Team 10

UART Protocol for Gantry Control

Recent Changes

To let Jack/Sai know what has last been changed.

V 2.3 – Added Invalid_Go_Command. Removed Gantry overheat. Added detailed definitions for commands in ELSE, GO command, Electromagnet and Arrived Command. Added more details in

V 2.2 – Added Recent Changes Section. Added RFID Return Mode Details. Moved RFID Controls from ELSE command to RFID MODE.

This RFID mode is used to transmit RFID information after an RFID Scan Request from the transmitter. Since there are only 12 types of chess pieces, RFID Mode will be used to request RFID scan and return the type of chess piece or no Tag Present (Moved from ELSE).

Overview

UART communication will be used between the Raspberry Pi and the Microcontroller of the Gantry to control the movement of the gantry. Sai and Jack have developed custom messages for the control of the gantry to move chess pieces.

UART Specifications

8-Bit Data Packets

Baud Rate 9600

Parity Bit TBD

UART Data Packet Description

8 bit UART Data Packet

Bit	7	6	5	4	3	2	1	0
Data	**TYP2**	**TYP1**	**TYP0**	**DAT4**	**DAT3**	**DAT2**	**DAT1**	**DAT0**
Initial Value	X	X	X	X	X	X	X	X

- Bit 7:5 – TYPn

These bits will select the type or category of data being transmitted in DATn bits. The mode selection will determine the type of data being transmitted in the remainding five bits.

No.	TYP2	TYP1	TYP0	TYPE/CATEGORY
0	0	0	0	N/A
1	0	0	1	X - Axis Address
2	0	1	0	Y - Axis Address
3	0	1	1	RFID Value Return
4	1	0	0	ELECTROMAGNET CONTROL
5	1	0	1	GO
6	1	1	0	ARRIVED
7	1	1	1	ELSE

- Bit 4:0 – DATn

Depending on the value of the TYPn bits (Bit 7:5), the value of the DATn bits will carry different meaning.

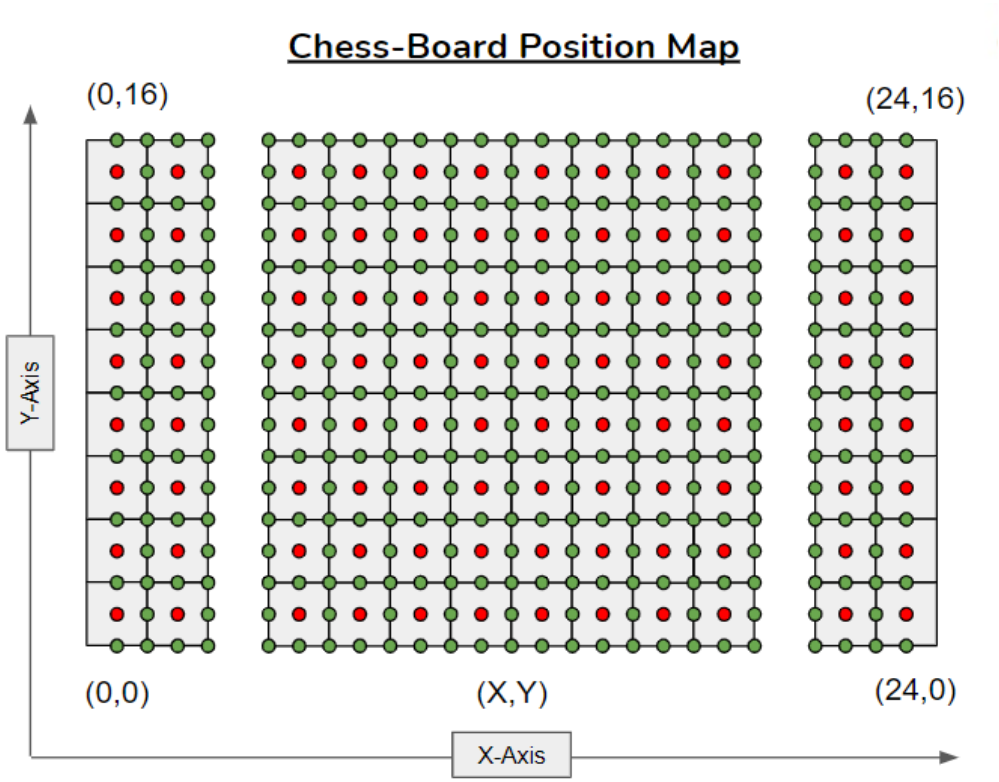
See below for further reference.

Defining DATn Bit for Different Modes

X-Axis/Y-Axis Address Mode

This mode is used to transmit position data for the gantry. The gantry will have [17 x 25] unique positions points and two bytes of data will be used to transmit the information. Upon receiving the information and "GO" command, the gantry will move to the transmitted position and send an "ARRIVED" command.

