APPLICATION OF MINI DISPLAY FOR DATA PROJECTION IN USER ELECTRONICS

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Abstract: This paper deals with application of a very small display in user specific equipment for projecting data collected at a source machine. The transmission of the data is realized using Bluetooth Low Energy wireless modules. The method of this process is described as well as the complete solution and realization of the prototype.

Keywords: Data collection, Display, Wireless communication, Bluetooth Low Energy

1 INTRODUCTION

The project is dealing with implementation of a really small OLED display into consumer electronics and its usage for displaying various data collected from a wide variety of sensors and different machines. The field, that is the authors field of expertise, is being currently in the process of adaptation to digital technology. Only few companies, that are leading this particular field, are, in recent years, starting to change long used analog electronics into their digital counterparts where the application allows to do so. With this approach, it is becoming more and more possible to output various digitally processes data from the particular machines and thus displaying them to the user in their accessories. In this particular field, it is still something very new and it is also subject to questions concerning usability because the old generation of users is more used to working based on what they directly see rather than to rely on outputted data from a machine. The realization of this solution is discussed here.

2 DESCRIPTION OF FUNCTIONALITY

The function of the application is described on the functional diagram in figure 1. The machine is currently fitted with various sensors for detection of incoming light and voltage and current measurement during operation. The whole solution is created in a modular way so the possibility of addition of new sensors or other measuring equipment is possible in the future. The signals from sensors are processed by the internal digital circuitry of the machine and there has to be stated that this is not part of the solution that is being discussed here. This part is realized by other manufacturer who owns manufacturing rights and know-how for the mentioned machine. The wireless modules and display implementation were realized by the author of this paper.

The wireless modules were used in the past project for conducting trigger signals for darkening of LCD display. These used modules are quite flexible so further functionality was added. The module is wirelessly connected to the machine using standard Bluetooth Low Energy technology. There is a GATT server realized on the module housing several characteristics used for collection of the data coming from the machine. When data come from the machine, they are written to the corresponding characteristic based on the type of data extracted from the machine. The machine notifies the module every time it has new data prepared for it so that there is no need for polling from the module side. However, the module needs to scan for advertisements from the machine in regular intervals because some of the operations are time critical (for example the light detection part).

Based on the standards in the field of application the timing had to be set to a period around 100 ms per scanning event.

The wireless module and the display are supplied from a Lithium Polymer battery which currently has a capacity of 150 mAh. In current setup, the appliance can run approximately 8 hours without the need for charging.

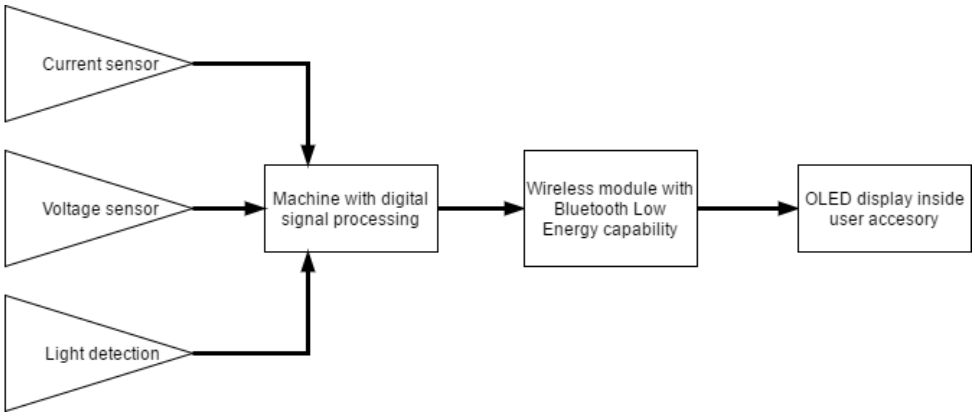

Figure 1: Functional diagram

After the module receives the data it processes it to some extent and then, using simple UART interface, it is fed to the OLED display. This part of the process is planned to be optimized in the future because the processing could be done already at the machine side and could save a considerable amount of power, thus extending the battery life.

