Contributions to optimization of storage and transporting industrial goods

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Abstract. Optimization of storage and transporting industrial goods in a factory either from a constructive, functional, or technological point of view is a determinant parameter in programming the manufacturing process, the performance of the whole process being determined by the correlation realized taking in consideration those two factors (optimization and programming the process). It is imperative to take into consideration each type of production program (range), to restrain as much as possible the area that we are using and to minimize the times of execution, all of these in order to satisfy the client’s needs, to try to classify them in order to be able to define a global software (with general rules) that is expected to fulfill each client’s needs.

1. Introduction
The goal of the worldwide economic and technical development that has taken place during the past years has been due to increasing social and economic needs.

The knowledge and innovation has created more flexible systems in storage and transporting industrial goods, based on information technology. The study of storage and transporting industrial goods is motivated by the needs of the people, and by the high interest in flexible manufacturing systems with high performance levels, which can replace the human factor in storage and transporting industrial processes [1-4].

Optimization of storage and transporting industrial goods in a factory are very important especially in our days when we try to protect our eco system. For this we must to use small spaces (deposits) but with as much efficiency as possible, also we must have the minimum amount possible of waste materials and to use mostly renewable energy (minimizing the use of electrical and gas power).

The aim is to improve the handling of goods in existing warehouses in Romania, which have had a wide range of products within application.

Objectives and directions are focused on analyzing, using, and capitalizing on the efficiency of storage space for materials and the entire logistics process [5].

We will analyze different product types, different storage and transportation systems, and from the results we will propose an optimal and innovative system for the storage and transportation industrial goods.
2. Current situation of storage and transportation systems

2.1. Current situation of storage and transportation systems in Romania

Most companies in Romania have not implemented an automated logistics system and especially not for the handling of goods.

The Romanian market for industrial equipment for handling, storing, and improving production flows increased by 30% in 2015 with 3,195 new units compared to 2,470 units in 2014.

Last year, on the Romanian market there were 872 forklifts sold, 568 electric forklifts and 1,755 technical vehicles for warehouse interior [6].

As a result of this study, we conclude that the current manipulation system is a classic one (man-mechanical system).

2.2. Current situation of storage and transportation systems in a society of industrial goods

A more extensive study was carried out in a society of industrial goods.

This society has as activity the trade of furniture materials and accessories, where:

- We have had a turnover of over 7,000 different landmarks in the last 5 years.
- We currently have about 4,000 different landmarks

All the landmarks in the two repositories are matrix stored, in rows and columns, each landmark having its own well-defined location, Figure 1.
- Warehouse 1 has 2,000 sqm
- Warehouse 2 has 1,500 sqm

![Figure 1. Location of the warehouses](image)

Currently, product locations are arranged by a matrix system on columns and rows, and the employee must climb the stairs to product locations Figures 2 and 3.

In this society are a very wide range of types of pieces and almost 5,000 items.
Figure 2. Matrix system on columns and rows

Figure 3. Matrix system on columns and rows

Figure 4. Small items

Figure 5. Big items

3. Experimental conditions

3.1. Objectives of experimental conditions
The main objective of this experiment is to optimize the storage and transportation systems in the warehouses of commercial enterprises.

   From this the results are:
   - Reduction of energy consumption;
   - Reduction of investment costs;
   - Reducing the consumption of labor;
   - Reduce accidents, risks and human errors;
   - Increased operability;
   - Increase cost / benefit efficiency;
   - Increase operational safety.

   With this will result in efficiency of the space and of the logistics system, it is necessary to design and implement an automated system for handling goods [3], [7], [8].

   Nowadays, the handling of commodity merchandise takes place in various ways both as automated systems and as classical systems serviced by the human operator, assisted by various computer
programs (databases, specific software for managing goods, etc.). These systems are costly and on the one hand their efficiency can be improved [7], [9-11].

The optimization of the storage and transportation systems aims to:
- Avoid product damage due to human factor;
- Avoid serving other products and / or alter the initial position on the site;
- Rapid service;
- Higher safety of the human operator by avoiding the risk of injury;
- Better product management;
- Efficiency of work in the warehouse;
- Space efficiency.

