Module Interface Specification for Chess Connect

Team #4,
Alexander Van Kralingen
Arshdeep Aujla
Jonathan Cels
Joshua Chapman
Rupinder Nagra

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1 Revision History

Date	Version	Notes
1/17/2023	1.0	Detailed Modules used by Arduino Mega 2560
Date 2	1.1	Notes

2 Symbols, Abbreviations and Acronyms

See SRS Documentation at [give url —SS]

[Also add any additional symbols, abbreviations or acronyms —SS]

Contents

3 Introduction

The following document details the Module Interface Specifications for [Fill in your project name and description —SS]

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at .... [provide the url for your repo —SS]

4 Notation

[You should describe your notation. You can use what is below as a starting point. —SS]

The structure of the MIS for modules comes from Hoffman and Strooper (1995), with the addition that template modules have been adapted from Ghezzi et al. (2003). The mathematical notation comes from Chapter 3 of Hoffman and Strooper (1995). For instance, the symbol := is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1|c_2 \Rightarrow r_2|...|c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by Chess Connect.

Data Type	Notation	Description
character	char	a single symbol or digit
integer	$\mathbb{Z}$	a number without a fractional component in (-∞, ∞)
natural number	$\mathbb{N}$	a number without a fractional component in [1, ∞)
real	$\mathbb{R}$	any number in (-∞, ∞)
boolean	bool	true (value of 1) or false (value of 0)
enumeration	enum	keywords assigned an integer value in order of declaration beginning at 0
structure	Piece	C++ struct data-type containing PieceType enumeration and int colour (0 for white, 1 for black)

The specification of Chess Connect uses some derived data types: sequences, strings, and tuples. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, Chess Connect uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	**Level 2**
Hardware-Hiding	
Behaviour-Hiding	Input Parameters Output Format Output Verification Temperature ODEs Energy Equations Control Module Specification Parameters Module
Software Decision	Sequence Data Structure ODE Solver Plotting

Table 1: Module Hierarchy

6 MIS of Arduino Controller Module

6.1 Arduino Controller

6.2 Uses

Arduino
Software Serial
Chess Board
Piece Identification
Communication

6.3 Syntax

6.3.1 Exported Constants

None

6.3.2 Exported Access Programs

None

6.4 Semantics

Name	In	Out	Exceptions
setup	-	-	TeensyConnectionFailed
loop	-	-	TeensyConnectionFailed
changeGameState	gameState	gameState	InvalidAction
changeGameMode	gameMode	string	InvalidAction
competeUserAction	string	userAction	InvalidAction, UnknownAction
lightLED	int, int	int	-

6.4.1 State Variables

gameMode := enum { beginner, normal, engine }
gameState := enum { init, play, end, reset }
userAction := enum { wait_white, wait_black, piece_lifted, remove_piece, promoting, valid_move, invalid_move, draw, resign, reset }
boardState := FEN string playerWarning := enum { check, checkmate, stalemate }

6.4.2 Environment Variables

HALL_PINS: input pin addresses for receiving signal from Hall-effect sensors
LED_PINS: output pin addresses for lighting up the LEDs on the board
rx_from_Teensy: input pin for communication with Teensy controller
tx_from_Teensy: output pin for communication with Teensy controller

6.4.3 Assumptions

- setup() will run before any other function.
- Connection exists between both controllers and remains constant

6.4.4 Access Routine Semantics

loop():

- transition:
  - Main control loop.
  - Polling sensors to update boardState FEN string.
  - Checking for check/checkmate/stalemate signal from Web App to update playerWarning.
  - Wait for userAction based on Hall-effect sensor inputs.
- exception: TeensyConnectionFailed

changeGameState():

- transition: Change gameState based on user input button presses (game start, draw, reset).
- exception: InvalidAction

changeGameMode():

- transition: Change gameMode based on user input button presses (beginner, normal, engine).
- exception: InvalidAction

completeUserAction():

- transition: Update boardState based on completed userAction
- exception: InvalidAction, UnknownAction

lightLED():

- output: LED_pin := HIGH ($\mathbb{Z} := 1$) or LOW ($\mathbb{Z} := 0$).
- exception: TeensyConnectionFailed

6.4.5 Local Functions

setup():

- transition: initialize serial connection; read board state; game state set to "init"
- exception: TeensyConnectionFailed

7 MIS of Piece Identification Module

7.1 Piece Identification

7.2 Uses

None

7.3 Syntax

7.3.1 Exported Constants

None

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
readSensors	int	Piece	SensorOffline
waitForPiece	int, int, Piece	bool	PieceMissingTimeout

7.4 Semantics

7.4.1 State Variables

None

7.4.2 Environment Variables

sensorInput: readings from various hall-effect sensors

7.4.3 Assumptions

Hall-effect sensors will give accurate readings.

