A mobile application for building smart water consumption habits

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Abstract. The article substantiates the necessity of forming environmental culture in the field of water consumption using software products. The paper creates a concept of a smart information system that combines a mobile application and technical devices that provide real-time control of water consumption and the occurrence of abnormal or emergency situations that significantly increase water consumption. Algorithms realizing the functional capabilities allow collecting and processing data from these devices and promptly recommend effective control actions. In addition, an interactive game is available to the user, which implies periodic performance of tasks related to household environmental literacy. Using object-oriented design methods, a user graphical interface has been created and a fragment of such a game is presented in the paper.

1 Introduction

Modern human actively uses different mobile applications in his professional activity or everyday life [1, 2]. The report of the Data Reportal analytical platform performed jointly with We Are Social and Meltwater companies, notes that the growth in downloads of mobile applications is 4.1% (estimated period April 1 – June 30, 2023) and equals 38.6 billion, and users spent $33.8 billion in three months on in-app purchases and the annual growth in consumer spending is 6.1% (+1.9 billion dollars).

Such popularity of mobile applications is not accidental. They are convenient to use at any time of the day without being tied to a specific place (e.g., when traveling in transport, while waiting for an order, etc.). The Data Reportal analytical platform’s report indicates the following among the main reasons for using apps in everyday life (in descending order from the most popular answer to the least popular): researching news and events, search for inspiration, search for information about products and brands, educational purposes and branding.

At the current stage of development of mobile applications functionalities that allow organizing human life, in order to improve the comfort of living, saving resources, operational management of resources or devices, etc. are actively provided for users [3, 4].

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In addition to the obvious convenience for the user, the interconnection of equipment is additionally provided, establishing a single center of control and task completion monitoring, the possibility of flexible management appears, the overall security of connected objects is increased, etc. [5, 6]. At the same time, part of the tasks can be implemented without direct human participation: program algorithms based on the received data (e.g., from metering devices) are able to determine corrective actions to achieve comfortable or safe conditions (depending on the situation) in automatic mode [7, 8].

The process of smart water consumption cannot be realized without the use of digital technologies. They are the technical means capable of continuously monitoring the processes occurring in the elements of water supply (e.g., pumping stations, pipelines, sewers), diagnose problems of water distribution and consumption, and determine and recommend actions that can change his attitude to water consumption in order to save resources to the user.

Thus, the aim of the research is to create the concept of a mobile application that provides smart water consumption by the user. For this purpose it is necessary to perform the following tasks: to establish objects and processes in the daily life of a person related to water consumption; to establish the rules of their interaction and formalize the results obtained; to develop a description of the main functionalities of the application depending on the categories of users; to develop the user interface layout.

The theoretical significance of the study lies in the creation of a model of human water consumption depending on his activities. The created model includes a description of all processes and related objects and parameters affecting the rate of change of states. The obtained results can be used in integrated intelligent systems that provide control of the state of natural resources and engineering systems, for popularization of careful attitude to nature and creation of public or private programs to support environmental movements. This is the practical significance of the study.

2 Materials and methods

With the help of theoretical research methods the description of objects and processes of the subject area was obtained, and the links between them were established. For this purpose, the methods of abstraction (objects, processes and their properties related to the research objective were selected and studied), analysis (the constituent parts of objects and processes were established), synthesis (the rules of interaction in the studied subject area were determined) were used. The listed methods are used in the works to create a formal description of the object of study to create the terms of reference for the development of a software product [9, 10].

The object-oriented design method was used to create the concept of a mobile application and transform the processes that ensure the functioning of the software product and create a prototype of the corresponding user interface. It allowed applying the principles of hierarchy, typing, access restriction, modularity, parallelism and abstraction to formalize the behavior and relations of objects. As it is noted in the works, in which this approach is used in creating complex information systems, it is possible to create models reflecting the logical and physical structure of any system based on the results of which the program code is created [7, 11, 12].

3 Results

The formation of certain habits in a person requires constant repetition of the same actions in similar situations [13]. Thus, at the heart of the functionality of the mobile application
should be templates of situations related to a certain topic, when performing which either some actions or the final result will be repeated. This can be achieved through the realization of an interactive process, when the user reacts to changes in the application, and the application, in turn, evaluates these actions and changes its state accordingly. To exclude the randomness of the user’s reaction to changes in the application state as much as possible, it is necessary to inform him of the best way to behave in this situation constantly. In any case, it is impossible to exclude a negative behavior scenario.

Modern software products are an ecosystem that includes many objects that ensure their synchronized operation. For example, sensors measure changes in environmental conditions (temperature, humidity, light level, soil acidity, etc.), technological objects (presence of pipe depressurization, voltage rise, etc.) and transmit them through communication channels to an expert system, which processes the received data, analyzes the changes and makes a decision (or forms recommendations to the user) to change the operation of the corresponding devices (or implementation of processes) to create comfortable conditions for humans (animals, plants, etc.).

