Implementation of Nine Men's Morris

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Outline

Introduction

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

Outline

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

Software and Hardware Tools

- Robotic Arm LBR iiwa 7 R800 1 by KUKA Laboratories.
  - Sunrise Workbench.
- Cognex IS 7000 Camera.
  - Cognex In-Sight Explorer.

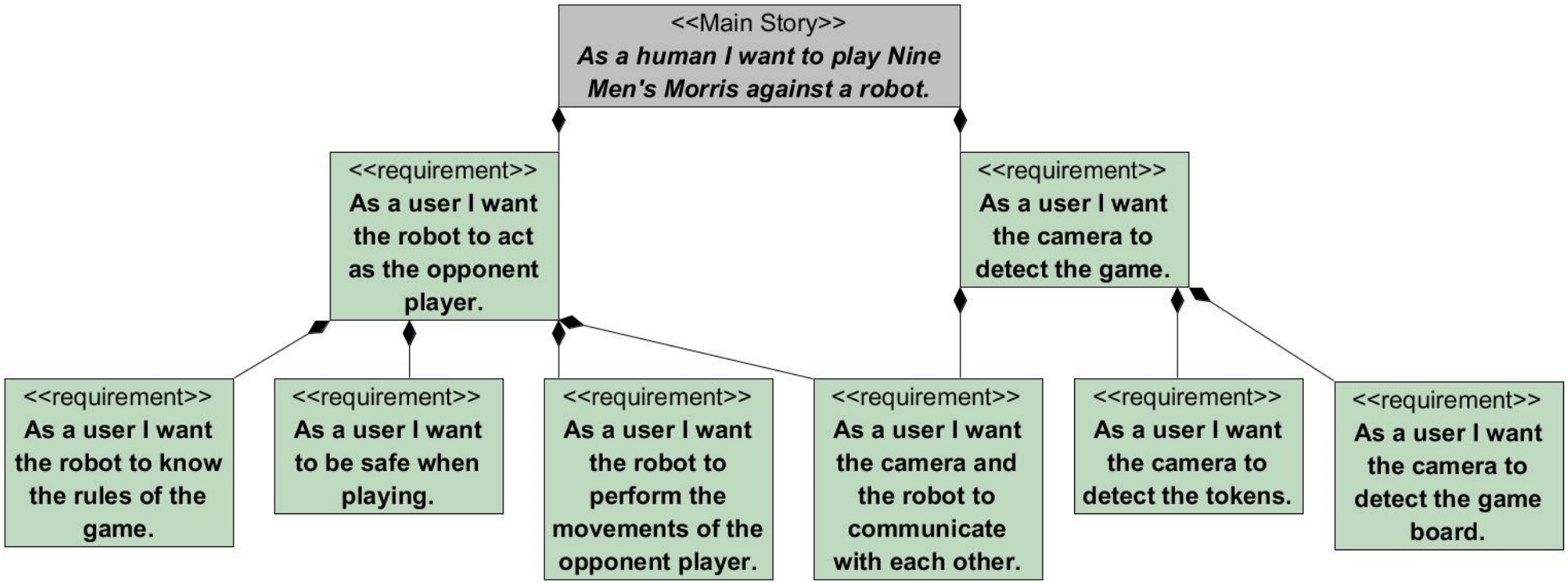
- Eclipse IDE for testing AI and Modbus TCP/IP Connection.
- GIT for version control.

Outline

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.

