Interactive Robot Chess

Report Name	Project Outline
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1 Project description

The Interactive Robot Chess project will develop a robotic and desktop based application, to enable users to play chess with a robotic arm.

This project will develop a desktop application to allow users and developers to interact and obtain information from the robotic system. There will be a desktop-based interface, developed in Kotlin [1], for users and developers. This should have two different layouts, one for users and the other for developers. To determine which interface will be accessed an authentification process will be used.

The user interface should show the current board state to allow users to correct the system if the board state varies from the physical board state. Further it should allow the user to choose a bot the user should be able to choose from a variety of difficulties. Moreover the user interface should include a visual and textual guide on how to setup the environment(callibration process) of the system to play a game of chess.

The developer interface should have the same functionality as the user interface. It should further expand on that interface by adding access to backend information and the ability to change values or states of the robotic application.

The robotic application adds functionality to the robot arm and the overall system. This system will be developed in the ROS middleware environment [2]. The robotic application will consist of a physical robot arm for chess movements, object detection and safety features; a simulation environment to test the functionality and safety of the system; a chess engine to enable the user to play a bot; an overhead camera to see the physical board state and safety features; and a communication protocol to enable communication to the desktop application.

The safety features of the overall system will need to take into account physical objects, eg. user arm, to insure neither the robotic arm nor the user will be hurt or damaged. To accomplish this the overhead camera and the robot arm sensors and camera will be used to enforce a stop of the robot arm.

This system can be used as a ground system to expand it to not only play chess, but also playing other kinds of board games. Further introducing the option to let other users, through an internet connection, do the movements instead of an engine will make it possible to interact and fill up empty players by actual users.

2 Proposed tasks

The following tasks will be performed on this project:

- **Investigation of the robotic arm and build process.** This task will explore the options of robotic arms and how to implement them in the ROS middleware. Further it will be necessary to consider the connection to external devices for communication. Reasearch into how to move chess pieces will be looked into.
  There will be a meeting with the Robotic group of the Computer Science department to determine which robotic arm will be used for this project based on its availablity and the investigation done.

- **Investigation of the chess engine and safety measures.** After confirming the robotic arm there will be a need to investigate which chess engine to use, an example for such a chess engine would be stockfish [3]. This investigation also includes the need to discover the method of interacting with the chess engines.
  The safety measures will need to be determined based on law and above mentioned safety features. Further there is a need to research how to implement these safety measures based on the available equipment.
- **Investagion of object detecion.** Here research to detect objects using cameras, such as the chess pieces, chess board and the users arm, will be accomplished. The detection will be realized by using libraries such as OpenCV.
- **Development.** The development will consist of two main subtasks:
  - **Robotic application.** The first part of the development will form the foundation of the project. It will construct the underlying data for the board. Arm movements to pick up and place chess pieces and getting to a resting position will be produced. This will also include the callibration and detection of above mentioned objects, to interact and gain information. Further the communication module and its corresponding protocol will generate the possibility to make internal information available to external devices. Safety measures are going to be implemented in the movement of the arm.
  - **Desktop application.** The second part of the development will introduce the interface for the user and the developer. The interface is written in Kotlin to make it available to different desktop environments. It will include all above mentioned functionality. Further the communication to the robotic arm will be realized utilizing the communication protocol.
- **Project Meetings and Project Workflow.** The project will involve weekly supervisor meetings. A project workflow will be setup up to ease the process of project management and realization of needed tasks. This will asisst in the reports at the meetings and the writing of the project report.
- **Preparation for demonstrations.** There is a need to prepare for the Mid-Project and End-Project demonstration, using notes and creating a presentation.

3 Project deliverables

The following project deliverables are expected.

- **Mid-Project Demonstration Notes** - A set of project notes will be produced for the demonstration. This will be included as an appendix in the final report.
- **Desktop application** - The desktop application as an executable file and possible installation manual. A version of this with its source code will be submitted for assessment. The corresponding source code will be available on a version control system.
- **ROS Software** - The robotic application code will include necessary files and third party scripts to run the application. An installation manual may also be added. A version of these files will be submitted for assessment and they will also be available on a version control system.
- **Final Report** - This document will be the report and associated appendices. This document will also include all relevant acknowledgements for libraries, frameworks and tools used in this project.

- **Final Demonstration** - Should include some prepared notes and a possible presentation.

Annotated Bibliography

[1] "Kotlin programming language," accessed February 2023. [Online]. Available: https://kotlinlang.org/

A modern programming language that makes developers happier.

[2] "Robot operating system," accessed February 2023. [Online]. Available: https://www.ros.org/

The Robot Operating System (ROS) is a set of software libraries and tools that help you build robot applications.

[3] "Stockfish 15.1," accessed February 2023. [Online]. Available: https://stockfishchess.org/

Strong open source chess engine