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ВЫЧИСЛИТЕЛЬНЫЕ ТЕХНОЛОГИИ
Федеральный исследовательский центр информационных и вычислительных технологий

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академик Б. Т. Жумагулов

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Results and Discussion

We used Naive Bayes classifier for text classification, NLP(Natural Language Processing) and packages required for work using NPM(Node Package Manager) in JavaScript programming language. The performance of the model is lower because the data for training is not collected systematically, but already the model is showing good results.

var natural = require('natural')

classifier = new natural.BayesClassifier(natural.PorterStemmerRu);

As a result, a neural network was created that classifies (classifies) the text into given classes.

Conclusion

Based on the research, we can say that we have done a great job on the study of machine learning and were able to develop a neural network that classifies incoming data according to the labels of the given classes found in the calculations.

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IRSTI 55.65.35

INTEGRATED DEVELOPMENT OF AN AUTOMATED TRADING SYSTEM ON THE EXAMPLE OF A DOMESTIC VENDING MACHINE FOR SELLING FLOWERS – A FLOROMAT

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Abstract

The vending machine for selling flowers belongs to the automated trade equipment and can be used for the sale of flowers by the self-service method. Such vending machines have received the common name - floromat, sometimes flomat.

Floromats are installed at the airports, train stations, supermarkets, theatres, concert halls, and even maternity hospitals. Their more modern models allow you to sell not only flowers, but also gifts, soft toys and other related products. The advantages of the absence of a seller, a small leasable area and round-the-clock operation of the device make this type of business today one of the fastest paying off.

Currently, only foreign-made vending machines are represented and used in the domestic automated trading market. Moreover, the vast majority of them are used to sell goods such as food. As practice shows, along with them, the number of operating floromats is single copies.

The concept of the integrated development of a separate automated trading unit, which will be considered on the example of the mentioned floromat, includes the following main successive stages: writing a technical task (functions and tasks of the floromat), calculations and selection of electronic and other components available on the market for assembling the device being created, development of an electrical device circuit, writing a control program code loaded into the microcontroller memory for the implementation of an automated sales process, designing and arranging its design using modern computer-aided design (CAD), analysis and simulation of physical processes (CAE), and finally the development of technical documentation for production.

Today, one of the important criteria in terms of various payment methods for goods is a digital payment method, for example, QR code payment via smartphones. The emerging relevance of this payment method has also affected the situation with vending machines, which requires the development of completely new algorithms for the integrated operation of a smartphone and the control center of such a device – the microcontroller.

The given and analyzed practical experience in creating a simple floromat indicates that the availability and presence of all kinds of electronic and ready-made mechanical components on the market, theoretical knowledge in the field of microcontrollers and practical experience with them, as well as certain skills in performing design work, allow us, in general, to create other types of various automated trading devices of our own domestic production.

Keywords: Vending machine, Floromat, SolidWorks 2018, Arduino IDE, Mega 2560 PRO MINI, ICT L83, Puloon LCDM-1000

Introduction

Vending (vend - to trade (through machines)) is the sale of goods and services using automated systems (vending machines). Currently, only foreign vending machines are represented and operate in the Kazakhstani's automated trading market. These devices on the market are mostly aimed at selling of fast food, confectionery, coffee and bottled drinks. However, the recent situation with the COVID-19 pandemic, in which strict restrictive measures were imposed on movement and a global quarantine was introduced, has shown a likely high demand in the future for solutions to the delivery and transfer of medicines, food and many other vital goods for everyday life of a person in a non-contact way. The lack of domestic developments in this direction sets new goals: the creation of our own vending machines to solve the above problems. An example for the development of analogues can be the creation of a vending machine for the automated flower sale - a floromat. Floromats are installed at the airports, train stations, supermarkets, theaters, concert halls, and even maternity hospitals. The advantages of the absence of a seller, a small rented area and round-the-clock operation of the device make this type of business today one of the fastest paying off and very profitable. In this article, a practical example of the floromat development will be considered in detail, starting from the creation of a technical concept of work to the implementation of its prototype.

Materials and Methods

The basic and main part of the study is aimed at studying the possibility of applying the existing low-cost hardware platforms of the AVR family, originally developed by Atmel, a well-known manufacturer of various microcontrollers and electronic chips, in the development of a vending machine, in our example, a floromat. Certainly, a preliminary review and analysis of existing on the market controllers and mutually agreed devices [2] for assembling vending machines and even ready-made systems [3] was carried out. And so, in order to solve our task such as controlling all the peripheral devices, mechatronics organs and other electronic modules necessary for the developed vending machine (hereinafter referred to as the floromat) for a convenient dialogue between the buyer (client) and the machine, a specific Mega 2560 PRO MINI microcontroller was considered [4]. This model differs from other platforms by the presence of the required number of UART (Universal Asynchronous Receiver-Transmitter) serial ports (4 in total) for connecting peripheral equipment such as a bill acceptor, a money dispenser and a GSM module, data exchange with which it is carried out according to the mentioned protocol. There are also a large number of digital inputs / outputs (54 in total) for transmitting a control signal, sufficiently large supply currents and a wide operating temperature range.

Specifications of Mega2560 PRO MINI:

- Microcontroller: ATmega 2560
- USB-TTL converter: CH340g
- Power Out: 5 Volt – 800mA
- Power IN.: 7 - 9 Volt
- Power IN. VIN/DC Jack: 5 Volt
- Power Consumption 5 Volt, 220mA
- USB: Micro USB
- Clock Frequency: 16MHz
- Operating Supply Voltage: 5 Volt
- Digital I/O: 54
- Analog I/O: 16
- Memory Size: 256kb
- Data RAM Type/Size: 8Kb
- Data ROM Type/Size: 4Kb
- Operating temperature: −40 °C /+85 °C
- Board's Size: 38×54mm

In the development of the terms of reference for the creation of the first prototype of the floromat, such basic factors as: price and availability of individual components (the ability to purchase on the market or place an order); component reliability; availability of the necessary proven libraries for connecting peripheral equipment and modules to the main microcontroller (Mega 2560 PRO MINI) were taken into account.

