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Predictive analytics of the state of computer devices in the inventory system

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Abstract

This article discusses processes for collecting, recording, and analyzing data about equipment and its condition. A general description of the inventory system is given and the possibilities of using a mobile application to improve the data collection process are discussed. The article describes the possibilities of using qr codes to mark equipment and simplify the process of obtaining information during the inventory process. Specific system design changes are described to be able to predict the condition of equipment and prevent breakdowns and data loss. At the end of the article possible ways of development and further application of predictive analytics technology are described.

Keywords: QR code; predective analytics; mobile application; inventory system, random forest;

1. Introduction

In the modern technological world, the functioning of all industries depends on technical equipment. It requires careful monitoring and care due to its high cost. Therefore, it is very important for enterprises to build a high-quality system for monitoring and maintaining the condition of equipment to prevent breakdowns and losses that can lead to economic costs.

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Inventory is a vital process of monitoring, managing, and controlling the stock items of an organization. Usually, dedicated people check the presence of the equipment, compare its condition with the original one every year and prepare reports.

Every year people automate all more processes, shifting them onto machines in order to stop performing routine tasks. This goes for inventory too. Optimization of the inventory process will lead to faster time spent on this event and saving human resources. Therefore, it is necessary to develop a special system that will simplify the inventory process.

Our inventory system consists of two interacting parts - the server and the mobile application. The function of the server side is to store information and provide it to the mobile application upon request.

2. Mobile application

The principal reasons for choosing a mobile phone as the main device for doing the inventory were compactness and the presence of a camera. Due to the low weight and size of the mobile phone, it will be easy to move it to the equipment during inventory. With the help of a photo camera, you can take pictures of the newly arrived equipment in order to compare their condition with the original during subsequent inventories and draw conclusions about the careful use of them by temporary owners and the need to return them for repair. We also need a QR-code scanner to doing the inventory. Using the one built into a mobile camera is more cost effective than buying a separate QR scanner.

On the mobile phone market, the two leading OS (operating systems) are Android and iOS, so in order not to spend twice as much resources and time developing two identical mobile applications, but for different OS, the solution was to write a cross-platform application. When writing a cross-platform application, only one array of code is written, which, when compiled, can be converted into applications for various OS and, moreover, build a web version. Other pros of cross-platform applications are consistency between platforms, cost-effective updates and reusable code, good for prototyping.

The mobile app was implemented using the Flutter SDK (Software Development Kit). Flutter is a free and open source mobile development kit user interface created by Google. Dart is a programming language for development with Flutter. The advantages of Flutter include: same UI (User Interface) and business logic in all platforms, developing a Flutter application takes less time than a native one, own rendering engine, you can create design and animation of absolutely any complexity, the ability to run applications in the browser without changing the code, ready-made plugins for working with native functions like Bluetooth communication, permission handling and so on, Flutter development framework functions quicker than its alternatives.[1]

Flutter applications are based on widgets. By combining ready-made widgets, creating your own, you can achieve any design. Depending on the platform, the design may look different, as the code is compiled to native.

The main function of the mobile application will be inventory taking, which includes scanning QR codes that are pre-pasted on all equipment. If the scan is successful, this equipment is marked. And then all the equipment present in the room is sent to the server.

Apart from the main function, the application has many others. Display of all equipment and search by various characteristics, adding images of equipment when it is first added to the database and during subsequent inventories, generating reports on equipment in a specific room, equipment for a specific person, moving an object between rooms and users, and tracking movement history. Also in this application, statistics will be collected for subsequent analysis and forecast of equipment breakdowns.

3. QR codes

QR codes (Quick Response Code) are an optical label that stores encoded information. It can be a link, just a text, a contact, a postal address, an invoice to pay for purchases. It is read by a special scanner, which, for example, is built into a cell phone camera.

In addition to QR codes, there are barcodes - a one-dimensional metric mark. Their difference in appearance is that the QR code consists of black squares, and the barcode consists of black sticks. Also QR codes can contain more information and support more data types.

To do the inventory, a sticker with a QR code will be applied to all equipment. It will contain brief information about the object and a link to this application, if it is not scanned through the application.

3.1. Data encoding into QR code

Depending on the content of information for encoding, a special type of encoding is selected. Digital coding for numbers only, Alphanumeric - for numbers and letters, for any characters Byte encoding, Kanji is used to encode Chinese and Japanese characters.

After determining the type of coding, the error correction level is selected. The Reed-Solomon algorithm is used to correct errors. Service fields are placed before the encoded sequence. They store information about the encoding method and the amount of information. The byte sequence is divided into a number of blocks defined for the version and correction level.

The QR code fields consist of a part that carries the encoded information and the part that is necessary for correct decoding (position patterns, alignment patterns, sync strips, mask and correction level code, version code). Position patterns - three squares in the corners of the QR code. The main space between them is filled with encoded information bit by bit from bottom to top.

3.2. QR code recognition

QR code recognition is done using the OpenCV library (Open Source Computer Vision Library). This library contains algorithms for image processing, object recognition, and so on.[2]

First, a snapshot of the QR code is taken. A binary image is made from it: a certain average threshold value is taken, pixels that are smaller become white, the rest black. The output is a black and white image.

