FIRE RESISTANT RECOGNITION SYSTEM

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ABSTRACT: In this paper, we aim to develop a fire-resistant recognition system in order to reduce the risk of those who are involved in intervention. In this system we will use to protect its integrity, the flame retardant polymer and it will be printed entirely in 3D. Also, for its remote control, design of the application will be developed using Python programming language. Data collection from the field will be done with the help of two cameras, one conventional and one thermal. The purpose of the conventional camera is to orient in space, while the thermal camera helps to identify the terminal signatures of potential people in danger.

KEYWORDS: 3D print, flame-retardant, polymeric, video-camera, fireman

1. Introduction

The use of polymeric materials, including clean polymers with mixtures and composites, has significantly improved the quality of our lives. However, there are fire hazards in nature due to climate change. The analysis of the evolution of flame retardant polymers involves exploring the role of conventional systems as well as new flame retardant systems used in polymer technology. The evolution of flame retardant polymeric materials can be analyzed from different perspectives, depending on the materials, techniques and processing applications used. The classification of polymeric materials in terms of fireproofing performance, allows the selection of the best material. The use of confidence indices based on the fire performance of a polymer is very important. [1]

3D printing or additive manufacturing is a process of making three-dimensional solid objects by adding layer after layer. Physical objects are produced using the data of a digital model or a 3D model. 3D printing allows the creation of complex structures and parts, which can not be produced by conventional production methods, can easily create complex geometries, ensuring great freedom in design. Another advantage is that the modeling of complex parts can be done in one thus eliminating the need to assemble component parts. [2]

2. The current stage

To achieve a fire-resistant recognition system, 3D printing is used, with a flame retardant filament, which will ensure the protection of the components of the system.

A thermal camera is a device that creates an image using infrared radiation, similar to an ordinary careme that forms an image using natural light. Compared to the range of 400-700 nanometers in which an ordinary camera falls, infrared cameras are sensitive to wavelengths from about 1000 to 14,000 nanometers. The camera lens focuses infrared energy on a set of detectors which also creates a detailed pattern called a **thermogram**. The thermogram is converted into electrical signals in order to create a terminal image that can be seen and interpreted as well. The thermal camera has internal measuring devices that capture infrared radiation, called microbolometers and each pixel has one. The microbolometer records the temperature and then assigns that pixel to a suitable color, which then shows that they are transmitted on the camera screen. (Fig.1)

Fig.1. Example - thermal camera app [3]

In most cases, polymers initiate or propagate fires because, being organic compounds, they break down into volatile combustible products when exposed to heat. However, in many fields such as electricity, electronics, transportation, construction, etc, the use of polymers is restricted by their flammability, regardless of the importance of the benefits that their use can be considered. To meet these requirements, flame retardants must be added to the polymer in order to slow down the burning and degradation of the polymers (extinguishing the fire), reducing the smoke emission. [4]

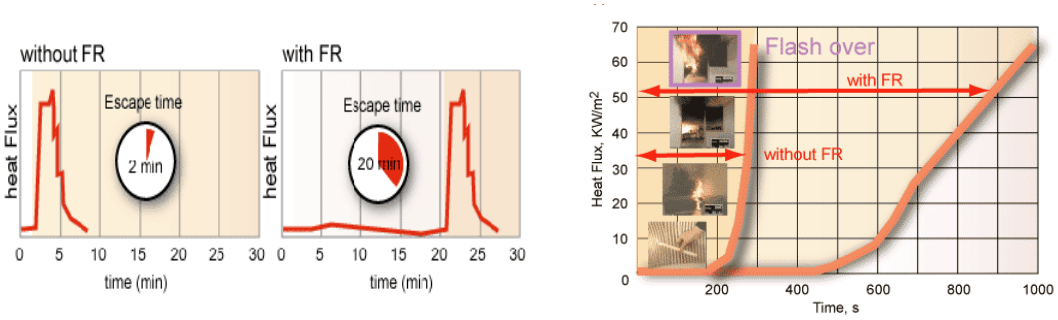

Fig.2. The difference between burning time, in case of usage flame-retardant material over any other [4]

3. Marketing strategic of the proposed product

The portfolio of customer needs has been established taking into account the characteristics of the products already on the market and the demand that exists in the field.