There are several important requirements for the work of the floromat when writing the terms of reference:

1. The operation of the floromat must be safe for customers and the operator;
2. Floromat must guarantee round-the-clock operation according to the algorithms and rules prescribed in the program code executed by the microcontroller. In the event of an emergency, the floromat must immediately send a message about the causes of the accident to the service operator's mobile phone;
3. After each realized bouquet, the floromat must send information (number of an empty cell) to the serving operator;
4. Floromat must accept all denominations of banknotes approved by the national bank of the country;
5. Floromat should ensure long-term preservation of bouquets, while the temperature regime should be in the range from +5 to +12 °C;
6. Floromat must also accompany all its actions with sound notifications;
7. Floromat should be outwardly pleasant, bright and exciting for customers;

An essential stage in the creation of a vending machine is the design and construction stage of the floromat case. For this purpose, a well-known professional tool for designing and simulating physical processes (CAD/CAM/CAE) - SOLIDWORKS 2018 [5] was used. Figure 1 shows the basic design of a floromat with a single-module cell zone. Structurally, the floromat cabinet is divided into three compartments: the upper compartment 1, where the evaporator of the refrigeration cooling system is installed, and the three-level zone of cells 2 (12 cells in total), the control compartment 3, the compartment for the main refrigeration cooling system (compressor block) 4. The main supporting structure of the floromat made by welding from a profile square pipe with a cross section of 15x15mm., and 1 mm thick sheet metal from which partitions, covers, shelves and a door are made. To reduce heat transfer between the cell area and the other three compartments, they are separated by 10 mm foam sheets, Figure 2.

Almost all models of floromats presented on the market have a small cell window, so there is a high probability of damage to the stems or petals of flowers in the process of loading bouquets by the operator or removing them by customers during purchase. Also, the cells have the same standard sizes for all types of bouquets, which exclude the possibility, for example, to install a bouquet of flowers

with a long stem. In case of breakdown of moving elements (doors, dampers, and servomotors), wire breakage or disconnection of contacts, these structures will not allow you to quickly repair, adjust or even urgently replace of components. To do this you will need to completely remove all the bouquets from the device and move them to another suitable room with a given temperature and humidity. It is also difficult to transport some models of floromats when changing the leased site (object), as they are heavy due to their huge dimensions and the lack of the possibility of their modular disassembly. To eliminate these shortcomings, a proposal was made to create a new convenient multi-module floromat The technical result consists in expanding the functionality of the floromat by the proposed alternative design of the floromat body, which allows for modular assembly and disassembly of the floromat, installation of a more powerful cooling system in it due to the dedicated lower section of the cabinet, which guarantees reliable and uninterrupted operation of the floromat.

The main control unit of the floromat is the control unit in Figure 3, where the following are installed: the microcontroller itself, the electromagnetic relay board, modules, DC-DC step-down converters and power supplies. As a box, an inexpensive PC system unit is used. During maintenance periods (microcontroller firmware, repair or replacement of modules), the control unit, due to the two guides installed at the bottom, is conveniently and easily slides out, without unnecessary need to disconnect the wires.

To fully understand the functionality of the floromat, and how the controls interact with the elements of mechatronics and its other components, the schematic diagram, made in the Fritzing program [6] is shown on Figure 4.

