisation are provided:
– check of correctness of work on test data (simple and complex figures);
– comparison of results with manual calculations and existing programmes (e.g. AutoCAD);
– Optimisation of algorithms to speed up work with large projects.

**Conclusion.** The developed integrated CAD system for area and perimeter calculation demonstrates high efficiency and accuracy when working with objects of any complexity. Its advantages - speed, integration with CAD formats and low cost - make it a promising solution for small and medium-sized businesses. In the future, we plan to improve algorithms through machine learning and expand functionality for 3D modelling.

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