This has led to a main need of studying market opportunities, customers and already existing products that meet this primary need: the one to check risk factors during a fire.

For the identified need, we have as market opportunities the following aspects: the need to obtain information before and during a firefighting intervention and a small variety on the market of existing products of this type. The products that meet this need are: **drones** and **thermal imaging cameras**.

Potential customers for this product are: **fire departments** and **special intervention units**.

Customer selection involves identifying actual and potential customers who could benefit from this product.

The table below shows the customer selection matrix, see Table 1.

Table 1. Customer selection matrix

	Top users	Users	Retailers	Service center
Fire departments	3	4	1	2
Special intervention units	2	2	1	

Data from potential customers:

The following survey is used in order to the case of product marketing, was sent and completed in an online form and it covers the following questions:

1. Are you currently using a device to retrieve data on the spot in an emergency?
2. Do you find such a device useful?
3. Can the current device be used in high temperature conditions?
4. Is it easy to use?
5. Is it easy to maintain?
6. On a scale of 1-5 how maneuverable is it?
7. Does it have a user manual?
8. Does it have a maintenance guide?
9. Is it a durable product?
10. On a scale of 1-5 does the current device increase the safety of the intervention crews?
11. Does it allow the collection of information in dense smoke conditions?
12. What improvements would you make to the current product?
13. Other improvements

Hierarchy and relative importance

After a brief study of the answers and the interpretation of the customers' needs, a group was made of the main ones and then, their relative importance. The form was completed using grades from 1 to 5, depending on importance considered.

Table 2.Selection matrix

No. Crt.	Customer requirments	Relative importance
1	FRRS is used in special interventions	5
2	FRRS can process data in extreme conditions	5
3	FRRS has a maintenance and use manual	4
4	FRRS it is easy to use	5
5	FRRS it is resistant to high temperatures	5

In figures 3 and 4, are presented the result graphics according to two questions from the online survey.