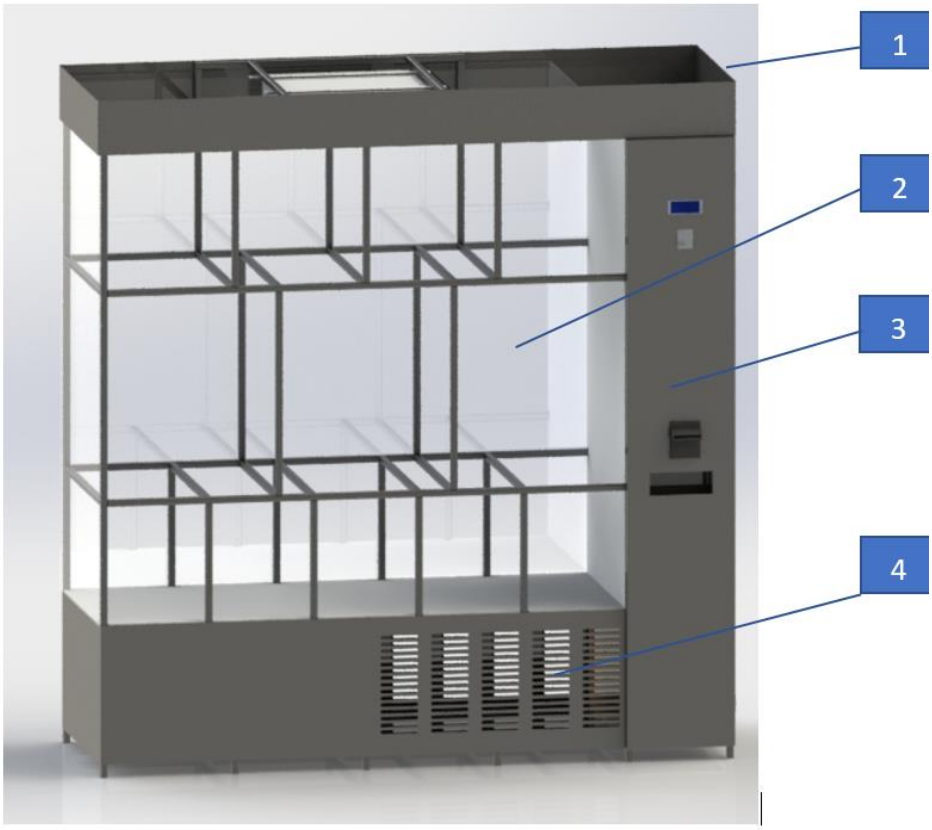


Figure 1 - Floromat design

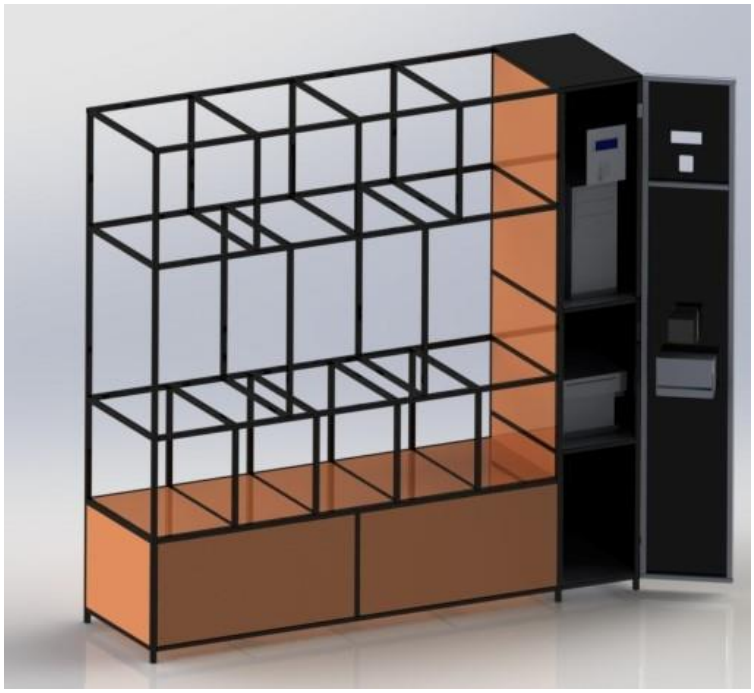


Figure 2 – Thermal insulation of the floromat

Figure 3 – Control block

So, this includes:

1. Microcontroller Mega 2560 PRO MINI;
2. Four-line liquid crystal display (LCD 2004) for displaying information about the selected product (price) and stages of the purchase process;
3. Sound speaker 3W 4 Om;

4. Keyboard (3x4);
5. GSM module;
6. DFPlayer Mini MP3;
7. Electromagnetic relay board (+5V), 16 channels;
8. Servo drive MG90S, 12 pieces;
9. Electric lock (12V), 12 pieces;
10. Bill acceptor ICT L83 (made in Taiwan) [7];
11. Change dispenser (money bill dispenser) Puloon LCDM 1000 (made in South Korea) [8];
12. Max232CSE module, RS232-TTL interface converter;
13. DC-DC step down converter (3.8-30V -> 1.25-35V, 4A);
14. Power supply AC-DC 12V 5A;
15. Power supply AC-DC 24V 5A;

In the normal (standby) mode of the floromat, the DFPlayer module (6) plays background music previously recorded on the Mini SD card through the sound speaker (3). At the same time, the display screen (2) displays a welcome inscription to its customers and a proposal to select a bouquet by cell number. After the client visually selects the bouquet he likes and enters the desired cell number on the numeric keypad (4), the display shows information about the cost of the selected bouquet and the value of the control characters on the keyboard to cancel or confirm the final choice. If the client confirms their choice, then a new message appears about the readiness of the floromat to accept banknotes, while the bill acceptor (10) starts to light up in red. After depositing a sufficient amount of money, the Mega 2560 PRO MINI microcontroller, in accordance with the prescribed algorithm, calculates the amount of change and sends command signals (certain bytes) to the banknote dispenser (11) via the serial port through the Max232CSE module to dispense the required number of banknotes. This dispenser model Puloon LCDM 1000 is designed to load only one denomination of banknotes; in this case 500 tenge banknotes were loaded. At the same time, the settings for the size of selected denomination of the banknote are determined by the position of the jumpers installed on its rear panel according to the technical documentation of the device. Immediately after the payment is made, the Mega 2560 PRO MINI microcontroller once again sends a command (discrete signal) to its desired pin, the output of which is connected to the corresponding pin (channel) on the electromagnetic relay board, after which the electric lock tongue (9) in the cell is automatically pressed. In the meantime, while the electric lock is still on (the tongue is pressed, t=1-2 seconds), the following discrete signal is sent to the servo drive (8) of the same cell, and through the transmitted torque of the servo drive, the door itself opens, the client picks up their bouquet, after an audible notification is displayed that the door will close soon. The floromat thanks the customer for the purchase with audio and text messages. Further, a text message (SMS) about the number of the empty cell is immediately sent to the bouquet loading operator via the GSM module.

In the event of an emergency power outage at the installation site of the floromat, its continuous operation for 1.5 hours is provided by the installed uninterruptible power supply with a capacity of 500 watts (80 Wh). Note that since initially this power is not enough to start and operate the refrigeration unit, the refrigeration unit is non-volatile from the power line of the main control unit.

The refrigeration unit itself is an independent system Figure 5, consisting of an evaporator (1), a compressor unit (2) and a management controller (3) with a temperature sensor (4) installed in one of the floromat cells. The controller uses a sensor to continuously monitor the temperature in the cell area. When the temperature rises above the set point, the built-in relay turns on and the compressor unit starts. The water condensate formed during the operation of the refrigeration unit is drained through the tube from the evaporator to the sump into the compartment of the compressor unit. Also, a timer is set in the control unit, to automatically turn off the compressor unit for periodic defrosting of the snow-covered evaporator.

