The design and building of a transportable demonstration field that ensures stable field illumination for soccer robots

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Title

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Topic of the assignment

Analysing the influence of (ambient) light on the digital recognition of soccer robots, selecting a suitable material for the playing surface and designing a transportable demonstration field.

Background information

Figure 1 – The old demonstration field.

The assignment is executed commissioned by RoboTeam Twente. RoboTeam Twente is a team of students that competes in the RoboCup, an annual competition in autonomous robot soccer. For promotional purposes, RoboTeam Twente wants to have a soccer field on which demonstrations of the capabilities of the soccer robots can be displayed. At the start of the assignment, RoboTeam Twente already had a demonstration field, but this field does not meet the requirements that have been set.

Relevance

The final goal of the assignment is to deliver a physical demonstration field that can be used for promotional purposes, on which the robots can perform demonstrations.

Assignment's objective

The main partial objectives of this assignment were to ensure the digital recognition of the robots and the selection of the right material of the playing surface. The entire field has to be transportable by car and quickly assemblable.

Approach

After analysing the background information of the assignment and composing a list of requirements, various (partial) design solutions were developed. By combining these design solutions, three concepts have been created which have been compared by the extent to which they meet the requirements. The selected concept was designed further into detail and eventually has been build. Throughout the entire design process, the sizes of and connections between parts were important aspects to ensure the transportability and assemblability of the field.

In a robot soccer match or demonstration, a camera mounted above the field registers the field surface and the objects, e.g. the ball and robots, on the field. An external computer analyses the camera's images and filters out unique colour patterns on the top of the robots to perceive the robots' position and orientation. Thereafter, it sends commands to the robots wirelessly to perform specific actions. Changes in illumination of the field disable the computer to filter out the colour patterns. In a test, combined with literature research, the influence of illumination on the computer's ability to recognize the robots was inquired. Additionally a testing process for the selection of a suitable material for the playing surface of the field was composed and executed.

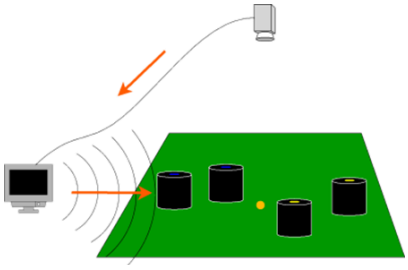

Figure 2 - Visual representation of robot recognition and control.

Results & limitations

It was found that an increase in the initial amount of illumination of the field stabilizes the computer's ability to recognize the robots, as it reduces the influence of changes in ambient light as perceived by the computer. Therefore an additional light source is integrated in the design of the field. This light source exists out of LED strips, which can be dimmed by regulating the flickering frequency. At full power, the LED strips do not flicker. The camera above the field takes images with a specific frequency as well. For some frequencies of the LED flickering, the image taking frequency conflicts and so subsequent images flicker as well. For now, the LED strip has to be used at full power in order to prevent flickering images.

Figure 3 – The new demonstration field.

The testing process of the surface material has resulted in the selection of a suitable material, which was used for the actual physical demonstration field.

Although all of the partial design challenges were solved and tested and evaluated individually, the full demonstration field has not been tested. Right before the scheduled testing moment of two days, the robots stopped working and needed major repairs. Thereafter, the robots were shipped to Australia were the RoboCup of 2019 was held.

Conclusion and recommendations

As all of the partial design solutions were tested and succeeded to meet the requirements, it is highly expected, as well by RoboTeam Twente itself, that the full demonstration field will be suitable to execute demonstrations on. It is recommended to program the option to adjust the camera's image capturing frequency in the user interface of the software that controls the camera, so that for every LED frequency a non-conflicting image capturing frequency can be set.

References

Figure 2:
Bruce, J. and Veloso, M. (2003). Fast and accurate vision-based pattern detection and identification. In: 2003 IEEE International Conference on Robotics and Automation (Cat. No.03CH37422). IEEE: Tapei, Taiwan. Page 2.