The position point data for each axis will be transmitted as a Binary Number.



8 bit UART Data Packet

Bit	7	6	5	4	3	2	1	0
Data	**TYP2**	**TYP1**	**TYP0**	**DAT4**	**DAT3**	**DAT2**	**DAT1**	**DAT0**
Initial Value	X	X	X	X	X	X	X	X

- Bit 7:5 – [0 X X] Address Mode Selection

These bits tell the receiver that the data bits will be X-Axis or Y-Axis Address depending on the value in bit 5.

- Bit 4:0 – [X X X X] X/Y-Axis Address in Binary Number

The Axis position value is converted to binary to be transmitted to the receiver. The values could range from 0 to 24 for X-Axis and 0 to 16 for Y-Axis.

RFID Address Mode

This mode is used to transmit RFID information after an RFID Scan Request from the transmitter. Since there are only 12 types of chess pieces, RFID Mode will be used to request RFID scan and return the type of chess piece or no Tag Present (Moved from ELSE).

Bit	7	6	5	4	3	2	1	0
Data	**0**	**1**	**1**	**X**	**X**	**X**	**X**	**X**

- Bit 7:5 – [0 1 1] RFID Address Mode Selection

  These bits tell the receiver (Pi) that the data bits will be for Identifying and requesting RFID from Chess Pieces.

- Bit 4:0 – [X X X X] These Pieces will be used to transmit/return information. If MSB is 1, the data is used to control RFID and if MSB is 0, the data is conveying a chess piece or a no tag present message.

Hex	No.	DAT4	DAT3	DAT2	DAT1	DAT0	Message
1	1	0	0	0	0	1	Black Pawn
2	2	0	0	0	1	0	Black Rook
3	3	0	0	0	1	1	Black Knight
4	4	0	0	1	0	0	Black Bishop
5	5	0	0	1	0	1	Black Queen
6	6	0	0	1	1	0	Black King
9	9	0	1	0	0	1	White Pawn
A	10	0	1	0	1	0	White Rook
B	11	0	1	0	1	1	White Knight
C	12	0	1	1	0	0	White Bishop
D	13	0	1	1	0	1	White Queen
E	14	0	1	1	1	0	White King
F	15	0	1	1	1	1	RFID NO TAG PRESENT
1A	26	1	1	0	1	0	RFID SCAN REQUEST

Electromagnet Control Mode

This mode is used to control Electromagnet on the gantry. Depending on the data bits, the gantry will turn on or off the Electromagnet or Flip polarity to topple the king in checkmate.

Bit	7	6	5	4	3	2	1	0
Data	1	0	0	X	X	X	X	X

- Bit 7:5 – [1 0 0] Electromagnet Control Mode Selection

  These bits tell the receiver that the data bits will be for controlling the Electromagnet.

- Bit 4:0 – [X X X X]

  These bits will be used to control Electromagnet. The Microcontroller on the Gantry will confirm command is carried out successfully by sending the data back.

DAT4	DAT3	DAT2	DAT1	DAT0	Control
0	0	0	0	0	Turn Off Electromagnet
1	1	1	1	1	Turn On Electromagnet
0	1	0	1	0	Flip Polarity

GO Mode

This mode is used to tell the gantry to “GO” to the (X,Y) Position of the last transmission.

Bit	7	6	5	4	3	2	1	0
Data	1	0	1	X	X	X	X	X

- Bit 7:5 – [1 0 1] GO Mode

  Upon Receiving “GO” command the gantry will proceed to go to the last transmitted (X,Y) Position. Any UART command received while the gantry is moving will be returned with a “BUSY” command described in the ELSE Data Mode Section.

- Bit 4:0 – [- - - -]

  These bits are irrelevant to the GO command.

When the gantry microcontroller is given the GO command, it will proceed to last sent X axis position and Y axis position*.

*If EM is off, the gantry will go to any location on the Position Map.

*IF EM IS ON, the gantry will only move either straight or diagonally.

Example (EM is ON): (1,1) to (1,16) is Valid

(1,1) to (15,15) is Valid

(1,1) to (24,15) is NOT Valid

ARRIVED Mode

This mode is used to tell the Raspberry Pi that the Gantry has arrived at the last transmitted (X,Y) Position and is ready for another command. The “ARRIVED” data byte will be followed by two bytes of X-Axis and Y-Axis data to confirm the current position.

Bit	7	6	5	4	3	2	1	0
Data	1	1	0	X	X	X	X	X

- Bit 7:5 – [1 1 0] ARRIVED Mode

  The Gantry will transmit “ARRIVED” data byte to signal that the Gantry has arrived at the last transmitted (X,Y) Position and is ready for another command.

  This data byte is followed by X-Axis and Y-Axis data bytes to confirm the current position.

- Bit 4:0 – [- - - -]

  These bits are irrelevant to the ARRIVED command.

