GAMIFICATION AND AUGMENTED REALITY IN AGRICULTURE – EDUCATION AND PRACTICE POSSIBILITIES

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Abstract

By the widespread increase of new technologies, Internet has become an essential element for generation Z, however, this is not particularly surprising given the fact that over recent years different IoT solutions have become widely available, well-known and increasingly cheaper. As we know the new devices like tablets, phablets, other smart devices and new services like Cloud Computing, Augmented Reality, Blockchain and Gamification have great potential in agriculture. Gamification nowadays is a method that become more widely used depending on field of use, thus it may meet needs of businesses and also educational institutions. However, the business assessment of these technologies must not be done only on the basis of the technology and taken out of its environment randomly, since the whole area is very complex. Since we do not concentrate on learning during games, students will find learning a pleasure rather than an imposition and it means many could improve their skills or receive information without realizing they are actually studying. In this article the authors show Augmented Reality and Gamification to highlight the possibilities in agriculture.

Keywords: gamification in agriculture, future possibilities in agriculture, AR and VR technologies, IoT, IT innovations, blockchain

Összefoglalás

Az új technológiák és az internet széles körű elterjedésével a Z generáció szinte lételemévé vált a mobil vagy más IKT eszköz használata. A kiterjesztett valóság (AR) használatával sok lehetőség merülhet fel, mind az oktatás, mind pedig a szórakoztatás területén. A játékosítás vagy gamifikáció egy olyan módszer, amely rendkívül jól kiegészíti korunk technológiai megoldásait, amely segítségével a vállalkozások és az oktatási intézmények igényeit is kielégíti. Az általa megszerzett tudást a hagyományos tanulási módszerrel szemben, hosszú időn keresztül tudják hasznosítani a diákok és a munkavállalók, melyet később a munkaerőpiacon is alkalmazni tudnak majd. A módszert használói hatékonyabban és kisebb erőfeszítéssel tanulhatnak meg egy-egy munkafolyamatot vagy tananyagot játékosítás révén. Ennek eredményeképpen a tanulás ezen innovatív megközelítése egyre inkább népszerűvé vált nemzetközi szinten. További előnye, hogy a motivációs problémákra is megoldást nyújthat. Ebben a tanulmányban a korszerű AR és VR megoldások által az agráriumban alkalmazható játékosítást igyekeztünk bemutatni gyakorlati példákon

keresztül. Emellett innovatív megoldásokat is gyűjtöttünk, amelyek a mezőgazdasági robotizációt és a mesterséges intelligenciát támogatják napjainkban.

Introduction

It is expected that the world's population will reach 9.6 billion by 2050. One of the main challenges for the future of agriculture is the proportion of food, feed and energy production on the land base. The population growth increasingly enhance the intensification in the sector, to produce larger yield of the highest possible quality on smaller area. It poses a number of challenges for farmers, moreover climate and extreme weather conditions and several negative effects on the environment make it more difficult (ENSZ, 2015).

Technological development following the turn of the millennium brought ground-breaking innovations which became part of everyday life. The way we communicate and obtain information has changed profoundly with the appearance of smart devices. Devices connected to the network, namely the Internet of Things (IoT) has a significant impact on the life of simple users and private sector but it also affects technological development of industry and agriculture. By these devices entered into production processes we are living in the era of Industry 4.0 since they connected in one network and can communicate to each other and in some cases Artificial Intelligence (AI) enables them to take decisions (Popp et al., 2018). By the expansion of IoT and the devices connected, our efficiency and productivity would improve and it represents a great potential for agricultural sector. Self-driving tractors and harvesters appeared over the last decade are used as part of the precision farming also in Hungary. New technological advances and innovative solutions are expected to be emerged for the agriculture in the near future which could be built on gamification, augmented reality and continuous and sensor-based data collection. Simultaneously, a new approach is to be developed in line with the new technologies (Big Data, Cloud Computing, Artificial Intelligence, etc.) which is not based on the usual physical data storage and collection any more but with the possibilities offered by the internet, connect networks and systems. As a result of the digitalisation and technological development, agriculture has an opportunity to be a priority development area besides industrial development.