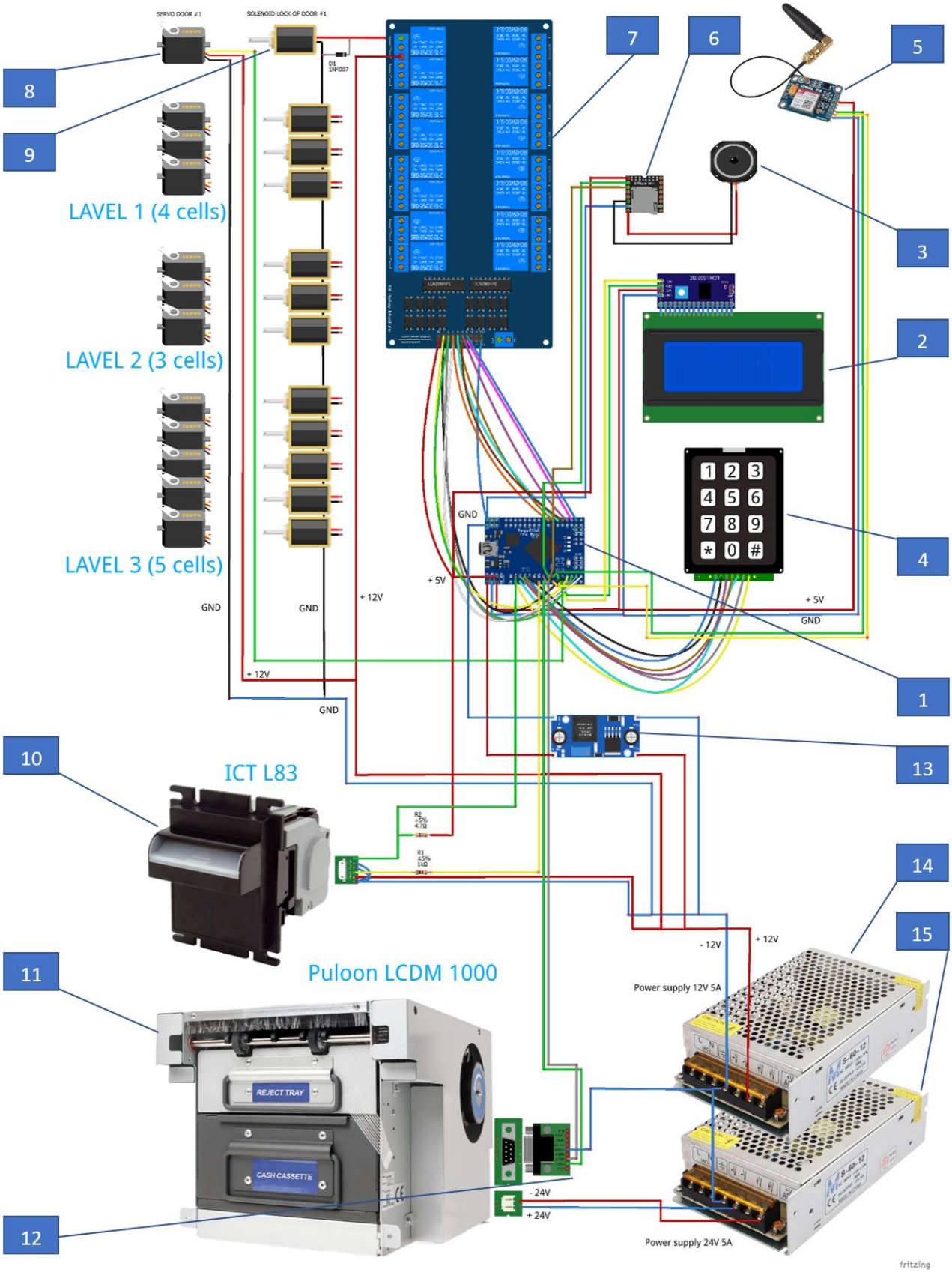


Figure 4 – Schematic diagram of the floromat

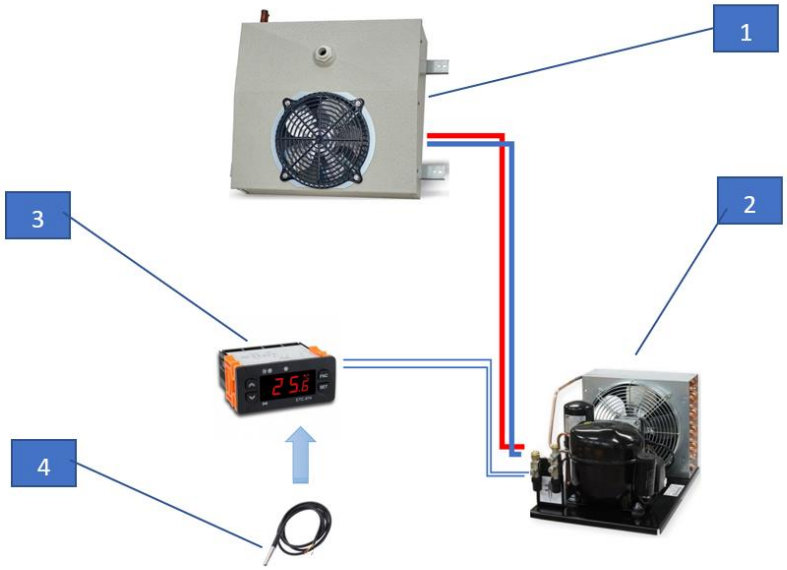


Figure 5 – Floromat refrigeration system

Figure 6 shows a listing of the initial source code for the executable program. The code is written in C++ in the Arduino IDE 1.8.10 [9], which is compiled and then loaded from there into the memory of the Mega 2560 PRO MINI microcontroller. The code consists of 647 lines, last modified on 09/17/2019.