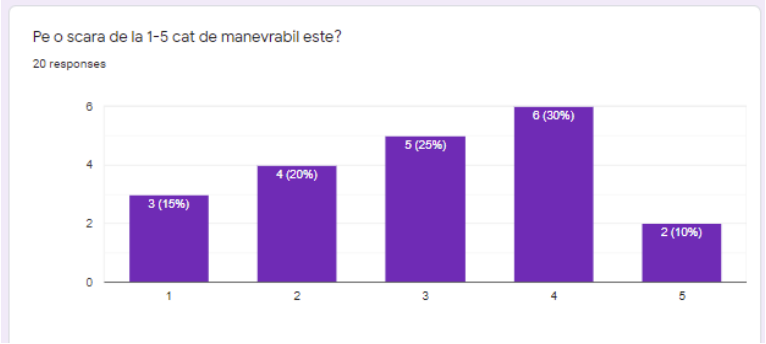

Fig. 3. Graphic representation of the q. regarding to handling

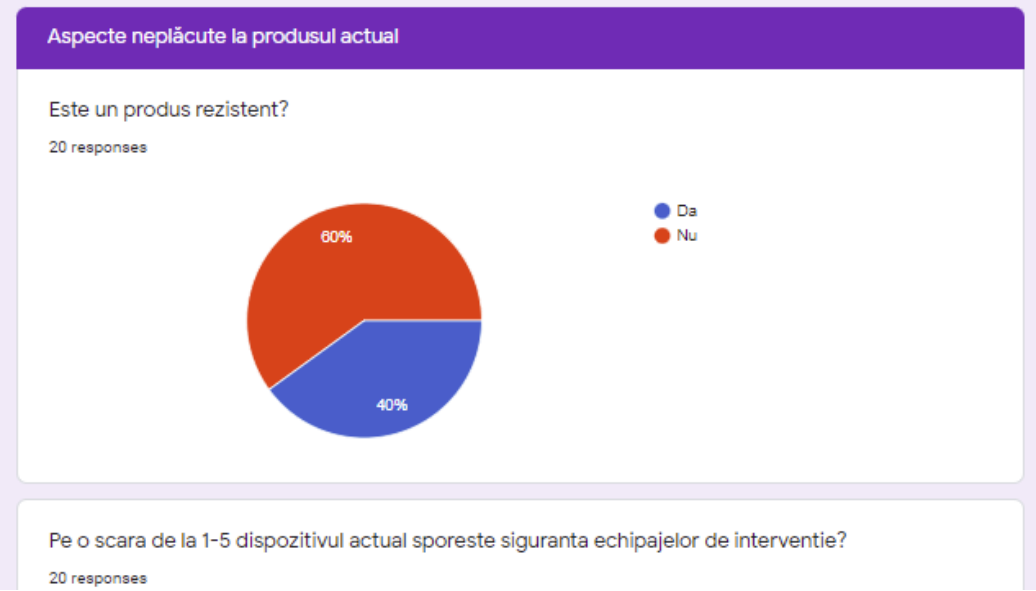

Fig. 4. Graphic representation of the q. related to product resistance

4. Establishing specs

An important step of the product development process, consists in establishing its specifications, those values and characteristics of the requirements,

An important stage in the process of developing a product is to establish the objective specifications of the product, those values of the characteristic sizes of the requirements, for which the market success of the product can be possible. These values are established according to the specifications of the competing products, so that they ensure an advantage, both from a functional and technical point of view of the developed product.

In order to determine the objective specs, a correspondence must be found between each primary requirement and the measurable quantity that characterizes it according to Table 3.

Table 3.Size requirements matrix

Requirements			Competitive products										
		The importance of the requirement	Overall dimensions	Wi-fi	Video camera resolution	Requires Installation	Degree of detail of the maintenance and installation manual	Mass	Material	Speed	Degree of protection at high temperatures	Audible warning	Selling price
			1	2	3	4	5	6	7	8	9	10	11
1	FRRS is used in special interventions	5	●	●	●			●		●	●	●	●
2	FRRS can process data in extreme conditions	5		●	●				●		●		
3	FRRS has a maintenance and use	4				●		●				●	
4	FRRS it is easy to use	5				●	●					●	
5	FRRS it is resistant to high temperatures	5							●		●		

In order to establish the ideal objective values and acceptable limit, a size is chosen for each size ideal goal (the best result the team can hope for) and an acceptable threshold (value that allows the product to be commercially viable) according to Table 4.
The following expressions were used for this purpose:

Table 4.Objective specifications (Limit values and ideal values)

No.	No. requirement	Characteristics/Specs	Feature type	Relative importance	Units	Limit values	Ideal values
1	1	Overall dimensions	STB	5	mm x mm x mm	280 x 242 x 300	256 x 220 x 260
2	1,2	Wi-fi		5	Yes/No	Yes	Yes
3	1,2	Video camera resolution	GTB	5	MP	5	12
4	3,4	Requires installation		5	Yes/No	Yes	No
5	4	Degree of detail of the maintenance and install manual	GTB	4	Scale 1-10	7	10
6	1,3	Mass	STB	4	Kg	3	1.5
7	2,5	Material		5	Material	Aluminium	Fire resistant material
8	1	Speed	GTB	4	m/s	0.5	1
9	1,2,5	Degree of protection at high temperatures	GTB	5	%	70	90
10	1,3,4	Audible warning		3	Yes/No	Yes	Yes
11	1	Selling price	STB	5	Ron	1500	1200

5. Conceptual design

The system of phenomena used to develop the general function **"Facilitate special interventions":**

Table 5. The main functions of the FRRS

No. function	Name of function
1.	Facilitates special interventions
2.	Retrieve data in extreme conditions
3.	High temperature resistance

The classification tree for the product “Fire-resistant recognition system (FRRS)”.

