```
geometry = []
for entity in msp:
if entity.dxftype() == 'LINE':
geometry.append({'type': 'LINE', 'start': entity.dxf.start, 'end': entity.dxf.end})
elif entity.dxftype() == 'CIRCLE':
geometry.append({'type': 'CIRCLE', 'centre': entity.dxf.centre, 'radius': entity.dxf.radius}))
return geometry
```

Figure – Example code in the Python language

CAD also performs additional operations to optimise needle routes. This is necessary to minimise machine running time and prevent self-intersection of stitches, which significantly increases the durability of the equipment. The optimisation algorithms take into account not only the geometric characteristics of the pattern, but also the technical limitations of the Jack semi-automatic machine itself, such as minimum line length or maximum arc radius.

As a result of CAD work, a file is created ready to be loaded into the Jack semi-automatic sewing machine. This file contains complete information about each stitch, including its coordinates, type and parameters.

Conclusion. The integrated CAD for the Jack semi-automatic machine greatly simplifies the process of creating and realising decorative elements for shoe uppers. It combines design, geometry analysis, route optimisation and machine data preparation to ensure high accuracy and speed of production. This system is particularly useful for small businesses where design flexibility and minimising human error are required.

1. Атрашкевич, А.Е. Интегрированные системы автоматизированного проектирования. Принципы разработки и функционирования / А.Е. Атрашкевич, А.Э. Буевич, Т.В. Буевич // Материалы докладов 56-й Международной научно-технической конференции преподавателей и студентов, Витебск, 19 апреля 2023 г.: в 2 т. – Витебск : ВГТУ, 2023. – Т. 2. – С. 30–32. https://rep.vsu.by/handle/123456789/40154.
2. Кудрявцев, И.В. Алгоритмы построения рабочих траекторий исполнительных устройств технологического оборудования / И.В. Кудрявцев ; А.Э. Буевич, Т.В. Буевич (науч. рук.) // XVII Машеровские чтения : материалы междунар. науч.-практ. конф. студентов, аспирантов и молодых ученых, Витебск, 20 октября 2023 г. : в 2 т. – Витебск : ВГУ имени П. М. Машерова, 2023. – Т. 1. – С. 24–27. https://rep.vsu.by/handle/123456789/40539.

KINEMATIC ANALYSIS PROGRAMME LEVER MECHANISM

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The kinematic analysis programme for a lever mechanism consisting of different assur groups is a tool for calculating the positions, velocities and accelerations of the links in the mechanism. Assur groups are the types of lever systems described in the "assur" module, including crank, four-link and other mechanisms. The programme is based on mathematical models implemented in a programming language and allows for detailed analysis of the dynamics and statics of mechanisms.

The aim of the study is to develop a kinematic analysis programme for a lever mechanism consisting of different groups of assur:

1. determines the position, velocity and acceleration of links depending on geometrical parameters and rotation angles;
2. implements algorithms to analyse kinematics and dynamics.

Material and мethods. Scientific methods used in this work include experimental studies with controlled conditions and statistical analysis of data to test hypotheses. Linear regression for dependency analysis and Monte Carlo method for modelling random processes and Cramer's method for solving equations.

Results and their discussion. Example of calculation of point coordinates for the second class mechanism of the first kind (assur group of type "pp21"):

Inputs:

– coordinates of points "A(0, 0)" and "B(4, 0)".

– link lengths "l31 = 3", "l32 = 3".

– parameter "n = 1".

Calculation:

pp21(x1=0, y1=0, x2=4, y2=0, l31=3, l32=3, n=1, x3, y3);

Calculation result:

– coordinates of point "C": $x_3 = 2$, . $y_3 = \sqrt{5}$

Example of calculation of velocities for the input link of the mechanism (Assur group of type "p1"):

Inputs:

– crank coordinates: "x1 = 0", "y1 = 0".