Program_Mega2560_with_ICTL83_Puloon1000_12_boxes_working_englis | Arduino 1.8.10

Файл Правка Скетч Инструменты Помощь

Program_Mega2560_with_ICTL83_Puloon1000_12_boxes_working_englis §

```
// Mega 2560 pro
// Almaty city, 17.09.2019.
// ©, "Samal Energy" LLP (by Darkhan Dogalakov)
// +7 707 215 2013.


#include <Wire.h>                         // библиотека для управления устройствами по I2C
#include <LiquidCrystal_I2C.h>            // подключаем библиотеку для LCD 1602
#include <Keypad.h>                       // needs to be in the library folder (Arduino/Libraries)
#include <EEPROM.h>                       // подключаем библиотеку EEPROM
#include <SoftwareSerial.h>
#include <DFPlayer_Mini_Mp3.h>

SoftwareSerial Serial_LCDM1000(15, 14);   // RX, TX
SoftwareSerial Mp3_set_serial(17, 16);    // RX, TX


// Настройки основные:
int good = 0;                             // Переменная для выбора товара - программы для выполнения
char keystr_1[5];                         // массив для последовательно набранных символов для выбора товара
char keystr_2[5];                         // массив для последовательно набранных символов для пароля
char keystr_3[5];                         // массив для последовательно набранных символов для выбора товара при добавлении/удалении
String Pass;                              // кодовое слово для режима редактирования наличия в ящиках товара

bool selected_good = false;               // Флаг о проведенном выборе товара
bool purchased_good = false;              // Флаг о проведенной оплате товара
bool mode_loading = false;                // Флаг режима загрузки товара в ящики
bool mode_delete = false;                 // Флаг режима удаления товара в ящиках
char prev_key;
int prev_num;
char key;
// - основные -


// Настройки прайса на цветы для каждого ящика (1-12):
int price[13] = {0, 1000, 4000, 2000, 2000,
                 4000, 4000, 4000,
                 6000, 6000, 6000, 6000, 6000
                };
// - прайс -
```

Figure 6 – Program source code listing

Figure 7 shows the settings for the coordinated operation of the microcontroller with the ICT L83 bill acceptor via the serial port, according to the instructions described in the device manual:

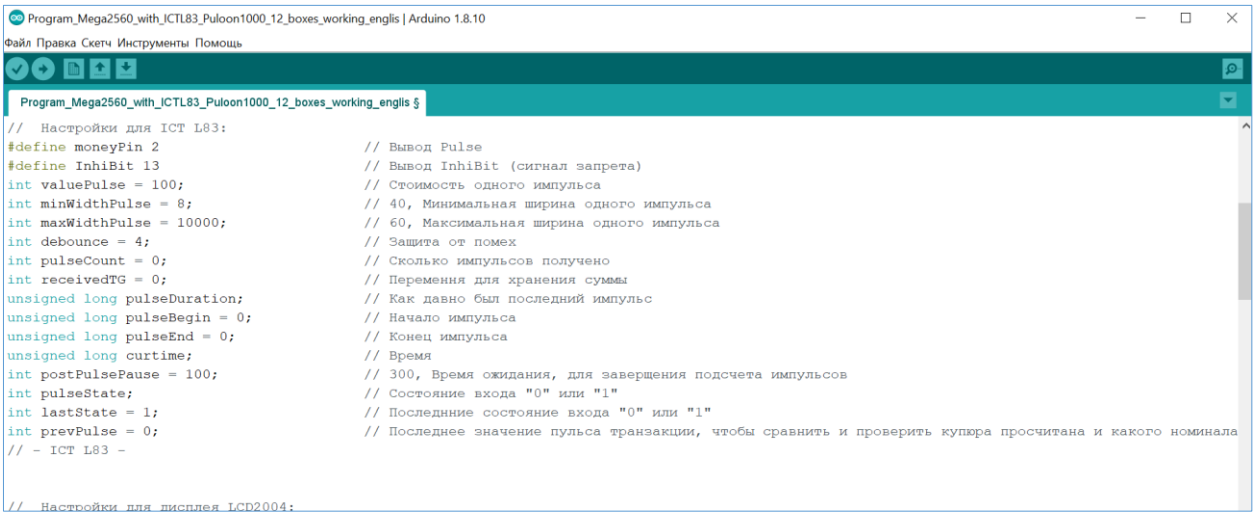


Figure 7 – Settings for working with the ICT L83 device

Figure 8 shows the settings for the coordinated operation of the microcontroller with the Puloon LCDM 1000 money dispenser also via the serial port, according to the instructions described in the manual of this device:

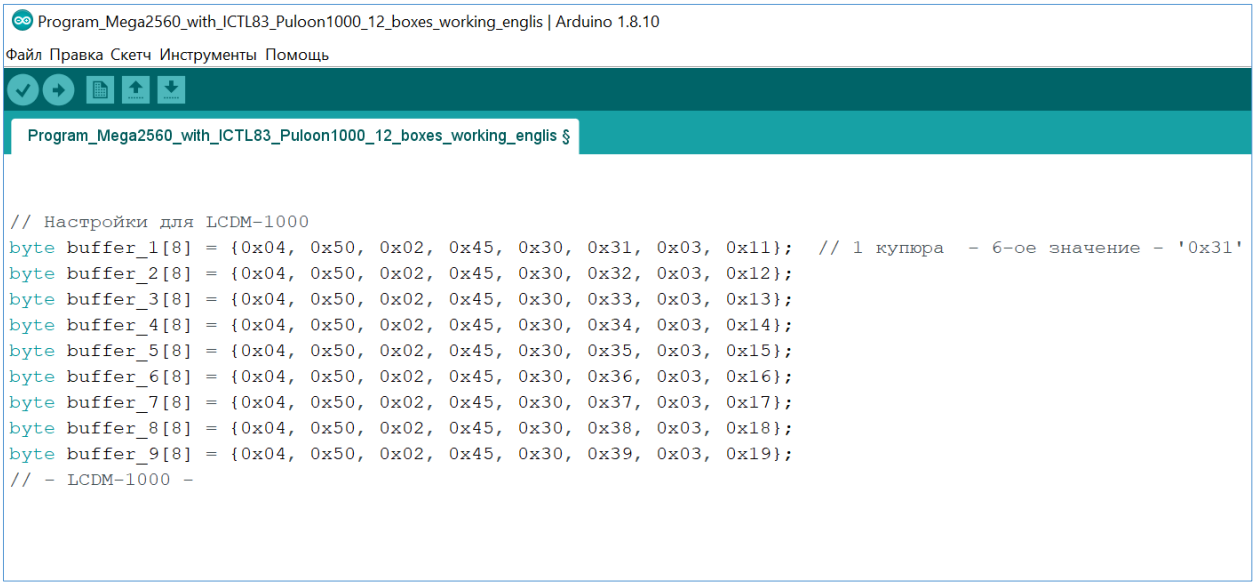
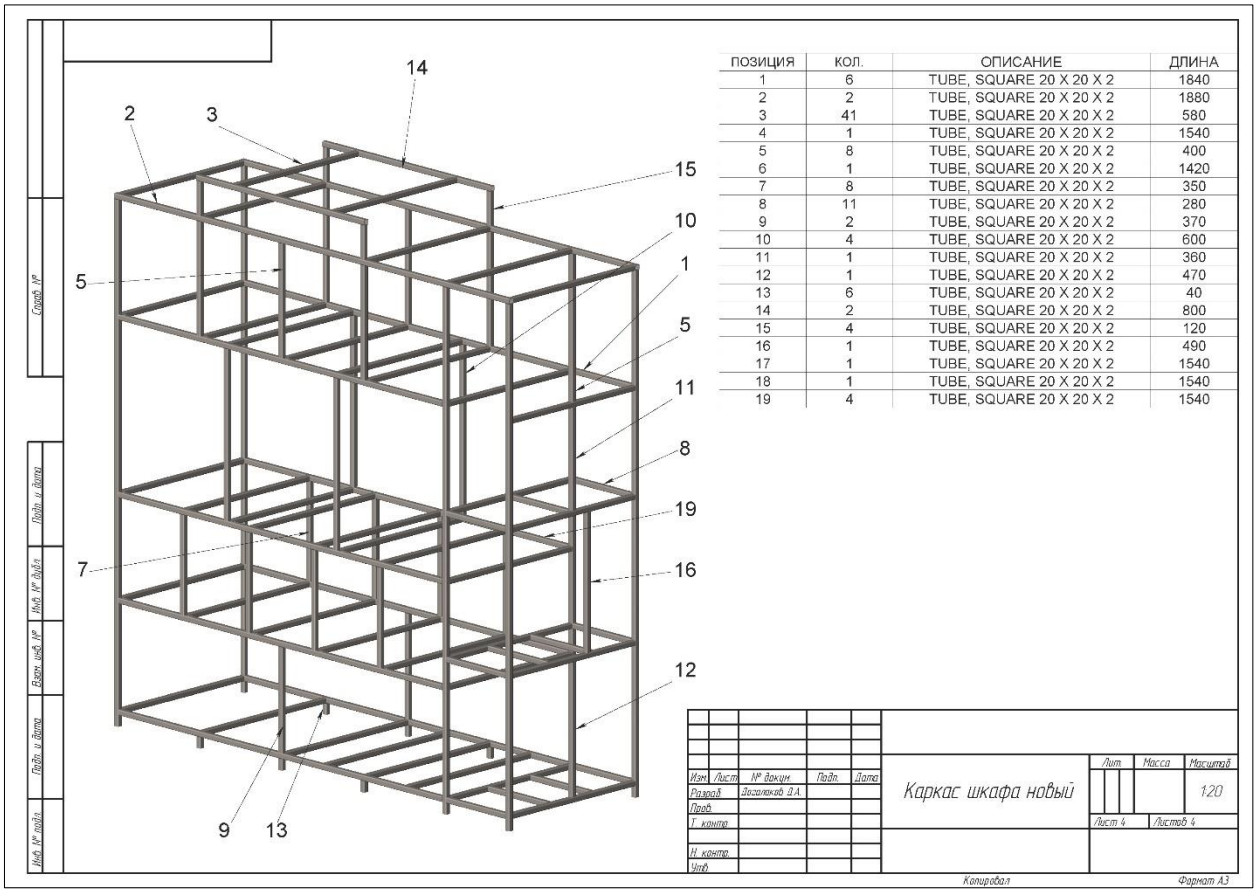


Figure 8 – Settings for working with the Puloon LCDM 1000 device

The SOLIDWORKS Weldments module included in the main SolidWorks 2018 package has a large set of special tools for convenient and fast creation of welding structures. While preparing design documentation for drawings, an automatically generated list of cutouts of all structural elements can be displayed, Figure 9. These data allow you to calculate the exact required amount of purchased material, and at the same time, pre-calculate the prime cost of the final product. On the drawing Figure 10 with front and right views, you can estimate the dimensions of the cells and the overall dimensions of the floromat.



