HMI EMBEDDED SYSTEM DESIGN AS A FUNCTION OF TECU

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ABSTRACT

The article deals with the development of HMI systems for agricultural tractors. The characteristic feature of this system is the full support of the requirements SAE J1939. The system is developed completely, at present is formed embedded platform using advanced components - FPGA RT MCU and it is simultaneously integrated and supporting subsystems, GPS, GSM, RFID, etc. data logging. Above this embedded platform is created based HMI Industrial OS with applications developed in LabVIEW. Interaction is made with the touch screen monitor with the possibility of use of integrated drivers. The system is the initial stages of testing and the next stage will be followed by PCB redesign due to the necessity to maintain dimensions of the tractor.

Key words: HMI, CAN-BUS, FPGA

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INTRODUCTION

Today´s use of electrical regulated systems which are integrated in farm tractors, or in farm machinery generally, is being devalued of mismatch of often used protocols of communication networks. In other words, every single system is regulated with different manufacturers. System model fulfills categorization as a distributed, on the other hand, largely suffers from the mutual incompatibility, whether physical or example, application-layer communication protocol. It carries considerable difficulties not only in the primary purpose of the control systems, but also complicates the implementation of an internal diagnostic system, which must use physical or virtual formed intercom gateway. We can only speculate whether this is not the intention of the producers. By studying the revised documents issued by SAE, in our case, the Recommendation J1939 is readily apparent elimination of the above-described problem. Logically, therefore, the question arises whether it is possible to create a system based only on the platform SAE J1939. Moreover, the task was set to facilitate the integration of the necessary hardware and software to implement the existing machines, including reconfiguration of existing systems and setting priorities for individual systems. The paper shows the primary hardware platform with basic equipment and software connectivity to HMI intended for agricultural tractors.

MATERIAL AND METHODS

Internal system with interactive intervention by the operator, referred to as HMI has a unique position in the complex regulated system because sometimes it makes decision processes of the operator and requests from other microcontrollers. This makes it more difficult algorithm and opens the way for program errors. Unfortunately, in its current form there is no possibility of testing in accordance with the requirements of AUTOSAR, MISRA, etc. It will be described the hardware platform with the lowest layer of software that can be exaggeration to call firmware. Crucial importance in the present development was reliability. This is to some extent a function of the complexity of the number of segments, diversity and relationships between them. At the level of peripheral integration in integrated circuits it is possible to solve a wide range of applications based SoC (system on chip). From past experience, we decided to discretize the various roles of the gate array and solutions bonds confer superior system based on MCU with RT operating system on top of which will be further built HMI / SCADA. Development of FPGA hardware platform is very complicated, so we used standard National Instruments industrial solutions with commercial name SBRI - 9626th. This embedded system is equipped with FPGA Xilinx Spartan -6 LX45 with 43,661 logic cells and the possibility of I / O up to 358. Those plates due to internal needs reduce the number of DIO to 96, which, far exceeds our needs. Superior RT system is a Freescale MCU running at 400 MHz supplemented with 256 MB RAM and a static memory is 512 megabytes NAND Flash . PCB also contains many peripherals - Ethernet, RS485, RS232, CAN - BUS, SDHC port. For our purposes, however, has been used in fact only Ethernet for the purpose of programming and for connection to HMI. Required periphery we were right in the FPGA, respectively hw support for microcontrollers.

Figure 1 shows the temporary system as a development board. This is not the final product; this is only a test device. The description of this board is done numerically. Under the number 1 is a primary part of the supply plate. All parts of the supply are electrically isolated switching DC / DC converters. To power SBRI - 9626 is necessary voltage range of 9 - 30V (12V default form), other circuits are powered by DC 5V or 3.3V DC. Since the FPGA inputs are 5V tolerant type, then the modules with I / O 5V level shifter used logic to 3.3V. An example might be the TX line of RFID module. For voltage 3.3V used standard linear voltage regulators, and all was very carefully smoothed capacitors. This was preceded by the development of modeling software Multisim. Number 2 shows the supply part of the PCB, which has been developed by us. Under the section 2 is specifically about backing up the Li - Ion batteries with a nominal voltage value of 3.6 V and a capacity of 2 x 2500 mAh. The charge control including protections (over-charging, short circuit, thermal) is a solution of Linear Circuits own. Switching between the primary power supply and battery backup is done autonomous path controller. For supply voltages in these sizes are necessary to increase the voltage using a step - up converters, these are dedicated for each module separately. On the same plate is then fitted with GSM communication module (4). It facilitates the exchange of data between our platform being developed and remote client applications that can represent as remote diagnostic module or making bridge between applicator such as purpose-built software for the remote user. The module can operate on three bands. So far we have developed a software module that uses the GPRS standard, the test is a multi- slot. The module also includes GPS with unidirectional data line UART. In addition to this module is the position of the 5 marked the part that is intended for communication on the CAN bus. Physically, the CAN module consists CAN exciter MCP 2551 MCP controller and CAN 2515th The FPGA is connected to the SPI bus, and given the current bus load of 50 % is thus set to 10MHz bus, which provides sufficient data stream. Marking 6 carries RFID module with protocol Machaster for operator identification. All RF components including antennas are integrated in the module. Data are overrunning the TX line UART with Baud Rate 9600 kbps. The seventh member is formed SDHC port with storage options for cards up to 32 gigabytes The number 8 stands for Information Display , which is being formed 2x16 segments.