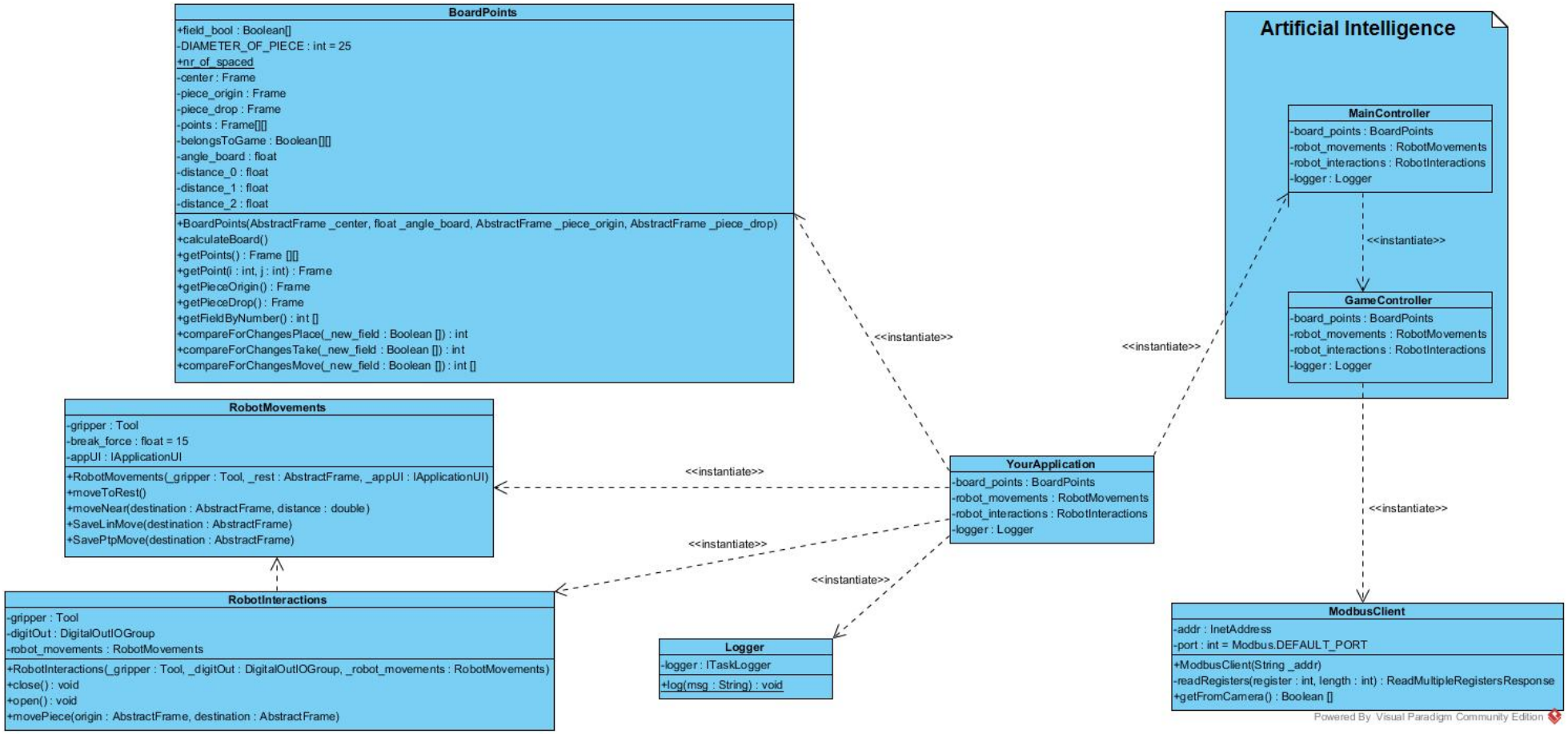
Main User Stories



Outline

Program Architecture

Class Diagram



Safety

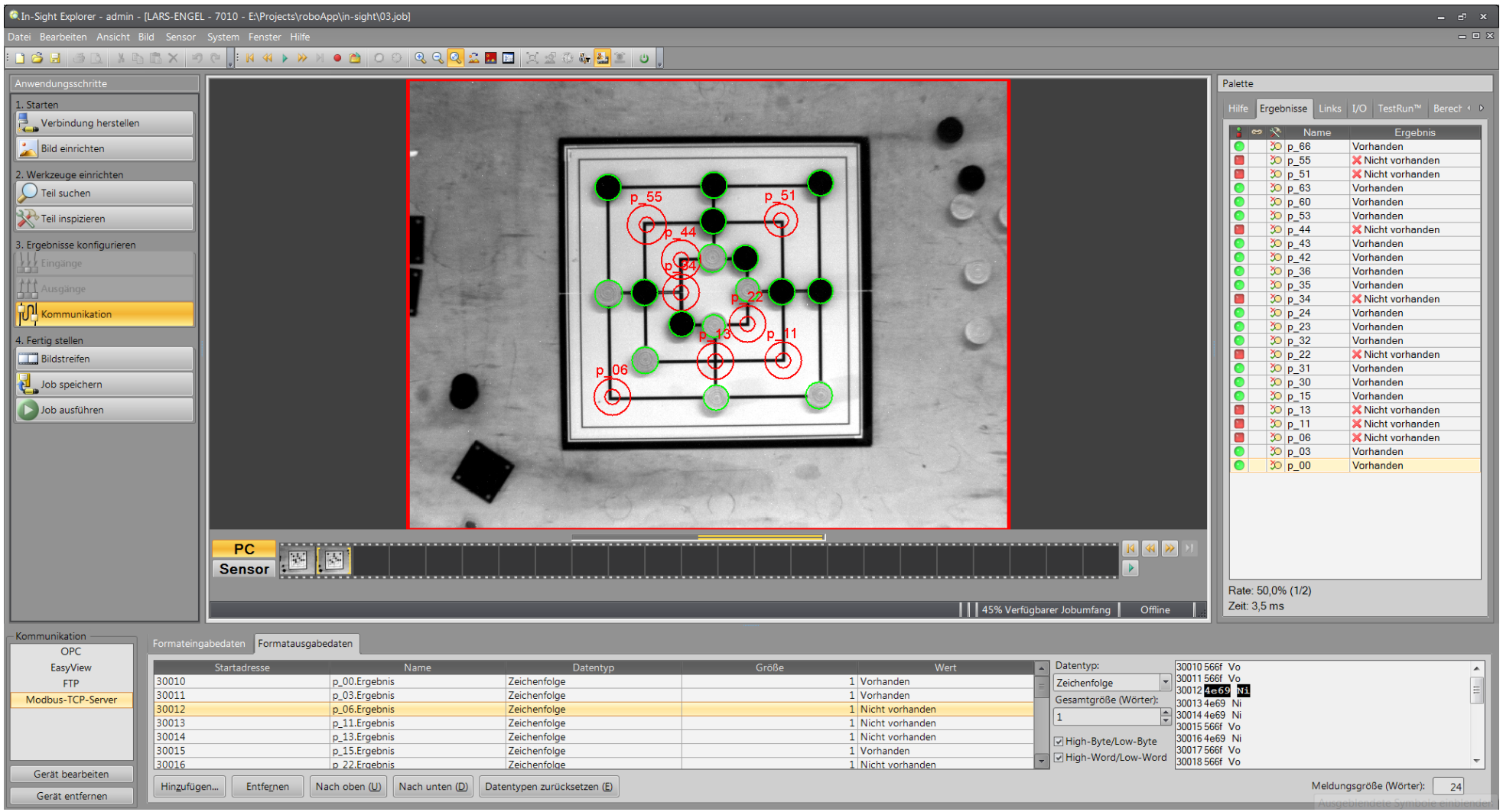
Listing 1: Extract from the Class RobotMovements

```
/**
 * 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.milliSleep(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

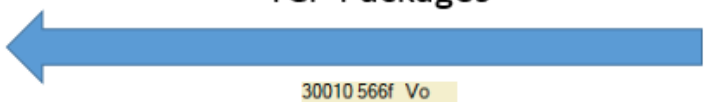


Communication between Robot and Camera

Modbus/TCP

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 Client

Modbus/TCP Server

[CameraIP]:502

Outline

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

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

ThankYou