Agricultural opportunity of gamification as a method

In this study, we want to create a structured literature processing, through the AR and VR evolution. We have gathered examples of current technical solutions from the early phases to the most recent ones. First of all, we did a keyword search with the help of repositories, and then we have limited the well-known authors and methods which results are presented in detail in the next chapter. The term of gamification is described by Deterding et al. in 2011 and they defined it when a game element is used in a non-gaming environment (Deterding et al., 2011). First, the method was used as a marketing tool but through its efficiency it has soon appeared in the area of HR and education. It is important that this method is an excellent motivation tool and it is used to raise the interest of potential employees for current agricultural professions. Lee and Hummer published an article about the introduction of gamification in schools and besides the advantages they highlight also the potential risks (Lee and Hummer, 2011). It can be used both for education and further training depending on industrial development. Moreover, despite the traditional learning method, the knowledge acquired this way can be used for a long time during seminars and later on labour market. Students may learn more effectively and with a lower effort using gamification. As a result, this innovative approach of learning has been becoming more and more popular internationally, furthermore, motivation shortage problems also could be solved by this method. Applications specifically written for AR devices (e.g. Oculus Rift, Samsung VR) allow in horticulture sector to practice pruning in virtual environment where a wrong pruning move do not cause crop loss. Positive feedback in gamification is important for employees therefore they can obtain scores, coins or brooches after learning the pruning methods of certain tree species.

During our previous research a gamification application, Koronakirály (CrownKing) has been developed. We made it partly for business purposes but at the same time it is a farm simulation application since the whole agribusiness included in it and strengthen the agricultural aspect. The name of the application, Koronakirály, refers to the Hungarian system for evaluating land quality (gold crown system). Our application contains production, processing, commerce, mission, questions, statistics and weather modules which seeks to strengthen the realistic nature of it.

The location of the app is Hungary and primary objectives are production and processing, then acquiring new areas. Users can learn the different agricultural techniques, plants, yields and the basic of commerce and market in different decision making conditions. The detailed description of our app is available in our previous article (Kovács et al., 2017).

Figure 1. The CrownKing user interface, services

Source: Own figure, 2017

As the figure above presents, users can process different raw materials and produce finished products in services modules. Left side of the page contains different services from which red wine production menu item is opened, where we can see the type and quantity of raw material needed, the production time, the price and the quantity of product to be prepared. We can produce brandies from different vine variety which can be sold at higher price because of the higher added value.

During use technology, raw materials, costs and revenues also can be learnt thus the transition from education to work will be easier and users could have the additional knowledge needed. Besides professional materials daily quiz questions give variety to the application which also ensure gamification and help students in learning. I mention here, as a further option, the installation of an online exam surface to help teachers and trainers in administration (Kovács et al., 2018).

Penetration of augmented and virtual reality

It is important to note that the term of virtual reality and augmented reality is not the same, however, several publication use them as synonyms (Azuma, 1997). The location means the difference between the two: when virtual headset (e.g. Oculus Rift) is used, we get into an artificial environment where the given game or application take place thus the reality is excluded, while in the case of augmented reality we stay in the same place and the different virtual items will be projected here. In augmented reality we watch some content through the camera of our smart phones or tablets and a specifically developed application projects images or information there (Szűts, 2011).

IKEA applied AR technology among the first. They developed an application which took much weight off the people's shoulders who intended to purchase furniture. This app shows furniture in that room where they would like to put in so they can match the new item to the wall colour and the existing furniture. For this, the camera have to be pointed where one would like to put the furniture and the application will paste it to scale anywhere in the scanned place.

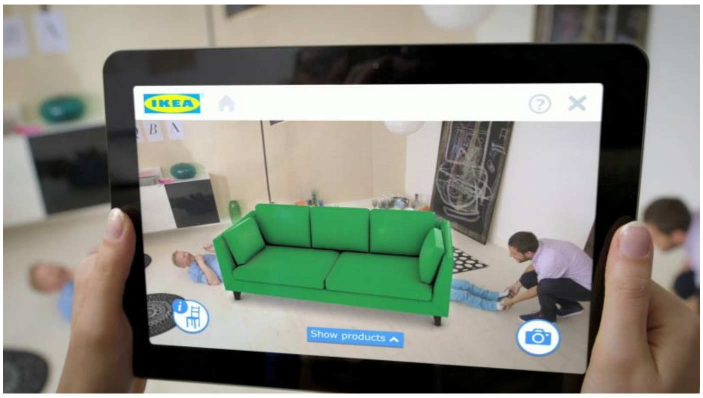

Figure 2. Ikea's AR application (IKEA place)

Source: I1, 2018

After this, Google developed a new Maps assistant which displays a fox when we use the GPS and it have to be followed to reach the destination. This development is an AR application and known as Visual Positioning System (VPS).

