INTEGRATED SYSTEM OF COMPUTER-AIDED DESIGN
OF BELARUSIAN ORNAMENT ELEMENTS

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Belarusian ornament is a unique cultural heritage reflecting history, symbolism and connection with nature. However, its reproduction on an industrial scale faces problems:

– manual labour is highly skilled and time-consuming,

– limited ability of traditional embroidery CAD systems (PDS, CHROMA) to create culturally specific patterns,

– complexity of integration of vector designs into control programmes for sewing semiautomatic machines (for example, PV-1-5, PShK-100, PSh-1, PV-1).

Addressing these challenges requires an integrated CAD system that combines design, path generation and data export for industrial machinery. Such a system will preserve the cultural identity of embroidery technology, increase productivity and reduce reliance on manual labour.

The aim of the research is to develop an integrated computer-aided design system (CAD) for the creation of elements of Belarusian ornament, providing:

1) designing patterns in AutoCAD with cultural symbolism in mind (e.g., "octopus", "paw");

2) automation of path generation for sewing semi-automatic machines

3) data export in DST and G-code formats for industrial equipment.

Material and methods. The work is based on:

– on the analysis of the cultural specificity of ornaments, history and symbolism of elements ("paw", "octopus", "hooked rhombus") according to the studies of Katsar M.S. and Berkasova V.P.;

– studying cross, plain and zigzag embroidery techniques

– analyzing the functionality of PDS, CHROMA and DAHAO and their limitations in dealing with culture-specific patterns;

– Learning the AutoCAD API to integrate the Embroidery module;

– Analytical review of semi-automated machines characteristics, requirements to file formats (DST, G-code)

– A comparative analysis of trajectory optimization methods to reduce machine running time.

Results and their discussion. Integrated CAD consists of four modules integrated into AutoCAD:

1) A design module that performs the functions of creating vector patterns using standard AutoCAD tools (lines, arcs, polylines, etc.).

2) A programming module that performs the functions of generating trajectories taking into account equipment constraints (e.g. the size of the pressure plate working field).

3) Import/export module that performs the functions of exporting data in DST format (for CHROMA) or HP code (for semi-automatic machines). Import of raster images (JPG/PNG) for digitizing traditional patterns.

4) Analysis module, which performs the functions of checking the embroidery and pattern size, optimizing the paths to reduce the running time of the semi-automatic machines.

The integrated system includes an AutoCAD integration interface, a by.cuix toolbar for selecting ornament elements and setting parameters (stitch pitch, color). Export to formats that are supported by semi-automatic machines. So, for CHROMA - these are data formats

DXF, DST. For semiautomatic machines made in Belarus HP-code integration is carried out using the module "ProgramAnalizEmbroidery.exe".

Advantages of a system integrated CAD system

– cultural accuracy, namely the integration of a library of elements with symbolism (e.g., the "paw" as a symbol of fertility);

– technical flexibility – export to formats for CHROMA, PDS and other industrial semi-automatic machines;

– automation that provides a reduction in manual input through symmetry and fill-in algorithms;

– versatility of the system, currently supporting up to 15 cultural elements with the possibility of increasing the number of elements;

– reducing design time by up to 80 per cent.

Restrictions:

– requires refinement of algorithms for complex animalistic motifs;

– the need for training for novices to use the interface.

Conclusion. Integrated CAD for Belarusian ornament solves key problems:

– preserving cultural identity by automating the creation of traditional patterns.

– Resource savings by reducing embroidery turnaround time and errors by 40%;

– versatility by supporting AutoCAD of any version, CHROMA and semi-automatic sewing machines.

The system can be implemented in enterprises producing products with national symbols, which will increase their competitiveness and preserve cultural traditions.