Display device for archery competitions

Antonín Pospíšil
Department of Control and Instrumentation
FEEC Brno University of Technology
Brno, Czech Republic
240222@vut.cz

Petr Petyovsky
Department of Control and Instrumentation
FEEC Brno University of Technology
Brno, Czech Republic
petyovsky@vut.cz

***Abstract*—This paper presents a system designed to improve the organisation of archery competitions. The system reduces errors and delays by replacing the traditionally used paper cards with an electronic system. The basic components of the proposed system are described. The communication between the parts and the basic description of the operation of the whole system are outlined.**

***Index Terms*—display equipment for sports events, archery, e-ink display, embedded system**

I. Archery

I have been organising archery competitions for five years. Our club organises competitions for 200-300 archers, such as national championships, competitions of the Czech Archery Association Cup. In cooperation with our partner club in Slovakia, we organize a 4-round international cup, in which about 400 archers from both countries participate every year.

A. Archery competitions

In the archery competitions, the archers first shoot 72 arrows in qualification. The values of the hits are added up, the archer with the highest score wins this part. The scores are used to create a ranking for each category, and the advancement key is used to create the initial pairs for the elimination round of the competition. The winner of the duel advances to the next round of duels. Finally, two pairs remain in the semi-finals, and the winners of these duels will compete against each other for the first place, the gold medal. The less successful in the semi-finals compete together for the bronze medal.

Several categories can be competing in one round at the same time, so shooters and their coaches need to know exactly where they will be competing in the next round. Matches are shifted to make efficient use of shooting range space and to make room for new categories. However, this brings with it the need to inform shooters which target ranges will be used for their next round of matches. This information is usually posted in several places on the range, and also available online in the results system, but often shooters do not pay enough attention to this information or do not perceive this information when concentrating on their performance.

B. Paper cards

Currently, paper cards with shooter's names are used to determine where the next round of competition will take place. These are placed in front of the shooting line by the number indicating the shooting position. When the duel is over, the cards must be manually collected and moved to the appropriate location. The time between the end of the round and the start of the next is often very short, it is important that this move is done quickly and flawlessly.

Moving shooter's cards to the correct position on the range currently requires a dedicated group of people to handle the exchange and organisation of these tags. It often happens that this group is made up of different volunteers at each event, and it is therefore necessary to train and explain the principle to the new group of people each time. Initial uncertainty or lack of knowledge of the system and possible lack of coordination causes unnecessary time delays and technical complications during the eliminations.

II. Information system outline

To simplify the organization of archery competitions, especially the elimination part, I propose a system that could simplify and replace the work of several people. Important information will be shown completely on the display in front of the archer.

Fig. 1. First prototype

The system replaces paper cards with electronic display devices (EDD) and a central control unit (CCU), the computer. Each device will display the shooter's name and other information needed to navigate the shooting range. The data will be entered into the computer and transmitted to the display devices. Because the distance between the EDD's can exceed 100 m, the RS-485 serial standard was chosen for communication between the devices.

According to the official archery rules, the numbers indicating the shooting position must be 4 m away from the shooting line, so the EDD's must be placed at this distance. This imposes requirements on the size of the display, the size of the displayed text and the overall amount of information that will be readable at this distance.

III. Electronic display devices

Each EDD will consist of an electronic display (E-ink), a microcontroller (MCU) and an RS-485 converter.