– crank length $l21 = 2$, angle . $f21 = \pi / 4$

– angular velocity $w21 = 2$ðàä/ñ , angular acceleration . $e21 = 0$

Calculation:

p1(x1=0, y1=0, l21=2, f21=π/4, w21=2, e21=0, x2, y2, vx2, vy2, ax2, ay2);

Calculation result:

– hinge position: $x_2 = \sqrt{2}$, ; $y_2 = \sqrt{2}$

– speed: $v_x = -2\sqrt{2}$, ; $v_y = 2\sqrt{2}$

– acceleration: $a_x = -4\sqrt{2}$, . $a_y = 0$

Example of calculation of reactions in joints for a four-link mechanism (Assur group of type "ps21"):

Inputs:

– values of forces and moments from the "force" structure.

– parameters "dig1 = 2", "dig2 = 1" (number of points of force application).

Calculation result:

– reactions in the joints:

$$R_x 1 = -P_{x2} + P_{x3},$$
$$R_y 1 = -P_{y2} + P_{y3}.$$

The assur programme demonstrates the following capabilities: accuracy, flexibility, speed.

The accuracy of the calculations is ensured by module algorithms that correctly handle geometric constraints (e.g., checking for intersection in "pp21").

Flexibility is shown in the support of different groups of assur (cranks, four-links), and allows complex mechanisms to be analysed.

Numerical methods (e.g., Cramer's method for solving systems of linear algebraic equations) provide speed of computation.

Limitations of the model's capabilities:

– friction and deformations of the links are not taken into account

– requires the input of precise geometrical parameters.

Conclusion. The programme for kinematic analysis of a lever mechanism based on the "assur" module allows for detailed calculation of positions, velocities and reactions in the links. It is based on mathematical models implemented in a programming language and provides:

1. versatility by supporting various assur groups;
2. accuracy, through the use of trigonometry and differential calculus;
3. the possibility of optimising designs through dynamics analysis.

1. Буевич, Т.В. Реализация алгоритма деления отрезка прямой на равные участки / Т.В. Буевич, А.Э. Буевич, О.А. Леонова // Материалы докладов 54-й Международной научно-технической конференции преподавателей и студентов, Витебск, 28 апреля 2021 г.: в 2 т. – Витебск: ВГТУ, 2021. – Т. 2. – С. 9–11. – URL: https://rep.vsu.by/handle/123456789/34435.

2. Кудрявцев, И.В. Алгоритмы построения рабочих траекторий исполнительных устройств технологического оборудования / И.В. Кудрявцев; А.Э. Буевич, Т.В. Буевич (науч. рук.) // XVII Машеровские чтения: материалы междунар. науч.-практ. конф. студентов, аспирантов и молодых ученых, Витебск, 20 октября 2023 г.: в 2 т. – Витебск: ВГУ имени П.М. Машерова, 2023. – Т. 1. – С. 24–27. – URL: https://rep.vsu.by/handle/123456789/40539.

OVERVIEW OF METHODS FOR THE DETERMINATION OF CRUDE FAT CONTENT

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The determination of crude fat content is an important task in the food industry, agriculture and laboratory research. Crude fat is a mixture of fatty acid triglycerides and associated fat-like substances such as free fatty acids, alcohols, aldehydes, provitamins and pigments. Accurate determination of fat content is essential for product quality control, regulatory compliance and consumer safety.

The aim of the research is to study and comparative analysis of methods for determination of crude fat content in fodder, mixed fodder and feed raw materials in order to select the most effective approaches providing accuracy, speed and cost-effectiveness of analysis.

Material and methods. The work is based on the results of analyses of scientific and technical information, normative documents (GOST 32905-2014) and studies devoted to methods of fat extraction, their physicochemical properties, as well as the application of modern technologies such as infrared spectroscopy and machine learning methods.

Results and their discussion. The study includes:

1. Analysing the theoretical basis of different methods for fat determination, including classical (e.g. Soxhlet method, Gerber method) and modern (NIR spectroscopy, machine learning).

2. study of regulatory requirements for accuracy, repeatability and reproducibility of the results established in GOST 32905-2014.

3. assess the influence of factors such as sample type, analysis conditions and equipment on measurement uncertainties.

4. Comparison of the advantages and disadvantages of each method in terms of accuracy, speed, cost and applicability to different product types.

The **Soxhlet method (solvent extraction)** is the classical method of extracting fats from products using organic solvents such as ether or chloroform. This method is based on dissolving fats in organic solvents, which then evaporate, leaving pure fat. Calculation formula: