

iRoobo

The purpose of this paper is the projecting of a terrain mobile robot and discussion about the necessary elements of the construction. The mechanical system was designed in Autodesk Inventor, and executed according to the design. The next subtask was the planning of the electronic parts of the controller as well as the integration of the sensors in the system. A variety of sensors can be found on the system, of which the most important should be the incremental encoders, used to measure speed and position.

On the system two FPGA development boards can be found: a Zybo, with larger resources (integrated ARM processor)- it is used to perform mathematical calculations, and a small-capacity FPGA (SPARTAN3e500), with 8 hardware-implemented controllers and with a MicroBlaze processor. These controllers control the 12V DC motor speed or the position of it. The MicroBlaze processor is responsible for receiving data and after a simple processing for writing to the appropriate register of the hardware-based controller. To the SPARTAN3e500 board 8 pieces of incremental sensors are mounted which measure the position and speed of the motors. The sensor's data is sent by the Spartan board via a fast SPI communication to the Zybo board. The fast hardware, the PID controller was implemented on an FPGA development board with the Xilinx System Generator design tool, the simulation was carried out with hardware co-simulation.

We can communicate with the ZYBO system using a Wi-Fi router via TCP protocol. Three TCP servers are running on the Zybo system:

- We can request data from the sensors (gyroscopes)
- Motor Controllers data can be read back (speed, position, intervening signal...)
- Parameters and instructions may be added to the system

The planning started with the mechanical system. With the help of Autodesk Inventor, several variants were designed until arriving to this mechanical structure of the discussed paper. The mechanical system was made based on the plans, and tests were made in which the gear ratios were carried out. The results showed that the modification of the system for fixing the motors is needed. The designing and rebuilding of the mechanical system took two months.

For the software and digital hardware development the FPGA system was chosen, because software and hardware are easy to develop together. The sensors were chosen so as to be easily fitted to the FPGA system, all sensors are working on 3.3V voltage level.

The incremental sensors signal's processing module is realized in System Generator. Once the position and speed could be measured, the controllers for the system operation have been designed, at first the PID control. The PID control was used for speed and position controlling, but the results showed that the PID is not efficient to perform the position controlling.

Due to the backlash in the referrals system, the position controlling hasn't been correct, so a different regulatory concept was developed, which has proven viable.

In the dissertation we present the implementation of the PID controller, position controller and the data processing modules of the incremental sensor in System Generator environment, as well as the simulations with hardware and software modules.

More massive complementary accessories such as robot arm, lawn mowers, etc can be fixed to the robot chassis.

Applicability is possible even in agriculture, eg. as a weeding machine, or even in safety engineering, as an actuating device.