ПОЗИЦИЯ	КОЛ.	ОПИСАНИЕ	ДЛИНА
1	6	TUBE, SQUARE 20 X 20 X 2	1840
2	2	TUBE, SQUARE 20 X 20 X 2	1880
3	41	TUBE, SQUARE 20 X 20 X 2	580
4	1	TUBE, SQUARE 20 X 20 X 2	1540
5	8	TUBE, SQUARE 20 X 20 X 2	400
6	1	TUBE, SQUARE 20 X 20 X 2	1420
7	8	TUBE, SQUARE 20 X 20 X 2	350
8	11	TUBE, SQUARE 20 X 20 X 2	280
9	2	TUBE, SQUARE 20 X 20 X 2	370
10	4	TUBE, SQUARE 20 X 20 X 2	600
11	1	TUBE, SQUARE 20 X 20 X 2	360
12	1	TUBE, SQUARE 20 X 20 X 2	470
13	6	TUBE, SQUARE 20 X 20 X 2	40
14	2	TUBE, SQUARE 20 X 20 X 2	800
15	4	TUBE, SQUARE 20 X 20 X 2	120
16	1	TUBE, SQUARE 20 X 20 X 2	490
17	1	TUBE, SQUARE 20 X 20 X 2	1540
18	1	TUBE, SQUARE 20 X 20 X 2	1540
19	4	TUBE, SQUARE 20 X 20 X 2	1540

Figure 9 – Weldment cut list (floromat cabinet)

