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QR AND 3D TECHNOLOGIES INTEGRATION IN CHILDREN'S SAFETY PROJECTS

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Abstract. *The paper focuses on QR and 3D technologies that can be integrated in safety project. There have been analyzed different situations of children's missing in USA, Europe and Ukraine. Advantages of QR code using and its creation have been justified. There have been analyzed general properties of PLA plastic, its benefits and its harmlessness for the nature. 3D printing ease of use has been defined too. There have been described all elements of the developed product for children's safety. The database for QR code has been analyzed. Results of parents' poll according to the idea have been showed too. There has been analyzed situation about the interest in the developed product.*

Keywords: *3D printing, QR code, project, safety, accessory, children's missing, biodegradable PLA plastic*

I. INTRODUCTION

In the US, a child goes missing every forty seconds. About 840,000 children go missing every year, and the FBI estimates that 85-90% of them are children up to 12 years old. Most missing child reports are resolved within a few hours, but many involve situations where a child has been missing permanently or for an extended period of time [2].

Every two minutes a child goes missing in Europe. Missing Children Europe collects call statistics from twenty two "116,000 hotlines". In 2021, there were more than 54,655 calls about missing children, including 13% compared to the previous year. Let's describe the statistics. 57% of these cases are associated with running away from home, 26% of cases of parental abduction, 6% are associated with child migration phenomena, 2% are associated with lost or injured children and 8% of other types [14].

The protection of children is a priority for Renew Europe. Every year, thousands of children go missing. Although there is no statutory publication of statistics on missing children in the EU, some organizations estimate that 300,000 children disappear every year. This terrible situation cannot be allowed to continue.

With the illegal invasion of Ukraine by the Russian army, children are extremely vulnerable. According to UNICEF and UNHCR, over 100,000 unaccompanied minors have been forced to flee the conflict. They are at enormous risks.

Today, during martial law and other difficult situations in Ukraine, in particular, during the evacuation of children to other regions of Ukraine or abroad, children can go missing. Let's remember one situation, which photo was on all world newspapers (see Fig. 1).

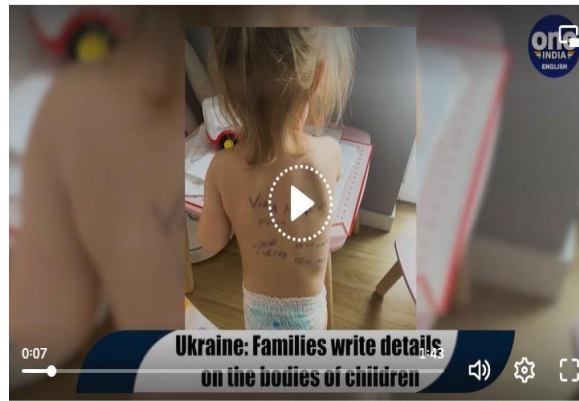


Fig.1. Screen of international news about Vira Makovii

When the war began, a Ukrainian mother scrawled contact information on her daughter's back. On the first day of the war in Ukraine, the roar of bombs falling on the streets near Kyiv made it almost impossible to write a pen on my daughter's tiny, bare back, and it was necessary to write down the information. The result was a messy scrawl: Vira Makovij, 10.11.19 is the name and date of birth of her child. Two phone numbers followed, one is “Mama” (mother) and one is “Tato” (father) [15].

The mother narrated that she did so in the hope that if she died during the war and only Vera survived, someone would be able to connect Vera with her other surviving family members.

It was a hasty action. So this information could be erased from child's back. Then nobody could help this little girl, because she didn't talk. However, this problem arises not only during martial law, but also in everyday life situations.

The purpose of the study is developing unique accessories to help parents to find their missing children with the combining 3D printing and QR code technologies.

II. LITERATURE ANALYSIS

One of the main directions for development of Ukraine and other country is the sphere of ensuring the children's safety. In last years issues of children safety have become an acute problem in our country. At the same time, the search for new approaches and technologies to the development of more effective projects to ensure the children's safety of has been continued too.

Children's safety projects were carried out by different scientists from Ukraine and other country [12, 7].

The actual problem of identification of young children who cannot identify themselves is existed. The approach for identifying children through a combination of QR code technology and 3D printing has been proposed.

Similar technologies are used in a digital pet ID tag. This tag has a QR code that links to the pet owners' contact details. Advantages of our technologies were described in the problem solving according existing approaches.

