

# Implementation of Nine Men's Morris

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# Outline

- 1 Introduction
- 2 Milestones of Project
- 3 Software and Hardware Tools
- 4 Workflow
  - Basic requirements to achieve target
  - Main User Stories
- 5 Implementation phase
  - Program Architecture
  - Safety
  - Visual Analysis
  - Communication between Robot and Camera
- 6 Difficulties faced
- 7 Conclusion

# Introduction

- KUKA Ibr iiwa 7.
- Game called Nine Men's Morris.
- Cognex Camera.
- Artificial Intelligence.

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# Milestones of the Project

- Human vs KUKA robot.
- Robot can detect human moves and can perform its own moves wisely.
- Robot knows its turn after human.
- Through a camera robot interacts with real world.

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# Software and Hardware Tools

- Robotic Arm LBR iiwa 7 R800 1 by KUKA Laboratories.
  - Sunrise Workbench.
- Cognex IS 7000 Camera.
  - Cognex In-Sight Explorer.
- Eclipse IDE for testing AI and Modbus TCP/IP Connection.
- GIT for version control.

# Outline

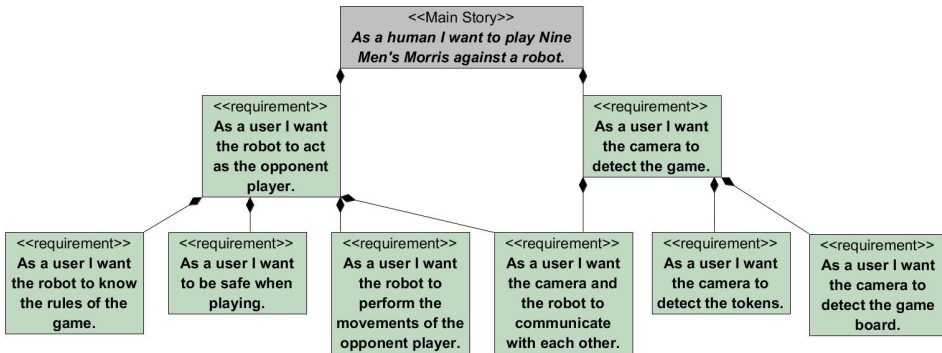
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# Basic requirements to achieve target

- Understanding of Nine Men's Morris games rules.
- Getting started with some useful methods of the robot.
- Learn how to use the Camera.

# Main User Stories

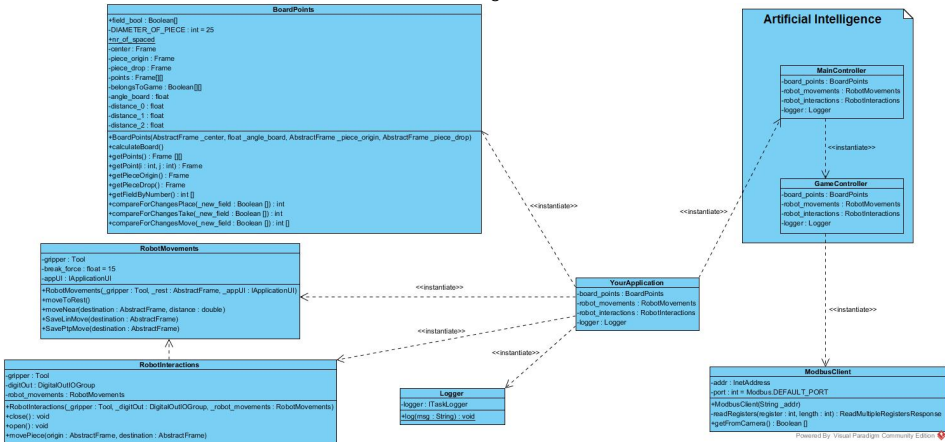


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# Program Architecture

Class Diagram



# Safety

Listing 1: Extract from the Class RobotMovements

```
/**
 * PTP Move method, which stops when a specific force is reached
 *
 * @param destination
 */
public void savePtpMove(AbstractFrame destination) {
    ForceCondition testForceCondition = ForceCondition.createSpatialForceCondition(
        gripper.getDefaultMotionFrame(), break_force);
    IMotionContainer movement = gripper.getDefaultMotionFrame()
        .move(ptp(destination)
            .breakWhen(testForceCondition)
            .setJointVelocityRel(0.5));
    IFiredConditionInfo firedCondInfo = movement.getFiredBreakConditionInfo();
    if (firedCondInfo != null) {
        ThreadUtil.millisSleep(1000);
        appUI.displayModalDialog(ApplicationDialogType.INFORMATION, "App Stopped...", "Continue");
    }
}
```

Listing 2: Call for save PTP Movement Method

```
robot_movements.savePtpMove(getApplicationData().getFrame("/piece_origin"));
```

# Visual Analysis

File Edit View Sensor System Window Help

1. Starten  
Verbindung herstellen  
Bild einrichten  
2. Werkzeuge einrichten  
Teil suchen  
Teil inspizieren  
3. Ergebnisse konfigurieren  
Eingänge  
Ausgänge  
Kommunikation  
4. Fertig stellen  
Blöck streifen  
Job speichern  
Job ausführen

PC Sensor

45% Verfügbarer Jobumfang Offline

Rate: 50.0% (12)  
Zeit: 3.5 ms

Startadresse	Name	Datentyp	Größe	Wert	Datentyp
30010	p_00.Ergebnis	Zeichenfolge	1	Vorhanden	30010 566F Vo
30011	p_03.Ergebnis	Zeichenfolge	1	Vorhanden	30011 566F Ni
30012	p_06.Ergebnis	Zeichenfolge	1	Nicht vorhanden	30012 466F Ni
30013	p_11.Ergebnis	Zeichenfolge	1	Nicht vorhanden	30013 466F Ni
30014	p_13.Ergebnis	Zeichenfolge	1	Nicht vorhanden	30014 466F Ni
30015	p_15.Ergebnis	Zeichenfolge	1	Vorhanden	30015 566F Vo
30016	p_22.Ergebnis	Zeichenfolge	1	Nicht vorhanden	30016 566F Vo

Hinzufügen... Entfernen Nach oben Nach unten Datentypen zurücksetzen

Meldungsgröße (Wörter): 24

# Communication between Robot and Camera

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# Difficulties faced during the project

- Understanding of robotics
  - Robot movement limitations
  - Coordination transformations
- Understanding of AI.
- Recognition by the camera.
  - Game board alignment.
  - Token recognition
- Communication of robot and camera.

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# Conclusion

- Human can play Nine Men's Morris against the robot.
- Possible Improvements:
  - 1 Better cheat handling
  - 2 Board orientation and location
  - 3 Choosing token color and starting player

# Thank You