7.4.4 Access Routine Semantics

readSensors():

- output: Piece
- exception: SensorOffline

waitForPiece():

- transition: Waiting to send signal based on a sensor transition from $HALL\_PIN[\mathbb{Z}][\mathbb{Z}] := \mathbb{R} \Rightarrow 0$
- output: bool value of $(PieceNotPlaced \Rightarrow false | PiecePlaced \Rightarrow true)$
- exception: PieceMissingTimeout

7.4.5 Local Functions

None

8 MIS of Chess Board Module

8.1 Chess Board

[Short name for the module —SS]

8.2 Uses

Arduino
Piece Identification

8.3 Syntax

8.3.1 Exported Constants

int numRows : Chess board rows
int numCols : Chess board columns
int LED_PINS[numRows][numCols] : 2-D array controlling the LED output pins
int HALL_PINS[numRows][numCols] : 2-D array controlling the Hall-effect sensor input pins

8.3.2 Exported Access Programs

None

8.4 Semantics

Name	In	Out	Exceptions
movePiece	int, int, int, int, PieceType	boolean	InvalidMove
removePiece	int, int	Piece	InvalidMove
isCheckmateOrStalemate	Colour	bool	-
boardToFEN	-	string	-
recieveMoves	-	Colour	InvalidMove
lightSquare	int, int, Colour	-	DigitalWriteFailed
pieceToChar	Piece	char	-

8.4.1 State Variables

gameMode := enumeration
check := boolean
checkmate := boolean
draw := boolean

8.4.2 Environment Variables

HALL_PINS: input pins receiving signal from Hall-effect sensors
LED_PINS: output pins lighting up the LEDs on the board
serialToTeensy: serial communication to and from the Teensy controller

8.4.3 Assumptions

- Serial connection between both microcontrollers will remain constant
- All LED pins will remain connected
- Hall-effect sensors will function as intended

[Try to minimize assumptions and anticipate programmer errors via exceptions, but for practical purposes assumptions are sometimes appropriate. —SS]

8.4.4 Access Routine Semantics

movePiece():

- transition: Update Piece type and colour on the ”to” square, while removing the piece from the ”from” square.

- exception: InvalidMove

removePiece():

- transition: Update Piece type and colour on the "to" square, while removing the piece from the "from" square. Remove the piece taken by the opponent.
- output: returns the Piece that was removed.
- exception: InvalidMove

isCheckmateCheckOrStalemate():

- transition: Update game state based on a command sent from the Web Application.
- exception: None

boardToFEN():

- output: FEN string representation of the current board state.
- exception: None

recieveMoves():

- transition: Process best moves recieved from the web application and light appropriate LED's.
- exception: InvalidMove

lightSquare():

- transition: Light appropriate LED's based on various conditions such as game mode, game state, check/mate/stalemate warning, etc.
- exception: DigitalWriteFailed

[A module without environment variables or state variables is unlikely to have a state transition. In this case a state transition can only occur if the module is changing the state of another module. —SS]

[Modules rarely have both a transition and an output. In most cases you will have one or the other. —SS]

8.4.5 Local Functions

pieceToChar():

- output: Converting the Piece type into the FEN-string character representation.
- exception: None

[As appropriate —SS] [These functions are for the purpose of specification. They are not necessarily something that is going to be implemented explicitly. Even if they are implemented, they are not exported; they only have local scope. —SS]

9 MIS of Communication Module

9.1 Communication

9.2 Uses

Arduino.h SoftwareSerial.h

9.3 Syntax

9.3.1 Exported Constants

None

9.3.2 Exported Access Programs

Name	In	Out	Exceptions
encodeMessage	string	-	UnknownAction
decodeMessage	-	string	UnknownCommand
processCommand	string	string	InvalidCommand

9.4 Semantics

9.4.1 State Variables

command: The decoded message to update values (game state, game mode, light specific LED, etc.).

9.4.2 Environment Variables

messageEncoder: The string formatting to send a message to the Teensy Controller via Serial Communication.
messageDecoder: The string formatting to read a message from the Teensy Controller via Serial Communication.

9.4.3 Assumptions

- Communication string format remains consistent
- Connection exists between both controllers and remains constant

9.4.4 Access Routine Semantics

encodeMessage():

- output: Translate game state or action into encoded string to be read by Teensy or the Web Application
- exception: UnknownAction

decodeMessage():

- output: Translate encoded message from Teensy or the Web Application and convert into state change command
- exception: UnknownCommand

processCommand():

- transition: Command received from Web Application or Teensy controller will be used to change the chess board accordingly.
- –¿ This could be to change the game state, game mode, player warning (check, checkmate, stalemate) or to light appropriate LED's
- exception: InvalidCommand

9.4.5 Local Functions

None

References

Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.

Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL http://citeseer.ist.psu.edu/428727.html.

10 Appendix

[Extra information if required —SS]