The advantage of using piezoelements in tensometric security systems is increased resistance to external influences due to their monolithic construction, a wide range of controlled force values and simplicity of construction.

In turn, tension measuring sensors have a thermal sensitive converter that controls the tension force of a thin string. This force must be fixed and correspond to the normalized value in accordance with the technical requirements for the product. The change in the tension value will lead to a change in the initial signal at the output and the actuation of the system DRCS as a result of touching it.

The presence of snow and the possibility of icing will interfere with the performance of the functions of sensors for measuring tension in the open air during the winter season.

Pressure sensors record the change in the surrounding situation due to the appearance of a foreign object (a person, vehicles, etc.) as a change in pressure on them, resulting from the perception of additional weight.

The field of application of tensometric detection means is quite large. It covers both security of individual small objects (jewelry, rare numismatic things laid out on shop windows or exhibition pavilions), middle-sized objects – valuable printed publications, paintings, cabinets, safes, and establishment of the fact of opening doors, windows, sieves, etc. Installation of sensitive elements of detectors directly under the object of protection or under the fastening elements of the cable on which it hangs is typical for the first case. The signal of the required value is generated when the object is removed. As for the second case, the tensometric security system sends an alarm when they are opened.

Tensometric detection means can be installed anywhere in the path of a potential intruder - under the floor covering, under the step of the stairwell, under the carpet, window sill, etc. They have no restrictions on indoor and outdoor use.

In general, tensometric protection information systems have the following advantages:

– high reliability and stability of operation;

– high level of masking due to visual imperceptibility of sensors and absence of any radiation in the environment;

– simplicity of installation and maintenance;

– high signal/interference coefficient (more than a hundred in the room), which determines high probability values of detecting facts of displacement from the place of installation of security objects or detection of moving objects and actuation up to false alarm;

– simplicity of the system operation algorithm and its construction leads to low cost, which, accordingly, implies wide application on various security objects.

The main disadvantages of tensometric protection systems include the loss of sensitivity of detectors in critical changes in ambient temperature and the difficulty of automatically checking the full health of the system, which is typical for many passive systems. In view of this, tensometric protection systems require periodic verification by directly affecting the sensitive element with the determining parameter of the determined value.

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DATA EXCHANGE BETWEEN ENGINEERING 3D MODELING PROGRAMS

Machine-building enterprises use software products of several global manufacturers to design three-dimensional models, such as CATIA, SolidWorks, Inventor Professional and others [1-3]. These professional automated design programs have their own data import and export functions.

There are also specialized data exchange translators such as Autodesk Direct Connect, 3D Evolution Conversion Engine, 3D InterOp, Acc-u-Trans, BackToCAD Technologies, CAD porter, converter Theorem Solutions, TransMagic, CADfix, Proficiency and others. However, most often users use the built-in data import and export capabilities.

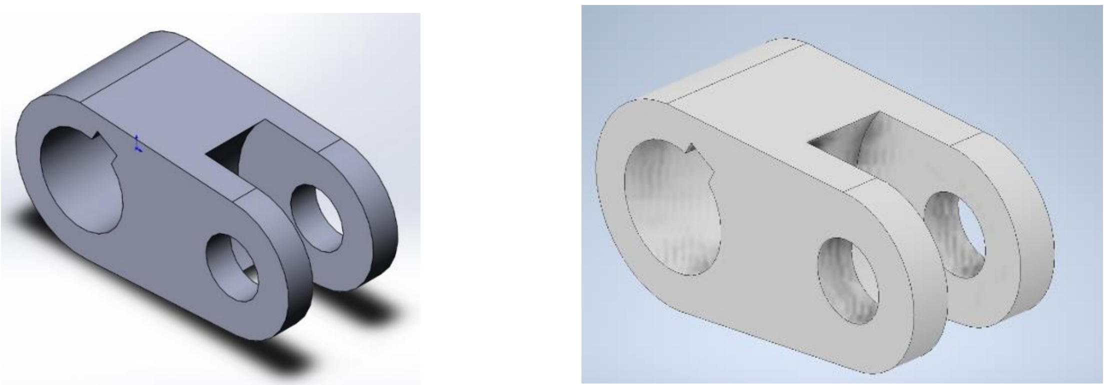
Consider the possibility of exchanging 3D models between two popular 3D engineering design programs, namely SolidWorks and Inventor Professional. Possible formats for saving and opening CAD models in these programs are presented in Table 1.

