Planning and construction of an automated parkour element with sliding-door mechnaism for the Robots unite event

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***Abstract*—This technical paper presents the process and construction of an automated parkour element. In the course of the project, mechanical, electrical and programming aspects are dealt with. At the beginning, all components are analyzed and presented individually with regard to their functions and project integration. One of the main goals of the documentation is to present the findings and work steps of the project in such a way that they can be transferred to similar project types.**

I. Introduction

In 2023, the use of robots in all kinds of work areas increased significantly. In addition to their use in manufacturing processes, they are also more often being integrated into elderly care and restaurants. Due to the ever-increasing importance of robotics in everyday life, there is now an ever-increasing number of robotic courses in schools. This should make is easier for interested young people to get into programming in a playful way and offer them the opportunity to learn certain subject areas at an early stage. In order to be able to put the skills they have learned to their own robots on a wide variety of parkour elements for previous skills and possible weak points. As there was no automated parkour element yet, my fellow student and I decided to built one and make it available for the events.

II. Planning and components

The automated parkour element consists of various mechanical, electrical and static components. The interaction of the individual components ultimately determines how well and smoothly the automated sliding door process works after a groper is being pressed by a robot. In order to be able to open and close the two installed sliding doors automatically, PLC programming is used, which is implemented using gate logic.
The element is divided into the arena area in which the robots move and the technical area in which all components necessary for the realization of the project were installed.

A. *Specification of the project*

The project had a few specifications that had to be observed. The passage elements must have a tube diameter of 50cm. Accordingly, the robots may only be large enough to fit through the sliding doors and overcome the parkour element. Furthermore, all electrical components should not be accessible from the outside. It is important, that these are installed inside the box to avoid possible electrical accidents. In addition, the element should be designed and automated in such a way that it can be overcome by a single robot as well as by two in a team. To make the overcoming process more difficult for the team, three puzzles were programmed. All options can be selected in advance in the technical compartment using switches. The most important specification was the structure and robustness of the wooden box.

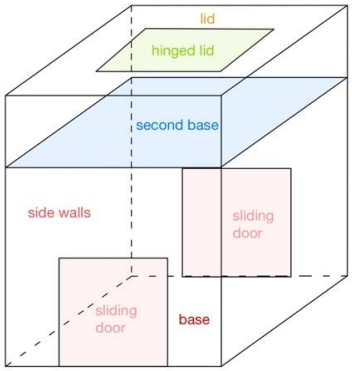

Figure 1:Structure of the parkour element

B. *Mechnanical and static components*

The robustness of the wooden construction, which is a wooden box with two sliding doors and two separate compartments, was particularly important for the project. As the wooden box is to be used more frequently and regularly in competitions and for training purposes in the coming years, it must be built to be very stable. The box must be able to withstand vibrations from robots when they drive against it. For this reason, the decision was made to use 15mm thick USB plates, which were screwed together using an interlocking system. In addition to the external construction, stable sliding drawers were also required for the sliding doors. The sliding door run in a track laid in the floor to prevent them from interlocking. As this is an automated sliding door mechanism, gear rack with a matching gear wheel had to be fitted on both sides. In addition, a construction was needed for the inner buttons to ensure that they are stable. Ultimately, the weight of the construction was a problem, which is why handles were mounted on both sides.

Figure 2: Wooden Box Construction

C. *Electrical components*

The electrical components are essential to automate the parkour element. Motors are installed on the sliding doors which open or close after a push of the installed buttons. The driving process is stopped at the respective installed limit switches. In order to systematically safeguard all the components, fuses were installed which trigger in the event of a fault and safeguard the remaining components. All installed elements were considered for the correct selection of fuses. The sliding door mechanism was not only protected on the software side but also on the hardware side by means of relays. The relays were installed for each running direction of each motor. This to prevent both left- and right-hand operation being controlled at the same time. To ensure that only the maximum required voltage is applied to the respective components, voltage transformers had to be installed for the motors and illuminated pushbuttons. The voltage transformer can also be used to adjust the speed of the sliding doors.

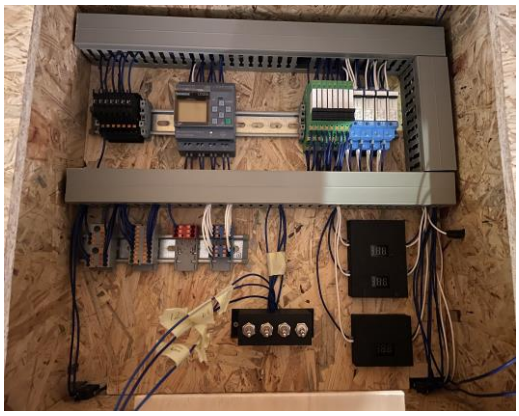

Figure 3:Electrical Components

D. *Programming*

All planned automations were implemented by using PLC programming. A Siemens LOGO 8 and a suitable expansion module were used to implement all functions. As the LOGO is small and compact, it is actually perfect for out project because the space in our technical compartment is relatively limited. It is also a good alternative to a large PLC as it is in the lower price segment. The PLC and the module each have inputs and relay outputs that are easy to connect. The simple gate logic, which we used for most programming, is very easy to understand and therefore no extensive programming knowledge is required to advance. Advantageous of the LOGO-Soft software, which is required for programming, is that all programmed functions can be tested and simulated immediately.

III. Dokumentation

The documentation is a very important part of the entire project. With the help of this, it should be possible for every reader to understand, rebuild and implement the project. The documentation should therefore be very structured and not too complicated. The many pictures and CAD-models make it easier to rebuild the automated parkour element.

A. *Event participants*

The replica is particularly important for participants of the robots unite event. With the help of the documentation, every step of the procedure can be reproduced and copied. In this way, equal opportunities can be created at the event, because every participant is able to rebuild the automated element and then use it for the necessary training purpose. In this way, the students can test their self-built robots on the element and implement or optimize any necessary functions.

B. *Finding location*

In GitHub the documentation can be viewed and read by anyone interested. All process steps, implementation and component dimensions can be found in the large documentation on Git. There is also a smaller documentation, which can be found in the lid of the technical compartment. With the assistance of this it is much more easier to understand how to select the puzzles correctly.

IV. Conclusion

Although the automated parkour element is not the biggest and most demanding project, but it is still very costly and time-consuming to plan and build. We were able to make good use of what we had learned during our studies to fully realize and complete the project. The documentation allows us to avoid mistakes, which also saves a few costs and time. We would therefore be delight if our parkour element is well received at the event and soon becomes an integral part of it.

V. Acknowledgement

Last but not least ´, many thanks to Prof. May, who gave us the chance to carry out this project without any big major restrictions. I am happy to be a small part of the “Robots unite” event due to the construction element. Many thanks to David Koginski for the good and smooth cooperation, which helped to complete the project very quickly.