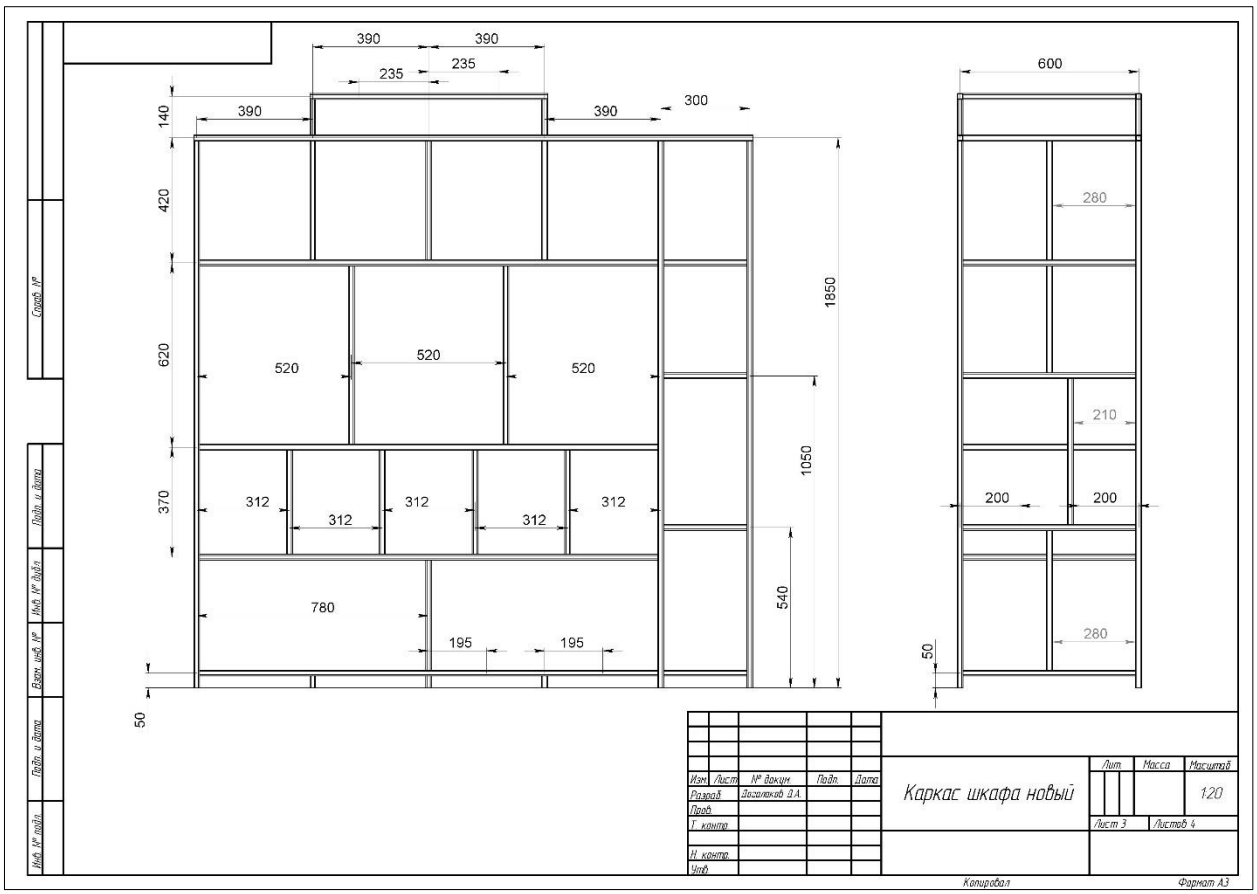


Figure 10 – Internal and overall dimensions of the floromat cabinet

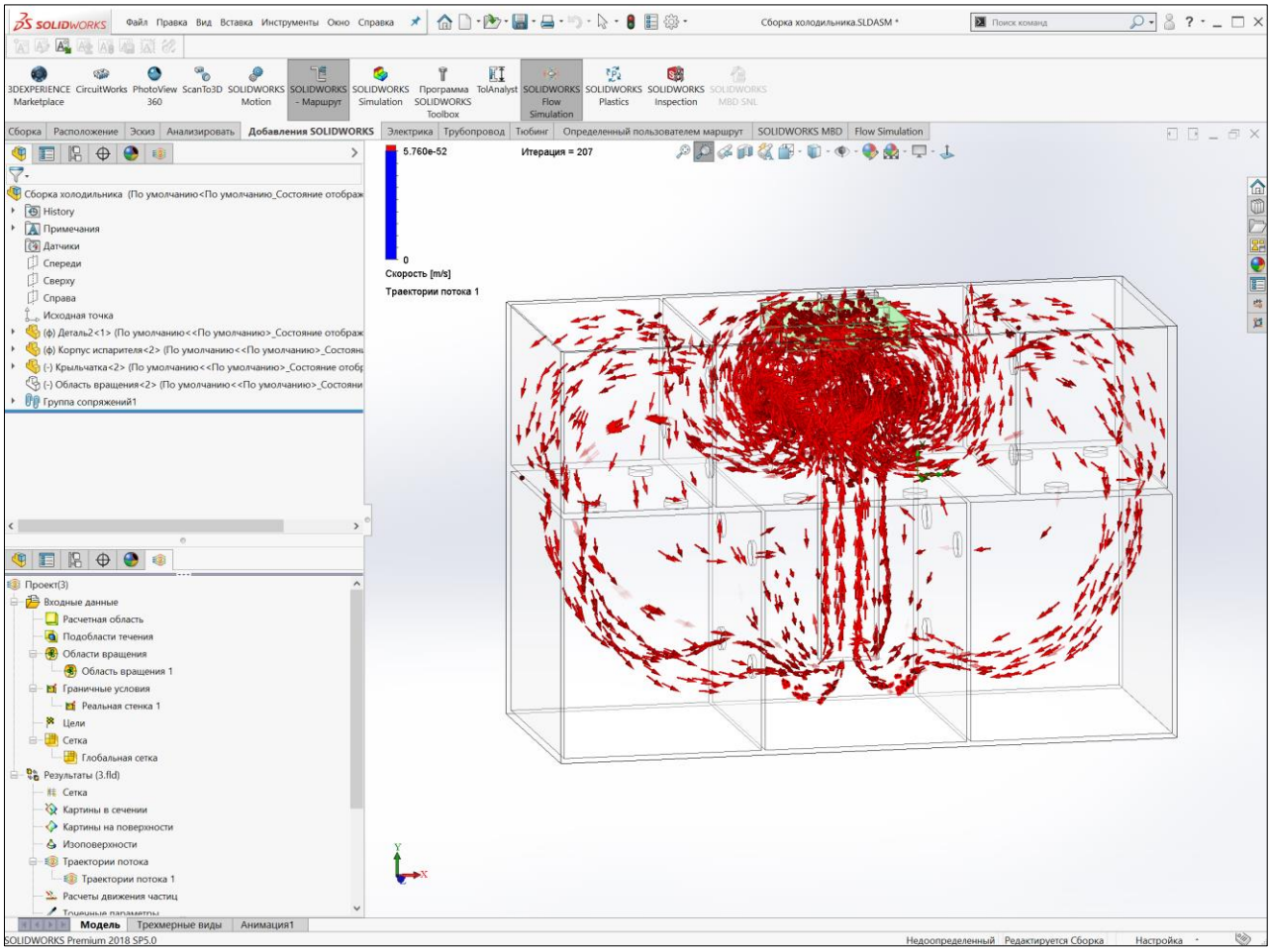


Figure 11 – Air flow simulation
for cabinet construction with a two-level compartment zone

SOLIDWORKS Flow Simulation [10] is an easy-to-use computational fluid dynamics (CFD) solution built into SOLIDWORKS 3D CAD to simulate fluid and gas flow to calculate product performance and capabilities. In our case, this tool was also used to solve the problem of uniform distribution of the air flow cooled by the refrigeration unit in the cell area, Figure 11**.** As a result of the operation of the cooling system and constant air condensation, water accumulates in the floromat evaporator. To drain it, a tube is used, which is lowered into the sump of the compressor unit. However, in the future, the possibility of re -using this water for watering arranged bouquets in cells is being considered.

In the manufacture of doors, partitions, shelves and outer walls of the floromat, an easily processed transparent material was used - plexiglass, 7 mm thick. The scans (files for loading into the multicam machine) were also made and automatically uploaded in the SOLIDWORKS 2018 program. Energy-saving cold light LED strips were used separately to illuminate the cells at three levels. Figure 12 shows a useful model of a domestic floromat that has passed the first tests.

Figure 12 – The first instance of the domestic floromat

Results and discussion

The conducted research and the results obtained in the course of its work prove that the AVR series microcontrollers can easily cope with the tasks of automating retail outlets by self-service. Using inexpensive and sufficiently reliable AVR microcontrollers and their analogues, when creating such devices, opens up great opportunities for connecting and configuring almost any peripheral device that has at least one of any of the existing matching interfaces. The use of the mentioned CAD/CAE design systems and simulations was a big help during the design and layout stage of such an apparatus, where there are a large number of devices. The next steps for full automation, taking into account today's information know-how in the cashless payment market, namely payment by QR code through mobile applications [11], are: the study and additional development of these technologies for their integration into the control system of the vending machine.

Conclusion

The creation of a domestic vending machine with these functions and software will have a significant socio-economic impact on the population and entrepreneurship. It will unite suppliers, logistics companies, lessors of trading floors (shopping and entertainment centers, residential complexes) and the customer directly in the business area. A contactless way to obtain the necessary food, medicine or essential goods in the face of possible lockdowns is one of its solutions. During the implementation of this project, unique experience and practical developments were obtained for the implementation of future domestic vending machines

References

1. Web Sources: Wikipedia. https://ru.wikipedia.org/wiki/Atmel/. (accessed 19.08.2022).

СОДЕРЖАНИЕ