IAIA Project #2

Gomoku & Checker Game Automation Using UR5e Robot Arm

School of Mechanical & Control Engineering
Course: Industrial AI and Automation

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Contents

1. Introduction

1. Background of the project

- **Motivation:** Physical operation of AlphaGo (in Gomoku)
- **Goal**
  - Robot Operation with real-time perception using camera
  - AI based decision making in game algorithm

2. Expected Results

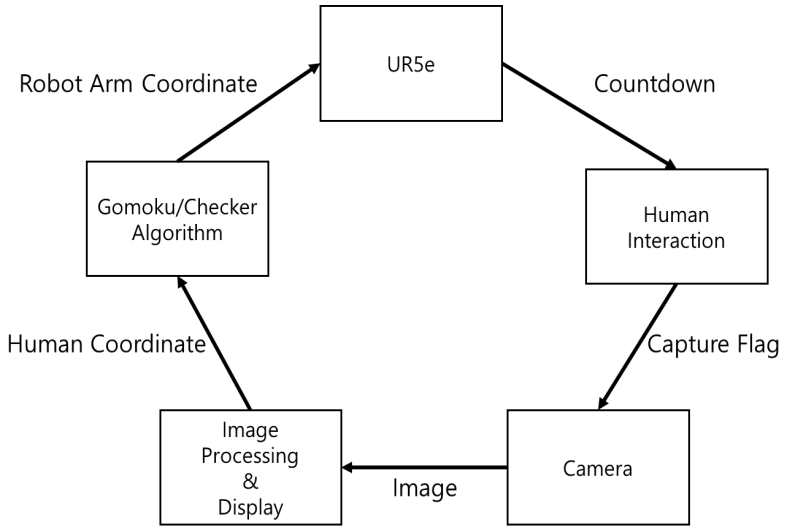
- Getting used to AI with friendly games
- Time-killing tools for solitary people