The combination of such two approaches in one mobile application allowed obtaining a software product that forms habits of smart consumption of water resources. The provisions of its concept are as follows:

1. The use of technical means and algorithms of data processing in real time mode carry out “observation” of the level of water use by the user in his life and form a set of recommendations to improve this process.

2. Involvement of the user in self-improvement in the field of water resources consumption and active involvement of the user in the process of careful attitude to natural resources using game technologies.

The realization of the first provision of the concept is carried out by integrating “smart meters” into the ecosystem of the designed software product. They are able to send real-time data on the consumed volume of water. Such information allows showing deviations from the norm of water consumption for a certain period of time. For example, with the help of such information it is possible to correct the duration or frequency of filling the bathtub for water procedures, using additional faucet nozzles to reduce the volume of water when washing dishes, etc. This allows controlling water consumption, on the one hand – to conserve water resources, and on the other hand – to reduce money spent on utility bills. In addition, the processes of automatic transfer of meter readings to the management company and keeping statistics of water consumption are realized. This is especially important if there are several premises.

The use of “smart meters” in the given examples is carried out in normal mode, i.e. during everyday water consumption. However, due to technical failures of equipment, wear and tear of communications or emergency situations, unplanned and uncontrolled water consumption is possible (e.g. for some reason a pipe is damaged, due to wear and tear of faucets water drips from the faucet, etc.). A person may not pay attention to some situations, considering it insignificant (for example, dripping from the faucet), or be absent for various reasons in the room when the pipe burst, then the use of touch sensors integrated into the ecosystem of the designed software product will allow to promptly notify the user, recommend to call specialized specialists or emergency services (depending on the situation).

The realization of the second provision of the concept was carried out with the help of a game belonging to the genre of life simulator with the character chosen by the user. Fig. 1 shows an example of a mobile application window with such a character and a recommendation from him.
The user is required to care for a selected character, which changes depending on the user’s level of engagement and the success of his/her actions. If the actions benefit the character, the character is happy and gets better, while sharing some new eco tips and adding eco points.

Tasks appear periodically depending on the time of day and the character’s mood. For example, in the morning the character wants to brush his teeth and recommends to save water, in the afternoon and evening – there are mini-games (wanderings with collecting useful products, sorting garbage, etc.). Accordingly, information about where the nearest collection points for certain types of waste are located appears as recommendations.

For successfully completed actions the user receives points, which can be exchanged for bonus points or coupons of partners supporting the development and operation of the application.

The mobile application can be used by two categories of users (not including the category of users who administer it), which correspond to two age categories:

1. The first category: children and teenagers. The functionality is limited to gaming functions only. At the same time, parental control is exercised over the expenditure of bonus points received when completing tasks.

2. The second category: adults (18+). For this category all functions are available: management and control of water consumption, game mode and store (recommendation of service providers for installation or replacement of devices, as well as sellers for technical means and devices).

At the same time, scenarios and characters for different categories may differ.

4 Discussion

The results obtained coincide with those from work related to the design and development of software products. This is due to the classical use of the stated methods, which are common in the software life cycle model.

When designing a mobile application or information systems in related works, the first stage has a set of functionalities determined depending on the formulated goal and target audience [2, 4, 7]. Based on the results obtained, the categories of users who have access to certain resources and actions in the system are defined, and its behavior scenarios are formed. As noted in studies that implement the approach of separation of functionalities, in this way the distribution of processing of technical and user data is carried out [1, 6, 8].
Creating a user interface with object-oriented design methods allowed making a hierarchy of graphical elements located on each screen, to establish the principles of inheritance of their individual characteristics and behavior models. When creating a user interface in the analyzed works, this approach allows systematizing and ordering the logical and physical structure of the software product [2, 5].

The anonymized data obtained during the operation of the created software product can be used as input data for sociological research within the framework of scientific works related to the involvement of the population in solving environmental problems [3, 14], as well as in simulation models modeling the demand for digital resources or software [15, 16].

5 Conclusion

Formation of environmental culture of the population is one of the priority tasks in modern society. The threats posed by anthropogenic impact on any kind of ecosystems are global in nature and require an increase in environmental awareness through a massive change in everyday habits of all people of the planet.

The mass use of smartphones and other gadgets in any sphere of human activity is a prerequisite for the creation of mobile applications, the main purpose of which is the formation of eco-habits that reduce the negative impact on the environmental situation in the world by making changes in the lifestyle of each such user. It should be noted that a software product that realizes such a concept is not a panacea that improves the environmental situation, but a means to draw attention, interest and involve a person in solving environmental problems. Therefore, special attention should be paid to the concept, the user interface of the application, and the value a user will get from the continuous use of the software product.

References

7. I. Krasnikova, L. Orlik, BIO Web Conf. 84, 02012 (2024). https://doi.org/10.1051/bioconf/20248402012
8. I. Krasnikova, I. Kulibaba, BIO Web Conf., 93, 03006 (2024) https://doi.org/10.1051/bioconf/20249303006
12. T. Dayton, A. Mcfarland, J. Kramer, Bridging user needs to object oriented GUI prototype via task object design, in User interface design, 15-56 (CRC Press, 2018)