Special research methods - collection methods and generalization of information,

critical analysis and forecasting as well sociological survey methods and statistical data processing with the help of Microsoft Excel have been used.

III. OBJECT, SUBJECT, AND METHODS OF RESEARCH

3.1. QR CODE TECHNOLOGY PROGRESS

The increasing of mobile Internet and portable devices have opened up a wide range of possibilities to the world. Nowadays QR codes using has become an integral part of everyday life and work. QR codes are found on places and items such as business cards, electronic devices, magazines, and T-shirts. A QR code (quick response code) is a type of barcode that is easily read by digital devices and stores information as a set of pixels in a square grid [9, 11].

The data stored in a quick response code can include website URLs, phone numbers, or text up to 4000 characters long. Abundantly smartphones have a built-in QR scanner, and some even have it built into the camera. QR Scanner is an easy way to scan QR codes. QR code scanning with the help of our device is very easy. Three simple steps must be made:

- 1) QR reader app or the camera on your smartphone must be opened.
- 2) The camera at the QR code must be pointed. The information you need, no matter what angle you point the camera at, can be got.
- 3) The data must be immediately displayed on the screen. For example, if the QR code contains contact information, your phone should download it immediately.

The QR code generation software does not collect personal information. The data it collects and shows to the creator of the code includes number and time the code, location was scanned, and the operating system of the device that scanned the code (for e.g. Android or iPhone) [9].

Although QR codes can serve many purposes, there are 4 widely accepted QR codes' versions. The data that is stored and is called the "input mode" is determined in your version. There are binary, numeric, kanji or alphanumeric. The type of mode is transmitted through information field version in the QR code [1].

Byte mode is used for characters from the ISO-8859-1 character set. It can store 2953 characters.

Numeric mode is decimal from 0 to 9. This mode is the most efficient storage mode, allowing you to store up to 7089 characters.

Kanji mode is for double-byte characters in the Shift JIS character set and is used to encode Japanese characters. It is an original mode that is pioneered by DENSO WAVE.

Although, it becomes the least efficient after that, saving only 1817 characters. The second kanji mode, called Extended Channel Interpretation (ECI) mode, allows you to specify the UTF-8 kanji character set. Although, some newer QR code readers cannot read this character set [9].

.Alphanumeric mode is used for decimal digitals from 0 to 9, plus uppercase letters from A to Z, and symbols +, -, ., \$, %, *, : and / as well as a space. Everyone can store up to 4296 characters.

Two additional modification modes of the other types are too. Structured Append mode encodes data by multiple QR codes and can read up to 16 QR codes at the same time. FNC1 mode allows you to use QR codes as GS1 barcodes.

QR codes can store a lot of data, while they may look simple.

But no matter how much it contains, scanning a QR code should give the user immediate access to the information. That's why it's called a quick response code.

3.2. ADVANTAGES OF 3D PRINTING TECHNOLOGY

The QR Code, printed on the product packaging or the other paper goods, is difficult to read because the packaging material can be slightly wrinkled or uneven.

The advantage of printing a QR code on plastic is that its surface has gradation. It could be more useful to print QR code on some hard surfaces. It will help to scan this code without some mistakes.

The solution to this problem is to print a QR code on 3D things. Let's describe all advantages of 3D printing. Additive manufacturing or 3D printing is the process of creating 3D solid objects from digital files [13]. 3D printing contrasts with subtractive manufacturing, where metals and plastics are milled [10].

The printing of 3D goods allows complex shapes to be created with less material than traditional manufacturing methods [4]. In its early days, the printing of 3D was only good for prototyping and one-off production, but now it is rapidly becoming a manufacturing method.

PLA plastic for 3D printing must be used for our experiment. PLA (polylactic acid) is more environmentally affable than other plastics. Because it's a biodegradable polymer base, it's much more environmentally friendly than conventional plastics like ABS, which aren't likely to degrade in the next 100 years or more [3].

It takes 500-1000 years for ABS plastic to completely decompose. This problematic nature of plastic has halted plastic researchers as large amounts of plastic are produced each year and some of it continues to end up in our waterways and oceans [3, 16].

PLA is a biocompatible, renewable, biodegradable and thermoplastic polyester derived primarily from corn starch. The monomeric lactic acid (LA) in polylactic acid (PLA) is derived from natural sources. Lactic acid is produced using bacterial fermentation of sugar cane, corn, potatoes and other biomass [5, 6]. Figure 2 shows the life cycle of PLA product.