1. Introduction

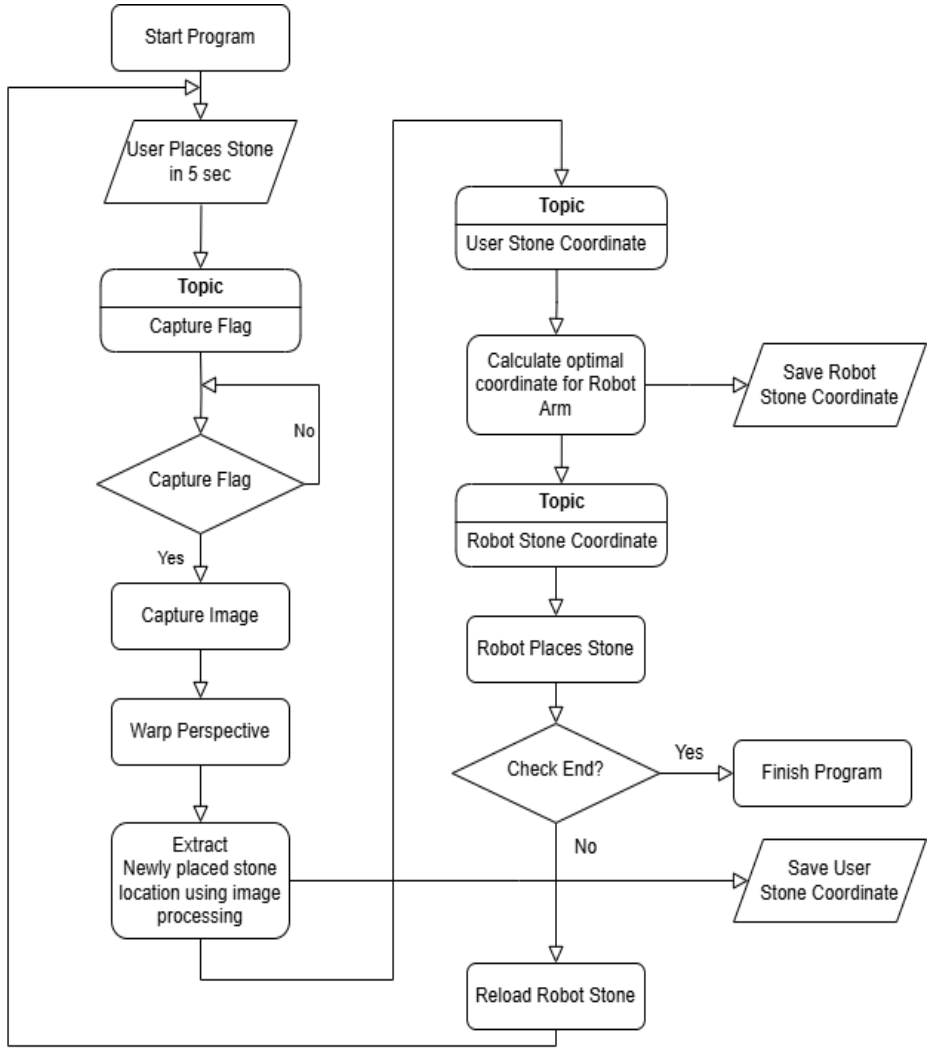
3. Development Environment and Hardware

1. OS: Linux Ubuntu 20.04
2. ROS Noetic
3. HW: UR5e Robot, Camera ODROID USB-CAM 720P
4. Packages: OpenCV, TensorFlow

4. RQT graph and Flowchart



Simplified RQT graph



Flowchart of our Program

2. Gomoku Game

Instruction to Gomuku Game

1) Gomoku game

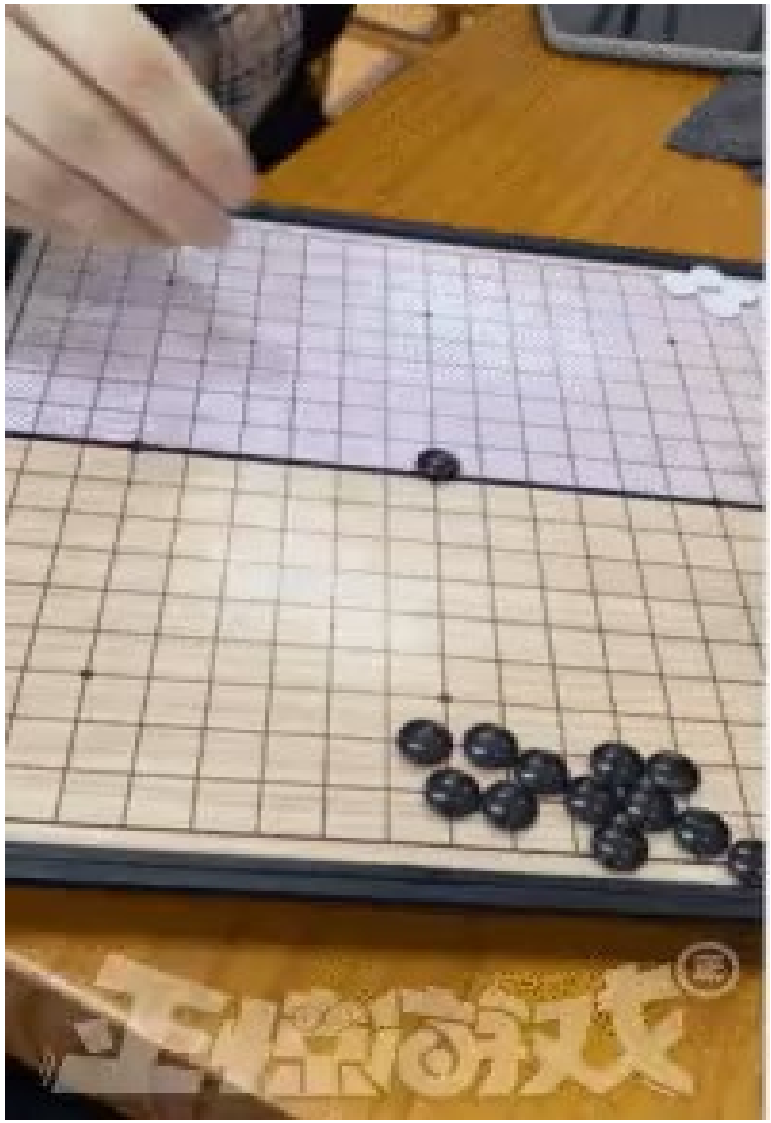
- Place five stones in a row

2) How it works

- User always plays first. Place a black stone
- Camera detects the user's stone and calculates the optimal move
- Robot arm places a white stone