3.2. Application in experimental conditions

As a novelty will be the creation of a coordination system (from supply to customer service) and optimization of automatic storage and transportation systems for goods, objects, a wide range of types, materials, plastic, metal (ferrous and non-ferrous), glass, etc. We will not limit to manipulating palette objects or a limited range of types.

To achieve the goal, we have proposed the creation of an automatic cargo handling system also considering the information inside the warehouses [5], [12], [13].

This system, Figure 6, will have to communicate fully with the three warehouses (reception warehouse, small size accessory storage 1 and large accessory storage 2).

This system may be a rail guided "stacker" device. Each warehouse will have such a system installed in the room and service between warehouses will be made through conveyor belts.

![Diagram](image)

**Figure 6.** Logical description of the process

This system has several advantages
- Avoiding the disclosure of products due to the human factor
- Avoid serving other products and /or alter the initial position on the site
- Rapid in serving products
- Greater safety of the human operator by avoiding the risk of injury
- Better product management
- Efficiency of work in the warehouse
- Space efficiency
3.3. Creating devices for experimental conditions

For this experiment we created, in our laboratory from University “Aurel Vlaicu”, engineer department, a device for recognition of objects, Figure 7.

We create this automatic and intelligent storage system prototype device that contains two departments, the factory and the retail sell department. In the next stage, the optical system must separate these items.

The device has a processor that is connected to a pc for recognition objects. In this pc we have stored 1000 photos of items. From the conveyor, the items pass in front of the camera which is responsible to detect these items. The selection device is responsible for selecting objects to be directed to the factory or to the retail branch.

The schematic structure of automatic storage system that deserve the factory and the retail sell department are exemplification in Figure 8.

Figure 7. Logical description of the process

Figure 8. Schematic structure of automatic storage system
4. Results and discussions
To determine the accuracy of optical recognition software we make the tests with more image recognition software. We selected, for these tests some small metallic (Figure 9) and plastic (Figure 10) and some big metallic (Figure 11) and plastic (Figure 12) objects.

![Figure 9. Small metallic items](image9)

![Figure 10. Small plastic items](image10)

![Figure 11. Big metallic items](image11)

![Figure 12. Big plastic items](image12)

The experimental data, for the accuracy for each software, are presented in Table 1.

| Table 1. Accuracy of recognition software |
|------------------------------------------|
|                                           |
| Small plastic objects | Big plastic objects | Small metallic objects | Big metallic objects |
| Soft 1 SVS | 96% | 98% | 96% | 98% |
| Soft 2 BLIPPAR | 98% | 96% | 98% | 96% |
| Soft 3 GAZIRU | 97% | 98% | 97% | 97% |
| Soft 4 IMAGE CAPTURE PLUS | 95% | 96% | 97% | 95% |
| Soft 5 API | 98% | 97% | 95% | 96% |

All software has no big errors when we determinate the recognition items by size and by materials in this prototype device. Also, we calculate the average delay time from the moment when the camera detects the object and
the moment when the software recognizes the item and give the command at selected device, Table 2.

Table 2. Average delay time of optical recognition software

| Software   | Maxim delay time | Minim delay time | Average delay time |
|------------|------------------|------------------|--------------------|
| Soft 1 SVS | 0.092 sec        | 0.090 sec        | 0.0913 sec         |
| Soft 2 BLIPPAR | 0.121 sec    | 0.121 sec        | 0.121 sec          |
| Soft 3 GAZIRU | 0.099 sec      | 0.099 sec        | 0.099 sec          |
| Soft 4 IMAGE CAPTURE PLUS | 0.108 sec | 0.108 sec | 0.108 sec |
| Soft 5 API                | 0.11 sec        | 0.09 sec         | 0.1 sec            |

5. Conclusions

It is very important to create automatic olives storage. With this storage, we can better manage all the items in society. In this storage, we can make an automatic selection between more types of items. For this we tested more image recognition programs.

All the software has a result of 100% to determine the correct dimension of the item and over 95% accuracy of recognizing the item itself.

This result was very good and indicates some minor errors which are not important in all technological processes.

The next test was to determine the delay time between the moment when the item is in the conveyor in front of the optical reader and the moment when the selected device chooses the item.

Also, this test shows good results and indicates, in all software, a delay time between 0.09 sec and 0.12 sec, which is faster than olive movement speed on conveyor that is 0.7 sec.

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