The communication protocol is currently implemented to support only simple commands. There are several possibilities to draw various shapes, for example circle, rectangle, line and a simple bird animation, which is provided by the manufacturer of the display in order to test the color depth of the display. Thus, the module needs to supply only a set of coordinates that are going to be used for drawing the shapes in a desired space on the display. Furthermore, a basic font is going to be implemented for including the possibility of drawing numbers and letters on the display.

Currently the requirement is only to display the processed data in any way on the display. This allows to store the fonts on a SD stick or in the internal memory of the module and thus the realization is simpler. In the future, however, the manufacturer requires that the font and all the presets could be changed "in field". That means more flexibility is required. The machine will supply all the data even with the graphical presets. Thus, the need for higher data throughput arises and it is possible that other wireless technology is going to be needed. Luckily there are many wireless modules on the market that even provide dual functionality, meaning that classic Bluetooth can be used in parallel with Bluetooth Low Energy and this combination could be sufficient for the whole solution.

3 DESCRIPTION OF THE USED WIRELESS MODULES

In this section, two variants of the wireless modules will be described. Both are manufactured by company Lairdtech. One of them, the BL600/620 is currently being used for the prototyping of the functionality and it is soldered to the wireless modules. The BT900 is one of the novel variants that is going to be used in the next iteration of the prototypes.

3.1 BL600/620 WIRELESS MODULE

The BL600/620 is a single mode Bluetooth Low Energy wireless module. Thanks to its custom-made programming language (Smart Basic) it is a very fast prototyping platform. The module can be seen in figure 2.

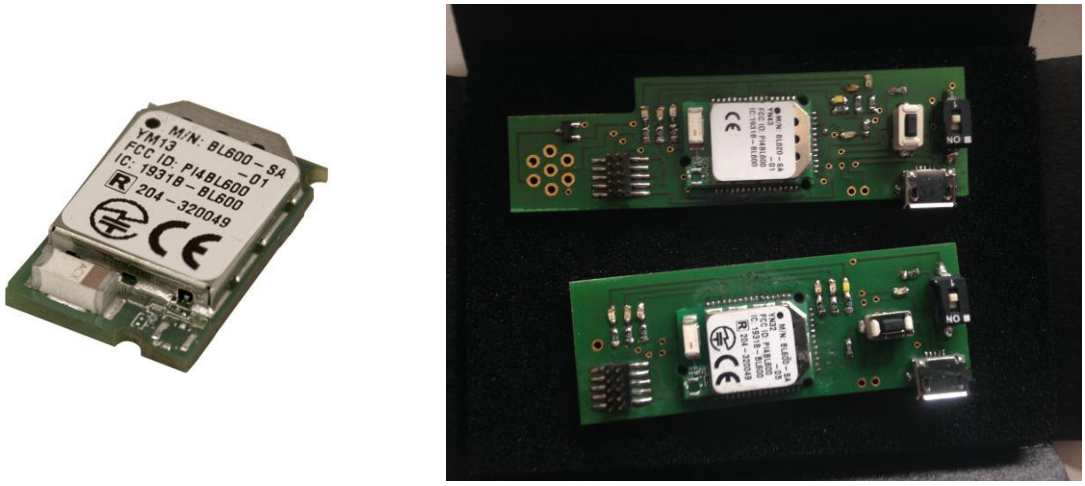

Figure 2: BL600/620 wireless module and its application on the prototype boards [3]

This module is unfortunately fit only for small amounts of data. Because of that it is used only in the preliminary prototype. It is not able to transfer all the graphic layouts and fonts simply because the protocol is made for other applications. The naming BL600/620 corresponds to slave/master module configurations.