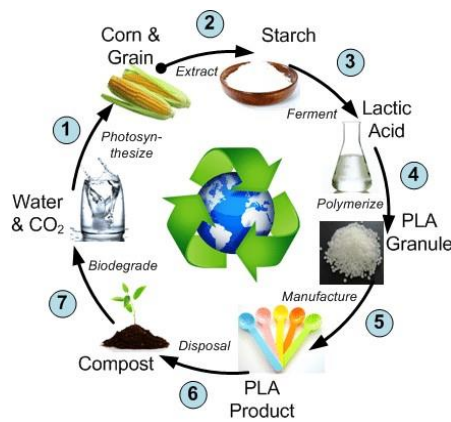


Fig.2. Energy Modelling for FDM 3D Printing from a Life Cycle Perspective [8]

Polylactic acid is a very practical material to replace petroleum-based polymers due to its excellent mechanical properties and superior processability [5]. The general properties of PLA show the table 1. Polylactic acid provides several leads over other materials, including:

- 1) Easy to 3D printing;
- 2) Environmentally well (if disposed of correctly);
- 3) Reliable for applications such as medical equipment and food containers;
- 4) It comes with a wide range of composites and color options to offer different properties and looks.

TABLE I . GENERAL PROPERTIES OF PLA

Property	Value
Heat Deflection Temperature	126 °F (52 °C)
Impact Strength (Unnotched) IZOD (J/m)	96.1
Flexural Strength	80 MPa
Density	1.24 g/cm ²
Tensile Strength	50 MPa
Shrink Rate	037-041% (0/0037-0.0041 in/in)

Polylactic acid is popular for 3D printing because it is easy to sand, paint, and post-process. An easy-to-use material, this plastic works at low extrusion temperatures and does not require printer chambers, heated platforms or heavyduty nozzles. Another advantage is that polylactic acid behaves better than many tougher plastics and does not smoke or stink. It is easy to store, can be made in a variety of colors, and can be used as a base for various composites with additional properties [17]. Made from recyclable and renewable resources, polylactic acid has many benefits for the future. What's more, with the rise in oil prices, corn-based plastics also have economic benefits.

3D printing technologies can change almost every major industry and change the way of people life, job and entertainment in the future.

IV. RESULTS

Analyzing the situation about children’s missing, measures for more children’s safety must be taken immediately. It is proposed a unique accessory that has the QR code. QR code will include some information about parents, their phone numbers or some information about the child’s illness. QR code will not contain the confident information (for e.g. about the child or parents). 3D accessory will consist of PLA plastic (that is biodegradable and decomposes totally in 12 years) and can have different design (see fig. 3 a, b).



Fig.3 (a). Unique accessory as MVP



Fig.3 (b). Unique accessory as MVP

Data Base includes the simple excel table or the simple Google's document with some information (see fig. 4).

	A	B
1	MOTHER	38050 65 56 65 5
2	FATHER	38095 59 95 55 9
3		
4	My NAME	Jack
5		
6		

Fig.4. Excel table with the information

If to talk about iPhones, there can be some problems with excel tables. So, Google’s documents would be more useful in this case (see fig. 5). If to plan create data base with some another information (not only parents’ numbers and etc.), it is used MySQL.



Fig.5. Google’s document with the information for iPhones

Another advantage of our product is the material, which does not cause allergies in children, does not tear, unlike paper or fabric. The material of our product is PLA plastic. It is safe and fully biodegradable for 12 years.

The main advantages include fast child’s identification and the communication possibility with his parents. The accessories include increased resistance to the influence of external factors and the possibility of restoring information, compared to printing with ink on paper or other materials. The information will be saved under the influence of destructive factors, such as high humidity, mechanical, thermal, chemical and other types of influence. This becomes especially relevant in the conditions of war.

The survey of 300 respondents, who are parents, was created. The next diagram shows the survey results (see fig. 6). 92 % of parents worried about the safety of their children. 74 % of parents were interested of our idea and our product. 21 % of parents wanted to use our product.