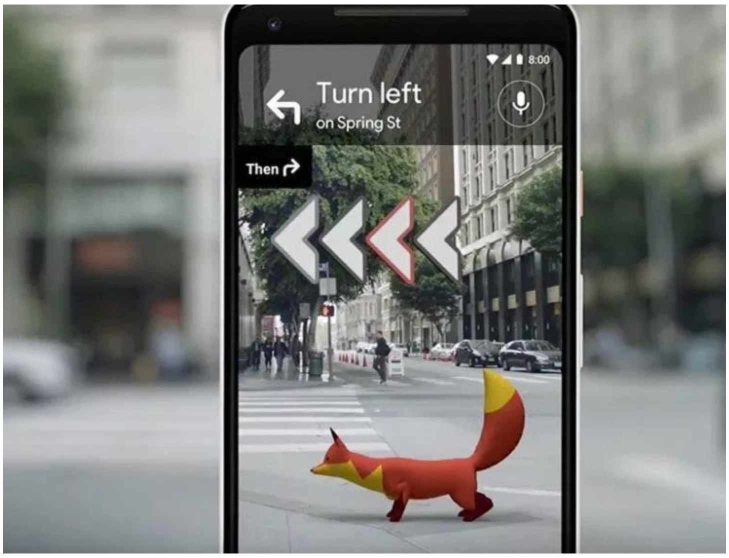

Figure 3. Google (VPS)

Source: I2, 2018

Microsoft's HoloLens is another tool as a displayer of augmented reality. Contrary to Ocolus Rift, which is one of the most well-known application, HoloLens displays virtual images and information as a hologram in real space and on real objects (Székely, 2015).

Among agricultural VR applications I highlight Bayer's development, Bayer VR farming. Gamification also plays a role in the application through games to solve and besides it, ecosystems and pests of certain soils also can be known (Figure 4). The application points out the possible reasons of the crop failures and makes various suggestions for prevention.

Augmented reality is now a relatively new technology, however, it has become more widespread, popular and available. Augmented reality, which was only used in scientific environment, has been involved in everyday life of simple users by the penetration of smart phones.

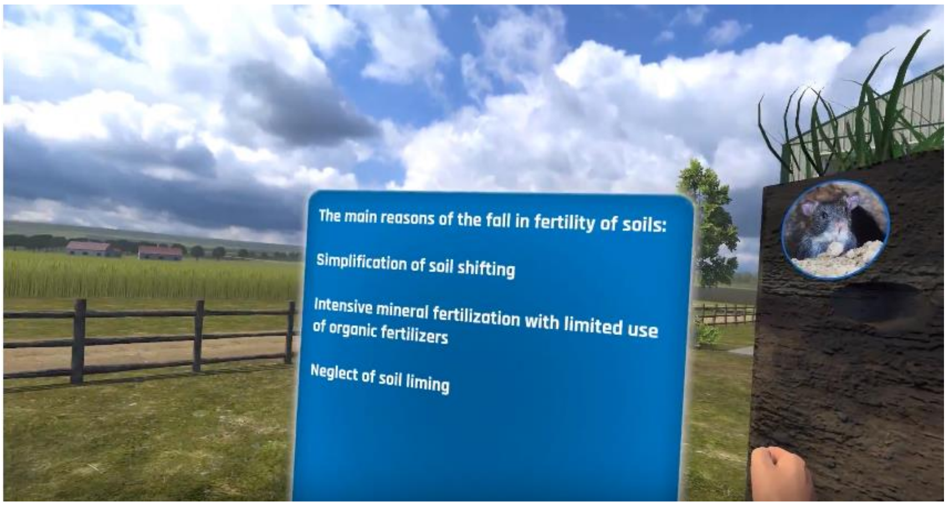

Figure 4. Bayer VR farming

Source: I3, 2018

Besides applications developed for educational purposes to help learning and provide practical knowledge, special dedicated software developer companies also have appeared with the aim of entertainment. It can be seen that both AR and VR technologies hold huge potential and they are present in everyday life when one plays, learns, uses GPS or plays sport. Furthermore, virtual tourist assistance services are also available today, an application presents tourist attractions and programs of Szolnok for visitors (Ráthonyi and Ráthonyi-Odor, 2017). This example demonstrates well the expansion and applicability of these innovative solutions both in scientific and daily life. Among agricultural VR games, Harvest Simulator is trying to make young people like farming through game. The weakness of the software that it is not platform neutral and in this way it is only available for Mac computers and PCs in single player mode. The software allows users to carry out different production tasks combined with missions in a virtual farm.

Innovative technologies and IT solutions for agriculture

As outlined in the previous chapter, AR, VR and gamification products have appeared not only on the market of everyday applications but it is used in different industrial sectors as specific software. The rapidly evolving informatics sector, the growing number and widespread usage of IoT devices with the decrease of their sales prices establish the possibility for innovative agriculture that could have been imagined only in the industrial sector a few years ago. Appearance of smart phones, smart bracelets and fitness tools in livestock farming and in sensor-based agriculture has begun as a result of the decrease in their price. This part presents briefly these innovative solutions. In Scotland, a smart collar developed by a start-up in Glasgow (Figure 5) has been applied for research and monitoring purposes since 2010. The concept of its operation is that the collar can sense when a cow is ready for mating since it indicates evidence entering oestrous (moves more, looks more restless), and the collar sends a message to the smart phone or laptop of the employee (King, 2017).

