Gamebot 2.0 – A robot playing Tetris on a NES

The Gamebot 2.0 is a robot capable of playing Tetris autonomously on a Nintendo Entertainment System (NES) console using computer vision and artificial intelligence. It is able to detect and act on a Tetris game running on a TV screen in real time, reaching scores of up to 53'000 points.

Introduction and Objectives

This project builds on the Gamebot 2.0 – a hardware built in the industrial engineering department of the BFH. The Gamebot 2.0 can control a Nintendo Entertainment System (NES) gamepad while watching and acting on the contents displayed by a TV connected to the same console allowing it to play Tetris on an original NES. However, the existing version of the hardware did not include any software components for the Gamebot 2.0 to play the game, but only the hardware components required to control a NES gamepad. The thesis's objective is to complete the Gamebot 2.0 project by developing software components to observe a running Tetris game on a TV and recognize the game's state to evaluate and execute suitable actions on the NES controller to maximize the score – ideally a maximum possible score of 999'999 points.

Research Design

In this qualitative research, several software components for the Gamebot 2.0 hardware are developed which allow the hardware to play Tetris on an original NES console using its gamepad. The image stream provided by the webcam is processed using an open-source computer vision library (OpenCV) to extract the relevant information of a running game.
The primary approach to process this information is to use a trained artificial intelligence agent to evaluate the game's state and act on it to progress the game towards higher scores. If this approach is not feasible, a fixed logic with a pre-defined set of actions is implemented instead. Each action is sent to a hardware abstraction component which translates these actions to the actual "button presses" that will be executed on the Gamebot 2.0 hardware.

Results

The result is a robot which can autonomously play Tetris on a NES console using computer vision and artificial intelligence, reaching scores of up to 53'000 points. Several software modules outlined below make up the software stack that enables the Gamebot 2.0 to play Tetris. The image recognition module can find the region of interest (the actual game screen) on a TV in front of the webcam. The game recognition module can use this region of interest to extract relevant information from a running game. The game-state machine module consists of a "fixed-logic" part which can start a new game, and an existing, but modified bot using deep reinforcement learning to play the game. Instructions from the game-state machine are translated by the hardware abstraction module to button presses which are executed as fast as possible. Using a custom developed benchmarking tool, it was determined that a button must be pushed for 35ms, and after releasing, a wait time of 35ms is required before the same button can be pushed again.

Implications and Recommendations

The Gamebot 2.0 surely is an eyecatcher when it is playing Tetris while its actuators emit a distinctive rattling noise when pushing buttons, grabbing the attention of bystanders. Watching the Gamebot 2.0 reaching scores of up to 53'000 points is already impressive and by further improving its algorithms it should become able to compete in the Classic Tetris World Championship where it must compete against real players that often reach a max-out score.

Raphael Andreas Krebs
079 770 75 87
raphael.krebs@outlook.com

Figure 1: Gamebot 2.0 Hardware