Table 1 – Formats in which models can be saved for export and import

SolidWorks 2022		Inventor Professional 2022	
Formats for saving CAD models	Formats for opening CAD models	Formats for saving CAD models*	Formats to open
SOLIDWORKS Part (*.prt;*.sldprt) 3D Manufacturing Format (*.3mf) 3D XML For Player (*.3dxml) ACIS (*.sat) Additive Manufacturing File (*.amf) Adobe Illustrator Files (*.ai) Adobe Photoshop Files (*.psd) Adobe Portable Document Format (*.pdf) CATIA Graphics (*.cgr) Dwg (*.dwg) Dxf (*.dxf) eDrawings (*.eprt) Form Tool (*.sldftp) HCG (*.hcg) HOOPS HSF (*.hsf) IFC 2x3 (*.ifc) IFC 4 (*.ifc) IGES (*.igs) JPEG (*.jpg) Lib Feat Part (*.sldlfp) Microsoft XAML (*.xaml) Parasolid (*.x_t;*.x_b) Part Templates (*.prtdot) Polygon File Format (*.ply) Portable Network Graphics (*.png) ProE/Creo Part (*.prt) SOLIDWORKS Analysis Library (*.sldalprt) STEP AP203 (*.step;*.stp) STEP AP214 (*.step;*.stp) STL (*.stl) Tif (*.tif) VDAFS (*.vda) VRML (*.wrl) SOLIDWORKS Part (*.prt;*.sldprt)	SOLIDWORKS Files (*.sldprt; *.sldasm; *.slddrw) SOLIDWORKS Analysis Library (*.sldalprt;*.sldalasm) SOLIDWORKS Assembly (*.asm;*.sldasm) SOLIDWORKS Drawing (*.drw;*.slddrw) SOLIDWORKS Part (*.prt;*.sldprt) SOLIDWORKS SLDXML (*.sldxml) 3D Manufacturing Format (*.3mf) ACIS (*.sat;*.sab;*.asat;*.asab) Add-Ins (*.dll) Adobe Illustrator Files (*.ai) Adobe Photoshop Files (*.psd) Autodesk AutoCAD Files (*.dwg;*.dxf) Autodesk Inventor Files (*.ipt;*.iam) CADKEY (*.prt;*.ckd) CATIA Graphics (*.cgr) CATIA V5 (*.catpart;*.catproduct) IDF (*.emn;*.brd;*.bdf;*.idb) IFC 2x3 (*.ifc) IGES (*.igs;*.iges) JT (*.jt) Lib Feat Part (*.lfp;*.sldlfp) Mesh Files(*.stl;*.obj;*.off;*.ply;*.ply2) Parasolid (*.x_t;*.x_b;*.xmt_txt;*.xmt_bin) PTC Creo Files (*.prt;*.prt.*;*.xpr;*.asm;*.asm.*;*.xas) Rhino (*.3dm) Solid Edge Files (*.par;*.psm;*.asm) STEP AP203/214/242 (*.step;*.stp) Template (*.prtdot;*.asmdot;*.drwdot) Unigraphics/NX (*.prt) VDAFS (*.vda) VRML (*.wrl) All Files (*.*)	Двоичные файлы Parasolid (*.x_b) Двоичные файлы Parasolid (*.x_b) Нейтральные файлы Pro/ENGINEER (*.neu*) Текстовые файлы Parasolid (*.x_t) Файлы AutoCAD DWG (*.dwg) Файлы IGES (*.igs;*.ige;*.iges) Файлы JT (*.jt) Файлы OBJ (*.obj) Файлы Pro/ENGINEER Granite (*.g) Файлы QIF (*.qif) Файлы SAT (*.sat) Файлы SMT (*.smt) Файлы STEP (*.stp;*.ste;*.step;*.stpz) Файлы STL (*.stl) Файлы деталей CATIA V5 (*.CATPart)	Файлы Autodesk Inventor (*.ipt;*.ide;*.iam;*.ipn;*.dwg;*.idw) Детали Autodesk Inventor (*.ipt) Параметр. элементы Inventor (*.ide) Сборки Autodesk Inventor (*.iam) Схемы Autodesk Inventor (*.ipn) Чертежи Autodesk Inventor (*.dwg; *.idw) Двоичные файлы Parasolid (*.x_b) Нейтральные файлы Pro/ENGINEER (*.neu*) Текстовые файлы Parasolid (*.x_t) Файлы Alias (*.wire) Файлы AutoCAD DWG (*.dwg) Файлы CATIA V4 (*.model;*.session;*.exp;*.dlv3) Файлы CATIA V5 (*.CATPart;*.CATProduct;*.cgr) Файлы DXF (*.dxf) Файлы Fusion (*.fusiondesign) Файлы IGES (*.igs;*.ige;*.iges) Файлы JT (*.jt) Файлы NX (*.prt) Файлы OBJ (*.obj) Файлы Pro/ENGINEER Granite (*.g) Файлы Pro/ENGINEER и Creo Parametric (*.prt*;*.asm*) Файлы Rhino (*.3dm) Файлы SAT (*.sat) Файлы SMT (*.smt) Файлы STEP (*.stp;*.ste;*.step;*.stpz) Файлы STL (*.stl;*.stla;*.stlb) Файлы Solid Edge (*.par;*.psm;*.asm) Файлы SolidWorks (*.prt;*.sldprt;*.asm;*.sldasm) Файлы панели IDF (*.brd; *.emn; *.bdf; *.idb) Файлы пометки DWF (*.dwf;*.dwfx) Файлы проекта Revit (*.rvt) Все файлы (*.*)

