

# Implementation of Nine Men's Morris

Lars Engel  
Vikash  
Ahsan Yousuf

Fachhochschule Kiel

30. Juni 2015

# 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.

# 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

# 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.

# 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

# 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

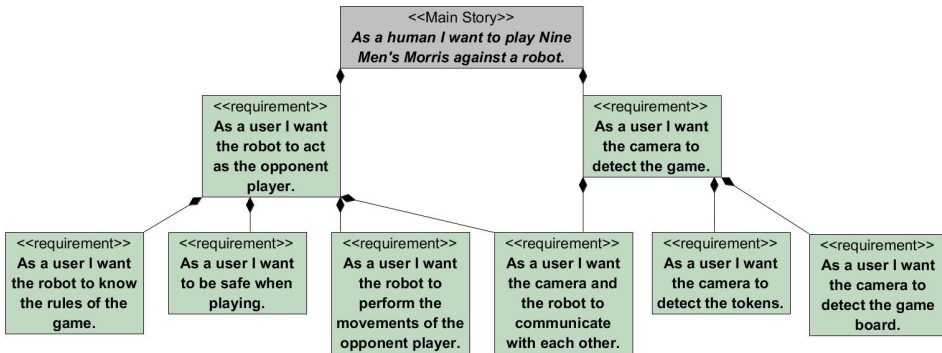
- 1 Introduction
- 2 Milestones of Project
- 3 Software and Hardware Tools
- 4 Workflow**
  - Basic requirements to achieve target
  - Main User Stories
- 5 Implementation phase
  - Program Architecture
  - Safety
  - Visual Analysis
  - Communication between Robot and Camera
- 6 Difficulties faced
-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



# 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

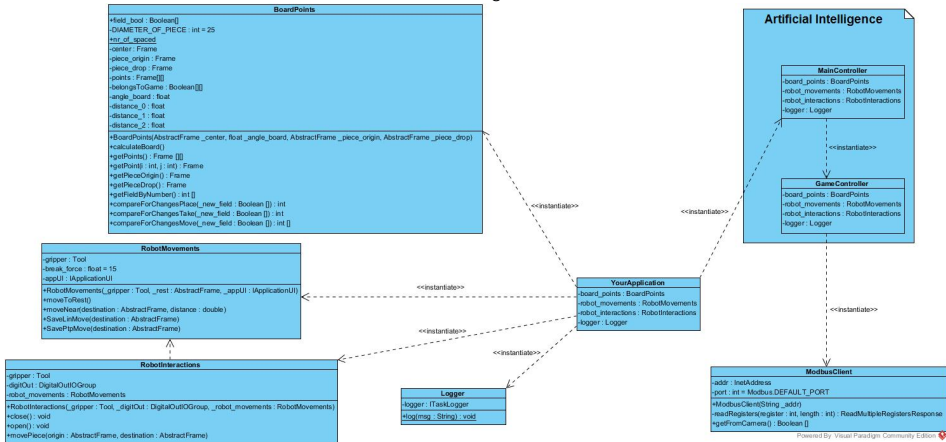


# Outline

- 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

# 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");
        savePtpMove(destination);
    }
}
```

Listing 2: Call for save PTP Movement Method

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

# Visual Analysis

File Explorer - admin - ILARS-ENGL - 7010 - E:\Projects\roboApp\in-sight\03.job

File Bearbeiten Ansicht Bild Sensor System Fenster Hilfe

Anwendungsschritte

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

PC Sensor

45% Verfügbarer Jobumfang Offline

Kommunikation

OPC EasyView

Modbus-TCP-Server

Gerät bearbeiten

Gerät entfernen

Formateingabedaten Formatausgabedaten

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 Vo
30012	p_06.Ergebnis	Zeichenfolge	1	Nicht vorhanden	30012 4666 Ni
30013	p_11.Ergebnis	Zeichenfolge	1	Nicht vorhanden	30013 4669 Ni
30014	p_13.Ergebnis	Zeichenfolge	1	Nicht vorhanden	30014 566F Vo
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

Palette

Name	Ergebnis
p_00	Vorhanden
p_03	Nicht vorhanden
p_06	Nicht vorhanden
p_11	Vorhanden
p_13	Vorhanden
p_15	Nicht vorhanden
p_22	Nicht vorhanden
p_24	Vorhanden
p_25	Vorhanden
p_32	Vorhanden
p_34	Nicht vorhanden
p_35	Vorhanden
p_36	Vorhanden
p_42	Vorhanden
p_43	Vorhanden
p_44	Nicht vorhanden
p_51	Nicht vorhanden
p_55	Vorhanden
p_56	Nicht vorhanden
p_57	Nicht vorhanden
p_58	Nicht vorhanden
p_59	Nicht vorhanden
p_60	Vorhanden
p_61	Vorhanden
p_62	Vorhanden
p_63	Vorhanden
p_64	Vorhanden
p_65	Vorhanden
p_66	Vorhanden
p_67	Vorhanden
p_68	Vorhanden
p_69	Vorhanden
p_70	Vorhanden
p_71	Vorhanden
p_72	Vorhanden
p_73	Vorhanden
p_74	Vorhanden
p_75	Vorhanden
p_76	Vorhanden
p_77	Vorhanden
p_78	Vorhanden
p_79	Vorhanden
p_80	Vorhanden
p_81	Vorhanden
p_82	Vorhanden
p_83	Vorhanden
p_84	Vorhanden
p_85	Vorhanden
p_86	Vorhanden
p_87	Vorhanden
p_88	Vorhanden
p_89	Vorhanden
p_90	Vorhanden

Rate: 50.0% (12)

Zeit: 3.5 ms

Meldungsgröße (Wörter): 24

# Communication between Robot and Camera

## Modbus/TCP



Modbus/TCP Client

ReadMultipleRegistersRequest(register, length);



TCP Packages



```
30010 566f Vo
30011 566f Vo
30012 4e69 Ni
30013 4e69 Ni
30014 4e69 Ni
30015 566f Vo
30016 4e69 Ni
30017 566f Vo
30018 566f Vo
```



Modbus/TCP Server

[CameraIP]:502

# 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



# 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.

# 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**

# 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