Figure 5. Smart neck Collar for Cows

Source: I4, 2018

Another system applied in another dairy farm has been examined by a research group of Osaka University. The method has been used to reduce lameness of cows which means 99 per cent of cow diseases. In this case movements of cows were studied in a farm monitored by video camera and their walk has been analysed. An artificial intelligence based algorithm was carried out for early detection of the disease and it can predict the cows affected by lameness at an early stage. The software has proved an effective tool for indicating lameness in moderate or severe stage in the experimental period (I5). A camera surveillance has also been carried out in Belgium where hatching and behaviour of broiler chickens were analysed by a research group and in 90 per cent of the problematic cases the system warned employees in time. Moreover in Beijing, AR was introduced with a special method of teaching students to implement virtual mapping of strawberries using the D'Fusion framework (Sheng et al., 2013). However, outstanding technology developments using IoT have taken place not only in livestock farming but crop production. German researchers are seeking to decrease the amount of fertilizer based on multispectral aerial images using drone technology. Infrared and near infrared spectral range allow them to assess the condition of the biomass in the area which indicate the supply of water and nutrient elements. In addition researchers may estimate production. Researchers found that in three years 34 kg nitrogen can be saved on average per hectares in the case of oilseed rape (Brassica napus). Various types of agricultural robots using sensors also appeared to help farmers measuring humidity, air pressure, soil compaction, water supply and collecting many other data on an ad hoc basis, in real time.

During an experiment carried out in England, given the name ‘Hands Free Hectare’, only robots were applied during the production of one hectare of spring barley (I6). In their experiment, Xiong and his colleagues carried out an algorithm and built an agricultural robot for weed detection using laser-based technology and in this way it could weed mechanically in real time (Xiong et al., 2017). Image processing detected weeds with a precision of 97 per cent, in addition, it determined the shortest possible route for effective weeding. This solution is an excellent example for illustrating the potential of these environmentally friendly, AI based technologies and proving that they could have an essential role in the agriculture of the future instead of introducing new herbicides and chemicals and increasing their quantity.

As a new technique, blockchain is known from crypto-transforms. Of course, nowadays, the use of block chains appears as part of supply chain management at some companies. As food counterfeiting is stronger on the Far Eastern market than in Europe, the Kerchin cattle Industry has introduced the tracking of the production and transport of frozen beef, which already accounts for 10 percent of its online sales. The importance of technology is demonstrated by the fact that the European Union and China, within the framework of the EU-China-Safe project, have decided to start working together on the use of blockchain technology to raise food safety regulation between the two regions. The use of the block chain in the tracking of agricultural products is an excellent opportunity, as vertical integration can be developed with smaller farms and producers. Wolfert et al indicate the sharing of information as a key factor for effective smart farming, but do not write about trust among the chain actors. Two scenarios are outlined when the first is an open collaboration system, the second is closed (Wolfert et al., 2017) In our opinion, the spread and introduction of closed systems in the coming years is more likely due to GDPR.

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Conclusions and future prospects

The aim of this study to highlight current technological development in agriculture through some example and how these solutions got into the sector. We presented the opportunity of gamification, AR and VR technologies in education and employee retention and their application in IoT and robotisation. It is clear that agriculture has to face with the rapid population growth, the crop loss caused by natural disasters or damages, the weather variability and the adverse age composition. Almost 20 years ago Kapronczai described that agriculture profession is considered less attractive (Kapronczai, 2002). Popp described in 2014 that the better qualified a person working in agriculture, the more possible he will leave this profession in the short term (Popp, 2014). High level digitalisation and application of IoT devices could mean the solution for all these problems. The presented experimental examples from abroad define well the future possibilities, those trends which should be followed by the agricultural companies of the future. Sensor-based farming is not a new phenomenon and it can be considered the cornerstone of the precision agriculture and the reduction in the price of these devices allows farmers to use modern technology during production or processing. In addition, researchers try to take into account the issue of sustainability to reduce the environmental footprint of the agriculture (using less fertilizer, chemicals, etc.). However, not only hardware innovations diffuse into agriculture but different ISO standards also contribute to the spread of environmental management schemes (EMS) (Ridley, 2001).

In summary, the technological development in the agriculture slowly begun. Smart farms have appeared and in the near future robotics is also set to play an increasing role in production. Several studies point out that potential in livestock farming may be greater as the automation of horticulture and other intensive plant cultures is very difficult even with current technologies. Thus, precision farming built on sensors and smart farms represent the future. However, prices of the presented devices are constantly falling, high investment costs mean barrier for domestic application. Although it is important to consider that despite long-term rate of return we can do a lot for our environment with the use of these technologies which will facilitate sustainability.

In addition, we cannot ignore the fact that the biggest limit in Hungary is the lack of capital for farmers, and the fragmented property structure is also hindering for the benefit of these innovative investments.

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