*– only CAD formats are indicated

As an example, we will use the lever model (Fig. 1) built in these programs. It should be noted that the main differences in the construction of the lever model, in the studied programs, is that in Inventor Professional there is no concept of "cut", but there is a concept of "extraction with a cut". How do the current differences affect the transfer of the lever model from one program to another and vice versa when saving it in specialized formats? This feature of the model construction will also be taken into account when evaluating the results of the exchange between graphic environments.



a b

a – the model was created in the SolidWorks 2022 program;
b - the model was created in Inventor Professional 2022

Fig. 1 – Comparative model of the lever

The comparison criteria were the presence of a model tree, the number of model tree elements, preservation of dependencies. In the table 2, the evaluation was carried out according to scoring criteria. With a score of "4", we note the fact of the transfer of parameters with a complete match of the model tree and dependencies. A score of "2" indicates the possibility of data exchange without complete matching of characteristics. A score of "0" indicates that the model is not suitable for export. A score of "3" and "1" shows an approach to the corresponding evaluation criterion.

Table 2 – Comparison of export of models in the most common formats

Program	Exchange formats / evaluation criteria					
	SolidWorks (*.sldprt)	Inventor (*.ipt)	IGES (*.igs)	STEP (*.stp)	Parasolid (*.x_b)	Parasolid (*.x_t)
SolidWorks	-	4	2	2	3**	3**
Inventor	0***	-	2	2	2	2

**- a high score was obtained by the SolidWorks program due to the presence of automatic diagnostics of importing the part;
*** - to update the file, you need to keep updating Inventor

The conducted studies showed the imperfection of the built-in exchange translators. The biggest problems arise when installing software products from different years of development and not updated to the latest version.

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ROBUST COMMUNICATION CLUSTERS: SECURE INFORMATION EXCHANGE AND REDUNDANT HASHING FOR THIRD-PARTY INCLUSIONS LOCALIZATION

Due to the proliferation of robotics and process automation technologies in the interaction between humans and robotic systems, there is an increasing need to ensure the security and protection of information transmitted between the components of these systems. Communication clusters formed spontaneously, involving robotic modules and humans engaged in cooperative tasks, are particularly vulnerable to information compromise. Therefore, it is crucial to securely protect the information from security attacks or communication failures.

Protecting information in communication clusters of this type requires the use of various measures to ensure data confidentiality, integrity, and availability, including:

1. Encryption: The use of cryptographic algorithms to encrypt transmitted data can ensure the confidentiality of information. Robotic system clusters can employ symmetric or asymmetric encryption for protecting communication channels [1].

2. Authentication and Authorization: The use of authentication mechanisms allows verifying the identity of users and robots accessing the system, based on the use of passwords, certificates, or biometric methods. After authentication, the system can employ authorization mechanisms to control access to various resources and functions, limiting privileges of users and robots within