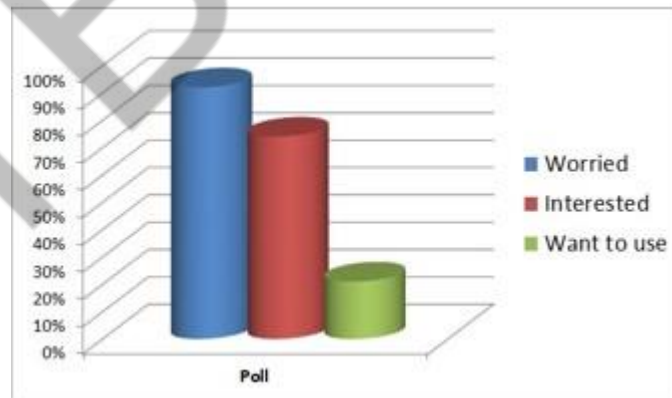


Fig.6. Results of parents’ poll according to our idea

The next stage of our research was the presentation our product and its usefulness. It has been used “Facebook” where some posts about our product were prepared, than these posts were shared in different groups (local city groups, many mothers’ groups etc.). “Tik Tok” with information about our product has been used. This social network helped to interest not only parents, but their children who wanted to have “cool” accessories and

to be different from others. This product in entertainment centers was presented too. Data analysis of various sources regarding public interest in our product is presented in fig. 7.

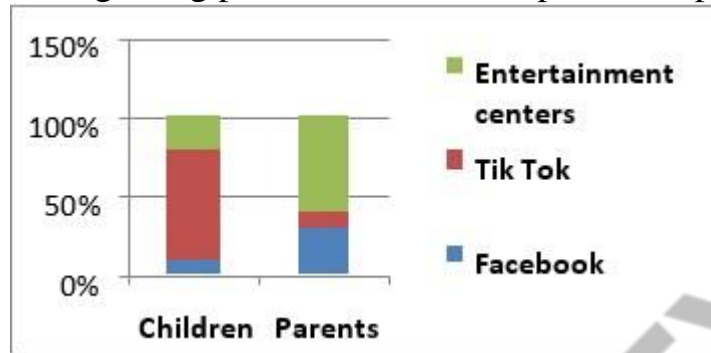


Fig.7. Results about the interest in our development

The results suggest that children are interested in using an accessory just to be fashionable. They didn't understand the importance of safety, because they are so little. Using "Tik Tok", entertainment centers and sometimes "Facebook", they asked to buy this accessory only for the entertainment.

But these results show that their parents are more interested in children's safety. And the best result of it is to present our development in entertainment centers, where it can be explained how it works and then it can be presented this accessory for some parents free.

To establish the interest of the authorities, a question about occupation was included in the survey (see fig. 8).

The results showed that 46% of people work in state structures (police, medicine, state emergency services). In this case, the interest of this category of the population in our product will allow us to bring information about solving the problem of children's missing to the authorities.



Fig.8. Results of questions about the occupation

The effectiveness of such measures will increase when this technology is integrated into child safety projects.

Our development provides integration to the children's safety projects. One of the components of these projects is training for actions in an emergency. This technique was described in the paper [12].

V. CONCLUSIONS

It has been established, that every 20 children go missing in Ukraine every day. And 1 child goes missing in Europe each 2 minutes a day. This sad statistic has been increasing every year. There is a need to provide emergency assistance to missing children.

The combination QR code and 3D printing technologies to create unique accessories that are useful and vital for children's safety have been proposed.

The QR code will not contain confidential information. In special cases, the information can be expanded and can include the blood group or the need to use special drugs (for example, insulin).

It has been established that PLA is the optimal material for printing accessories. Polylactic acid is more environmentally well then other plastics. It is safe and fully biodegradable for 12 years.

The advantage of printing a QR code on plastic is that its surface has gradation, unlike paper, which can be damaged. QR code will include the information about parents, their phone numbers or some information about the child's illness.

It is predicted that our development will be of interest to many parents around the world and can be useful in the security system of local communities, police, medicine and other emergency services.

Future research can be dedicated to development and implementation of the difficult Database, that will include information about insurance policy, child's illness and blood group or some another information. The database will include a privacy feature that will be accessible by medical, police and emergency services. This can help improve safety and save the lives of more children.

The proposed QR code and 3D printing technology will contribute to increasing the protection of children in emergencies, providing emergency medical care and quickly finding parents and relatives of lost children. The content of the information encoded in the QR code for different age groups of children, as well as the legislation of other countries, requires separate research.

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