The module has following technical parameters:

- Supply voltage 1.8 V – 3.6 V,
- Bandwidth 2.4 GHz,
- CPU ARM Cortex M0,
- Dimensions 19mm x 12.5mm x 3mm,
- Pin count up to 28,
- Transmit power up to 4 dBm, [3]
- Cost 12.54 EUR

3.2 BT900 WIRELESS MODULE

The BT900 module is an upgraded version of the BL600/620 not only from software point of view but also the internal structure of the module has been adjusted to support both Bluetooth modes. Consequently, the module offers much more internal memory and also has faster CPU. Thus, it allows for higher data throughput which is needed for the next iteration of this prototype. The main advantage for the modules from Lairdtech is the fact, that the code is portable from one module to the other. The SmartBasic programming language is universal for all the modules this company creates which makes them worth their price. The BT900 module is shown in the Figure 3.

Figure 3: The BT900 Bluetooth dual mode module [2]

The module has following technical parameters:

- Supply voltage 1.8V – 3.6V,
- Bandwidth 2.4 GHz,
- CPU ARM Cortex M3,
- Dimensions 19mm x 12.5mm x 2.5mm,
- Pin Count 18 programmable,
- Transmit power up to 8 dBm, [2]
- Cost 17.92 EUR

4 DESCRIPTION OF USED OLED DISPLAY

The OLED display used in this application is manufactured by company Tinycircuits. The display has a resolution of 96x64 pixels and the color depth is 16 bits. Thus, it allows to create all kinds of user interfaces which is required in this application. During development, a certain problem has been found in the application of the display. The accessory, where it is used, is very close to a person eye so the data displayed are not sufficiently readable by the user. For that reason, special optical eyepiece had to be assembled using custom made optics just for this application. The housing of the eyepiece has been modelled using Solid Works modelling software and was printed on a 3D printer so the casing would fit precisely the geometry of the accessory. The display is then stored in this housing which also ensures that it remains without any risk of damaging it. The OLED display is shown in figure 4.

The display has an on board integrated microcontroller, energy management and battery charging circuitry so it can be used as a stand-alone unit. The connection between the wireless module boards and the display is realized using simple UART interface. [1]

Figure 4: OLED Display „Tinyscreen“ manufactured by Tinycircuits [1]

The display has following technical parameters:

- CPU Atmel SAMD21 ARM,
- Resolution 96x64,
- Pins 20,
- Color depth 16 bits,
- Supply voltage 2.7V – 5.5V,
- Dimensions 25.8mm x 25.0mm, [1]
- Cost 39.95 USD.

5 CONCLUSION

This paper deals with an implementation of a very small OLED display into user accessory. Preliminary prototype has been built and the solution tested in its preliminary stage. The prototype consists of two PCBs, a housing realized on a 3D printer fitted with custom-made optics and the mentioned OLED display. Next iteration of the development process is going to follow in coming months. The display has been interconnected with previously designed PCBs which are populated by BL600/620 wireless modules with Bluetooth Low Energy capability. So far it is possible to display various shapes and animations on the display which are controlled from the remote master module. The field tests, where the module is going to receive the data directly from the machine is going to be performed in the following months as well.

REFERENCES

[1] TinyScreen+ (Processor, OLED & USB in one). *Tinycircuits.com* [online]. Akron, Ohio: Tinycircuits, 2017 [cit. 2017-03-12]. Available at: https://tinycircuits.com/collections/all/products/tinyscreenplus

[2] Datasheet BT900-SA-0x, BT900-SC-0x. *Lairdtech.com* [online]. London: Lairdtech, 2017 [cit. 2017-03-12]. Available at https://assets.lairdtech.com/home/brandworld/files/Datasheet%20(HIG)%20-%20BT900%20Series.pdf

[3] Datasheet Single Mode Bluetooth Low Energy (BLE) Module. *Lairdtech.com* [online]. London: Lairdtech, 2017 [cit. 2017-03-12]. Available at: https://assets.lairdtech.com/home/brandworld/files/Datasheet%20-%20BL600.pdf