Ø = **Facilitates special interventions**

$Ø_{11}$ = *easy to use a FRRS*

$Ø_{111}$ = severity

$Ø_{112}$ = friction

F_{122} = muscular force in order to press the screen

F_{122} = muscular force in order to press the keys

$Ø_{12}$ = *retrieve data under extreme conditions*

F_{121} = wifi signal diffraction

F_{122} = wifi signal absorption

$Ø_{14}$= *High temperature resistance*

F_{141} = the actuating force of the surrounding elements

6. Detailed design

Detailed design was addressed in the SOLIDWORKS design program, but also using the 3DEXPERIENCE xShape application. The FRRS housing was made by surface modeling, while the locomotor system was based on displacement with the help of a track assembly.

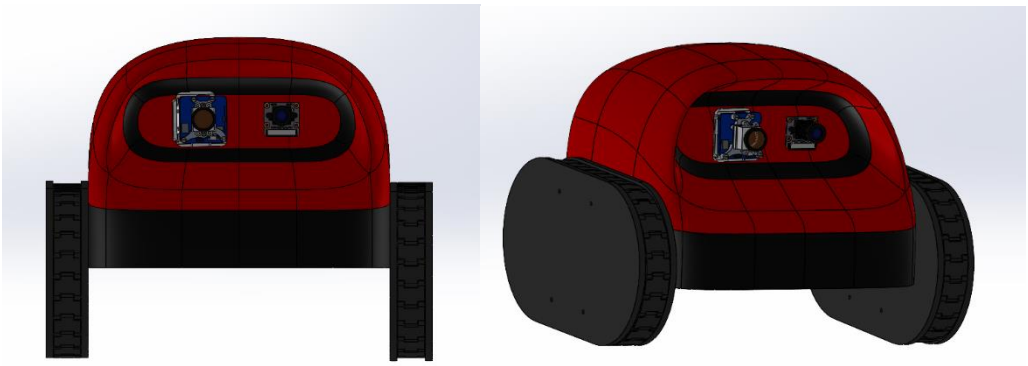

Figure. 5. Fire resistant recognition system (FRRS)

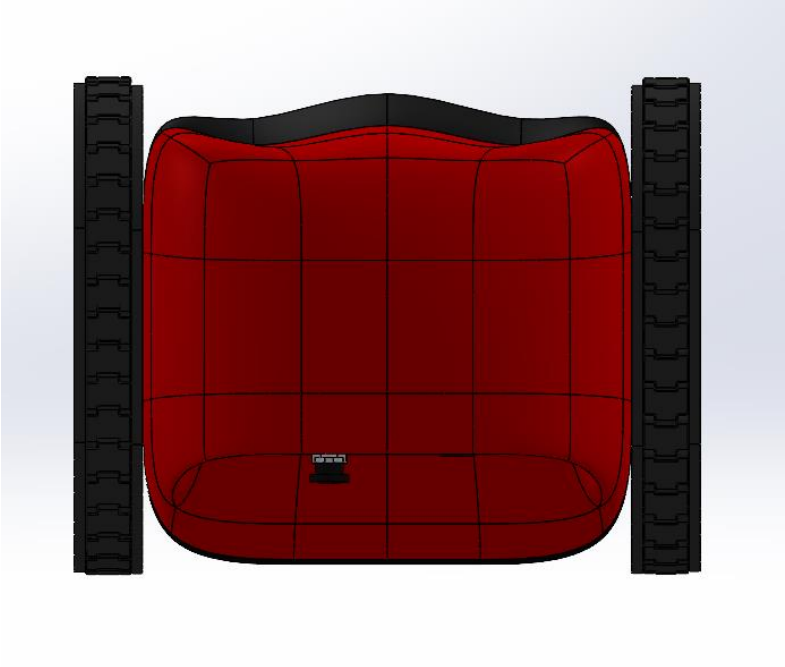

Figure. 6. Fire resistant recognition system (FRRS)

7. Conclusions

To sum up, the main advantages of the presented system are the two cameras that help to control and identify the possible immediate dangers, the reduction of the risk to which the rescue teams are subjected in the rescue mission and the low cost of manufacturing the robot, due to the means used.

Various concepts have been developed in order to achieve the final fire resistance recognition system; Following a thorough analysis, a final version was chosen that was modeled in 3D using the SOLIDWORKS program.

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