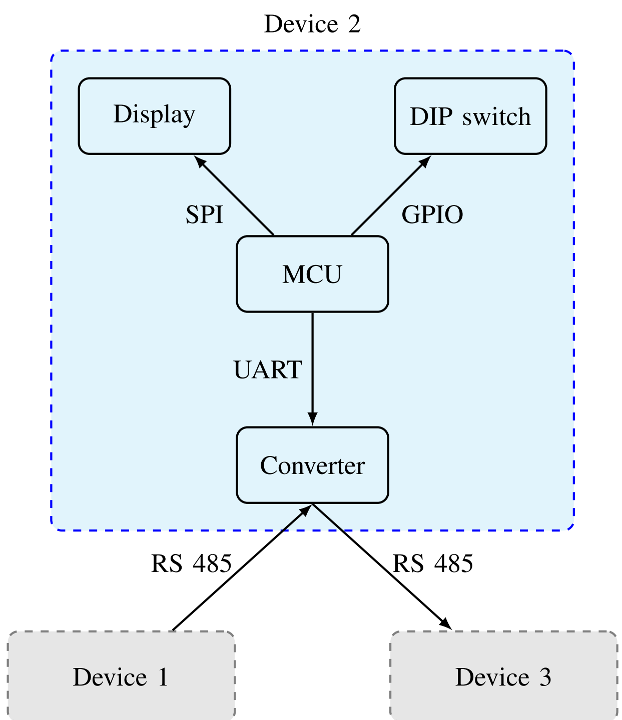

Fig. 2. Block diagram of the EDD

A. Microcontroller

The following solution was choosen. Raspberry Pi Pico microcontroller (MCU) has been selected to control the entire EDD. To operate the display, a memory is required in which the prepared image is stored before it is displayed. And also the font used occupies considerable space in the memory due to its size.

Especially because of these memory capacity requirements, it is not possible to use a simpler microcontroller such as the Arduino Nano. Increasing the memory capacity by using external memory, adds not only the cost but also the complexity of the whole system.

B. Display

Since archery is mainly an outdoor sport, it was necessary to find a display that would be easy to read even in direct sunlight. E-ink technology was chosen. It is a passive display, i.e. it does not need an internal light source to function, it reflects light from the surrounding environment.

This type of display also consumes electricity only the moment when the image on the display changes. Since the devices will be powered from a central unit this feature is not as important as if EDD's were wireless. The display of the display device consists of a black and white 7.5" display with a resolution of 800 x 480 pixels made by Waveshare company. The display driver communicates with the MCU over 4 wire SPI.

C. Device-to-device communication

The individual devices are connected in a daisy chain topology. As mentioned in the previous chapter, the RS-485 serial communication standard has been chosen. The control unit sends information about the shooters to each display unit individually. Each device has an address corresponding to the number of the target in front of which it is placed. The address of the device can be changed using the DIP switch on the back of the device.

There are also two RJ45 connectors on the rear panel for connecting the previous and next device. The connection itself is made using a UTP cable, where one pair is used for communication and the other two pairs are used to power the unit. The remaining pair will not be used in this system and is reserved for future improvements.