Position patterns are the same on all QR codes - three nested squares with sides with a ratio of 7: 5: 3. To find it, all contours are searched, squares are selected among contours, and they are checked for the presence of two nested squares in them. The found contour is a square if two conditions are met: the area of the found contour and the area of the bounding rectangle are equal and the width and height of the bounding rectangle are equal.[3]

If more than three position patterns are found, then take a new snapshot and repeat the algorithm until there are exactly 3 of them.

The lower right corner of the QR code can be found as the intersection of the lower left and upper right lines of position patterns.

The remaining space is divided into small cells. The color of the cell is checked, if white is set to 0, if black is set to 1. An array consisting of 0 and 1 is obtained.

Service information about the QR code form, mask, code version is read from the rest of the QR code fields.

Next, the previously obtained binary array is processed. A mask is applied to each of its cells by means of an exclusive or. There are 8 masks in total, each has its own formula.

The coding mode is determined, errors are detected using error correction, and the found ones are corrected. And finally, the data is decoded in accordance with a certain mode.

4. Predictive analytics in the inventory system

The inventory system is primarily designed to track the location of equipment, assign persons responsible for its use and prepare reporting documentation. However, modern technology allows us to expand the useful functionality of the system due to the presence of a large number of sensors and built-in equipment condition monitoring systems. The collected equipment performance can be used to predict future breakdowns. Early detection of anomalies in operation and elimination of potential malfunctions will significantly reduce equipment downtime and disruptions to the work process. Predicting computer hardware failures, such as hard drive failures, can also help to avoid the loss of large amounts of important data. [4] In the case of predicting breakdowns of physical equipment, this can increase not only the safety of its use, but also significantly reduce financial losses.

The most suitable forecasting methods for this task are machine learning methods. It is worth noting that algorithms of machine learning require a large amount of accumulated data for their work, it is especially important to take this

into account in the case of using new equipment, therefore, an approach is proposed in which training is carried out on data of normal operation. Thus, we will identify abnormal deviations from the normal operation of the equipment.

To collect, store and process data, changes were made to the system architecture, new modules were added - the final structure of the system is shown in Figure 1.

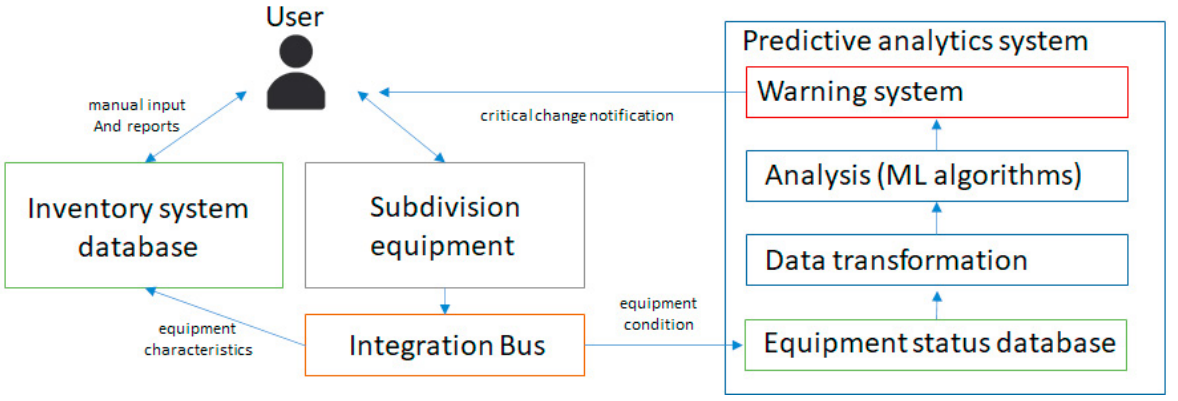

Fig. 1. System structure.

The integration bus automatically collects data from all available equipment in the department. The physical characteristics of the hardware (for example, the number of hard drives in the computer) is sent to the hardware database and is checked against previous characteristics, the device status data or its component is sent to the device status database. Then this data is preprocessed and sent to the analysis module. At the moment, we are collecting data and building models for analysis. The random forest is chosen as the base algorithm. Based on the analysis results, the system sends messages to the user to the mobile application through the critical change notification module.

5. Further development

Test implementation of the inventory system has already improved the convenience of equipment monitoring, reduced labor costs and reduced the number of errors in the preparation of inventory lists. The use of mobile application and qr codes allowed to quickly add photos of devices for their further identification and exclude the facts of unauthorized replacement of equipment. The next stage of development is the introduction of the device status forecasting (predictive analytics) system. Important steps for this have already been taken - the system architecture has been finalized, an integration bus has been prepared, a machine learning algorithm has been selected. It is necessary to tune the algorithm, according to which anomalies in the operation of devices will be detected. The random forest algorithm should show good efficiency due to its ability to efficiently process data with a large number of features, as well as high quality processing of both continuous and discrete features.

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