3) Features

- Don't hesitate to place stone (It may detect wrong position)
- Place stones on the correct grid to avoid recognition errors



https://github.com/DahamChoi/omok

3. Checker Game

Instruction to Checker Game

1) Checker game

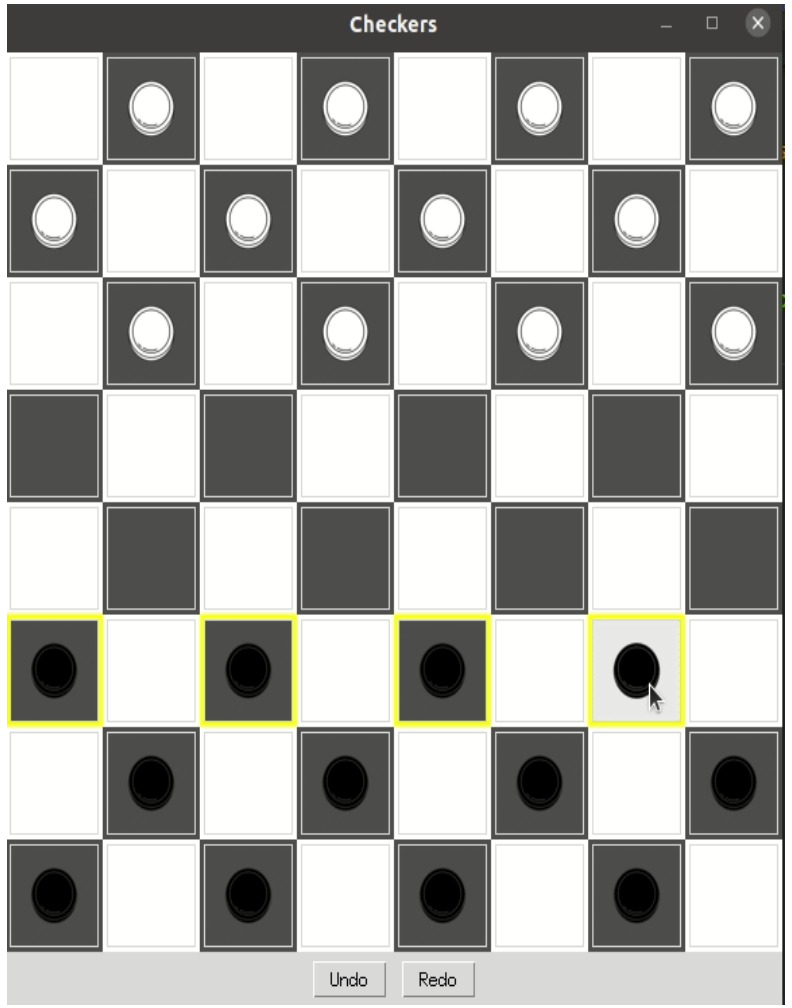
- Jumping the opponent's stones and remove them

2) How it works

- Select for mandatory jump rule
- User always plays first. Place a black stone
- Camera detects the user's stone and calculates the optimal move
- Robot arm places a white stone

3) Features

- Remove the captured stone manually
- Place stones on the center of the compartment to avoid recognition errors



4. Demo Video

5. Conclusion

1) Performance of Image Processing
   - Accuracy of Gomoku Game: 100% position detection
   - Accuracy of Checker Game : 100% position detection
2) Performance of AI
   - **Gomoku:** 16 Games, 5 wins, 11 losses for A.I. model
   - **Checker:** 8 Games, 0 win, 8 losses for A.I. model
3) Research Conclusion
   - The project achieved both

     Real-Time perception and AI-based decision.
4) Further improvements
   - Exception Handlers for (After countdown situation, Detection fault case) Gomoku program
   - Robot abnormal movement prevention