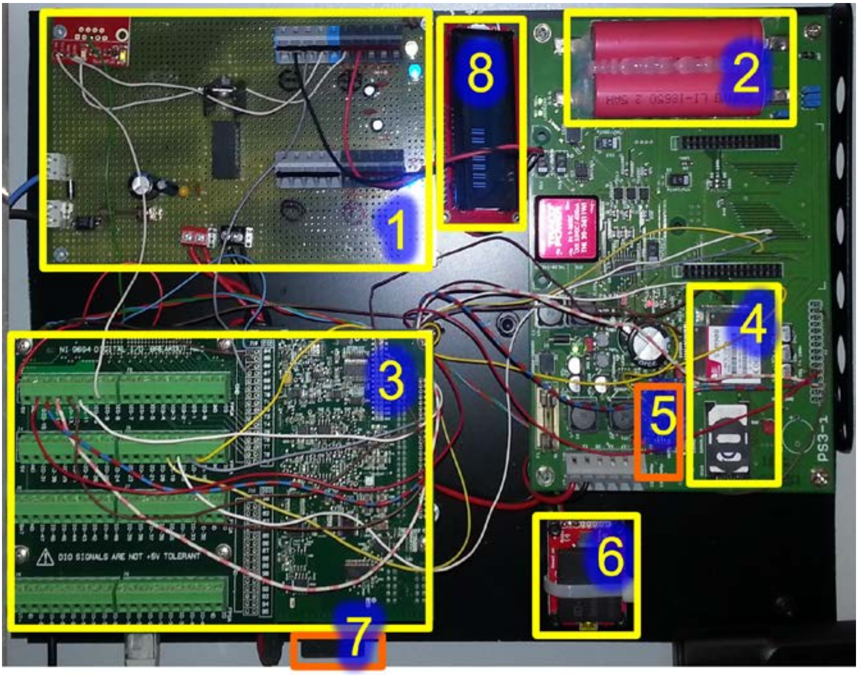

Fig. 1 – Embedded system (1. power sources – DC/DC convertors, 2. Li-Ion back-up batteries, 3. main embedded system NI sbRIO9626, 4. GSM/GPS module, 5. CAN-BUS module, 6. RFID reader, 7. External storage, 8. Info display

HMI is being still under development, it is necessary to think over the open architecture due to the implementation of other protocols, now it is being considered with ISO- BUS as a virtual terminal Implement. Therefore, it is modified embedded system platform with Intel Atom installing MS Windows XP Embedded. This system booting from a CompactFlash card which is installed rapidly native LabVIEW NI. General HMI options on this platform are very broad. Among other things, it is intended to visual applications with connectivity over TCP / IP implemented in GSM Module. We can´t forget the needs of internal diagnostics, which we have not yet conceived the protocol OBD - 2, the hardware based artist ELM327 is the HMI integrated approach and it provides a virtual serial port driver through the VISA.

Figure 2 shows the mask. It should be noted that some modules are disabled and basic mask is being created due to testing response time and lower the reliability of embedded systems with FPGAs. Data exchange between the two parts is going on TCP / IP. In the future it will be necessary to address the overall style of power and integration in tractors without delay or manual way to disconnecting the battery.

Fig. 2 – Main screen of HMI.

RESULT AND DISCUSSION

The results of the current development of primary embedded boards show significant advantages of using FPGA compared to earlier test platform based on ARM Cortex core. As regards the intended central system, it is necessary to calculate a considerable number of peripherals. Contemporary MCU are greatly limited the number of peripheral IO and IRQ constant invocation and related problems. In contrast, the FPGA can emulate the hardware for each bus. Of course this is at the cost of increased programming effort. For an example, asynchronous serial bus often referred to UART. Loop dedicated to the FPGA on the RX waiting for the start bit and according to the selected bit is sampled DI of eight bits (optional) and the whole transfer is completed stop bit. Of course you can also solve parity or signal inversion, in that hw but this is not necessary. It is significantly positive individual FIFO settings for the application. For example, the RFID module is needed only 21 elements of data type U8. Similarly, you can also emulate SPI or I2C, appears problematic bus. Transfer to the bus is generally more sophisticated and the need tolerance voltage on the bus would still require a driver, so this module consists of a platform of microchip. As the microcontroller has its own buffer for two messages, then interrupt the MCP 2515 follows the input gate array and data are transferred to the buffer FPGA. Only here is based on comparison with the protocol (as required) decisions about their treatment.

From the above it is clear that the distribution of individual routines gate array dramatically decreases the load master system represented by RT with Freescale MCU. Speed basic loop RT system is chosen time of 10 ms, of course, change timing is possible even in a running system. FPGA clock speed is fixed, the frequency of 40 MHz. The requirements of SAE J1939 recommendations are implemented in developing the system at the application layer, because the physical layer is consistent both with SAE J1939 and with with ISO 11898. But for now, not a module diagnostic protocol according to SAE J1939, which will be harder implemented, resp. now it is necessary to dedicate a relatively large size of the FIFO FPGA-RT and vice versa.

CONCLUSIONS

Experimental testing of developed systems have shown considerable potential of use of FPGA for embedded applications. In our case the HMI TECU segment (units SAE J1939 27hex), which is made up of modular touch panel with an industrial PC and embedded base plate, that carries all the activity. As already mentioned, this is a relatively early stage of development, but the chosen architecture easily allows expansion. It shows , for example , the information display, which only serves to display the system status will be replaced by a more expansive type of panel TFT / LED / OLED . It is also necessary to create additional opportunities for visualization viewer, is currently considering the detail of hydraulic system. In the longer term it will be necessary to focus on more comprehensive system of wireless transmission of data used for GPRS is no longer sufficient as audiovisual services and sophisticated database management systems.