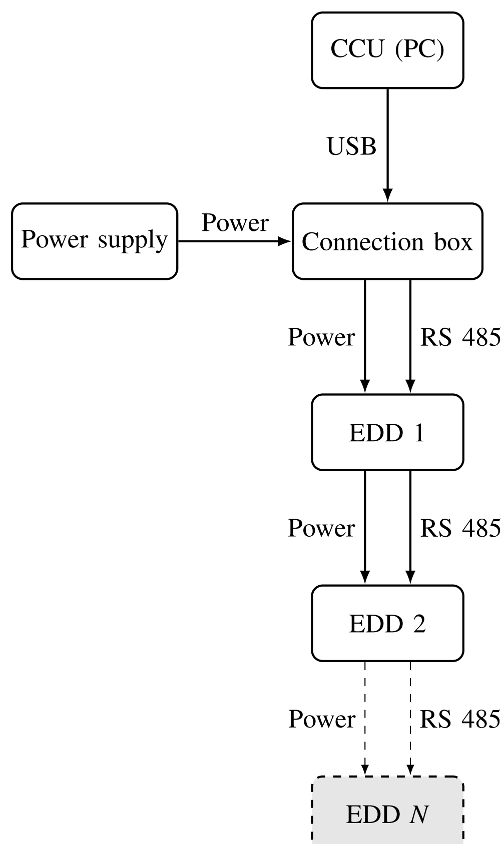

Fig. 3. Connections between devices

Data is sent from the control unit to each device individually, i.e. in unicast mode. After the transmission of the message, the display device will send an acknowledgement of receipt of the data to the control unit. CRC-16 is added to the transmitted data to ensure reliable transmission of information and to detect any errors that may occur. One round of elimination matches typically takes 20-30 minutes, so the status of the device must be monitored outside of the sequence of new data transmissions; the activity of the display device is checked approximately every 5 minutes. If the controller loses contact with one of the display devices, it makes several attempts to re-establish communication. If this fails, the user reports the disconnection of the device to the control program.

IV. The central control unit

The connection between the EDD and the central control unit is made via a connection box that contains a USB to RS-485 converter and provides the connection of the display devices to the power supply. The computer is connected to the connection box via USB on one side, and the display devices are connected to the RS-485 bus via RJ45 connectors on the other side. Activity on the bus is indicated by an LED on the side of the connection box.

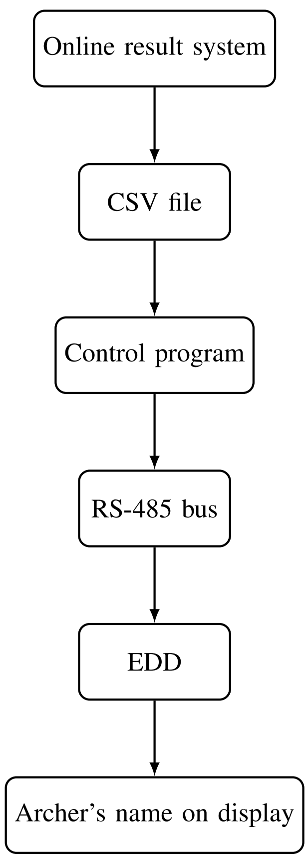

Fig. 4. Data flow from scoring application to shooter

The CCU consists of a computer running a control program. Once connected, the control program allows the user to monitor the status of the individual display devices, enter and send custom text to the displays (e.g., display of break end time, etc.). Last but not least, to confirm the sending of the next round to the display devices.

This CSV file is generated by the online results system, for display purposes it is necessary to edit the downloaded file to the desired format (change the order of the information columns) and remove redundant information. Before each round, the prepared data is presented to the user for review. Once the user has approved the data, the control unit sends the appropriate data to each of the EDDs.

In the background, the control program maintains communication with the individual display devices, monitoring their activity.

V. Future improvements

It would be useful to further extend the control system to connect directly to the online scoring system from which it will automatically extract scorer data. This connection would allow to increasing the amount of information shown on the display of the device, for example the results of individual sets of matches.

For easier handling and preparation of the whole system, it is necessary to remove the wired connection between the devices and switch to wireless communication between all units.

VI. Conclusion

The proposed system of electronic display devices is an effective solution for simplifying the organization of archery competitions, especially in the elimination phase. By replacing paper cards with an automated electronic system, the transfer of information between organizers and archers will be significantly accelerated and made more accurate, eliminating potential errors and delays.

The use of E-ink technology ensures good display readability even in difficult lighting conditions, while the RS-485 communication bus enables reliable data transfer between the control unit and the individual displays. The system also provides the ability to monitor the connected devices and detect unit faults early.

Further development of the system should be directed towards integration with the online results system and the transition to wireless communication, thus increasing flexibility and facilitating installation and handling of the devices. These improvements could make the competition even more efficient and provide a better experience for shooters and organizers.

This system will minimize the initial delay caused by the printing and sorting of shooter's cards prior to the elimination rounds and will shorten the breaks between elimination rounds. In practice, this can save around 20 minutes of preparation time between the qualification and elimination part of competition, and around 15 minutes during the elimination rounds. It is also possible to use volunteers for other work on the range, approximately 2-6 people. The time and number of people will vary depending on the size of the event and the current operation of the eliminations in that event.