ELSE Mode

This mode is used to for everything else that is not covered by the previous modes.

Bit	7	6	5	4	3	2	1	0
Data	**1**	**1**	**1**	**X**	**X**	**X**	**X**	**X**

- Bit 7:5 – [1 1 1] ELSE Mode

  These bits tell the receiver it is used for something else not covered in the previous modes.

- Bit 4:0 – [X X X X]

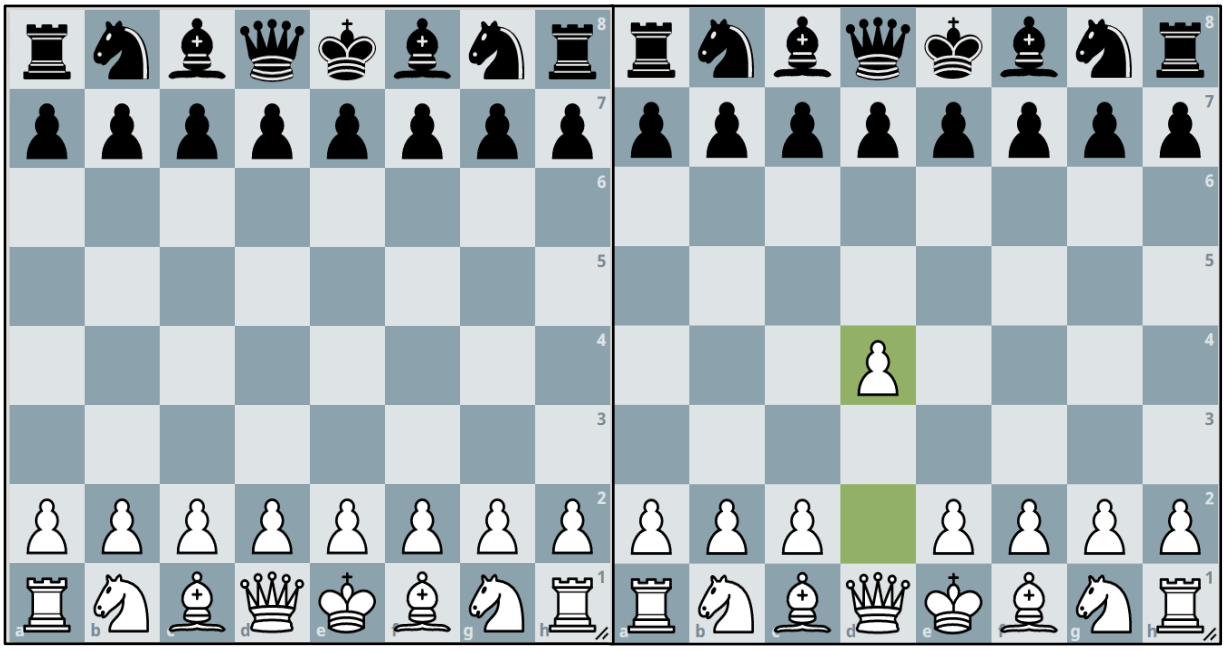
  These bits will be used to define particular messages described below.

No.	DAT4	DAT3	DAT2	DAT1	DAT0	Message
0	0	0	0	0	0	Reset Gantry
1	0	0	0	0	1	
2	0	0	0	1	0	Invalid "GO" Command
3	0	0	0	1	1	Invalid "UART" Command
4	0	0	1	0	0	
5	0	0	1	1	1	Gantry BUSY
6	0	0	1	1	0	Parity Error. Resend
31	1	1	1	1	1	General Error

- Reset Gantry – Resets the gantry by homing towards the switches and moving towards the default position (0,16). After Calibration, the gantry will send ARRIVED command followed by current X address and Y address.
- Invalid GO Command – When EM is on and the location to GO is invalid. See GO Mode for more details.
- Invalid UART command – UART command is not valid. Not defined as per the document.
- Gantry Busy – Microcontroller Busy. Sends the BUSY command back if a UART command is sent to the microcontroller while it is working on something else.
- Parity Error. Resend – When received, will send the last sent command back.

Example

- Moving a pawn from D2 to D4.
- The UART data will be from the perspective of the Raspberry Pi.



1. Firstly, move the gantry to D2. The Point D2 would correspond to point (11,3) in the position map.

UART Transmit [0 0 1 0 1 0 1 1]
X-Axis Address of 11

UART Transmit [0 1 0 0 0 0 1 1]
Y-Axis Address of 3

UART Transmit [1 0 1 X X X X X]
GO Command – The gantry will then proceed to move to (11,3).

2. Upon Arrival, the Pi will receive an ARRIVED command along with two data bytes of the gantry's current position.

UART Receive [1 1 0 X X X X]
ARRIVED Message

UART Receive [0 0 1 0 1 0 1 1]
X-Axis Address of 11

UART Receive [0 1 0 0 0 0 1 1]
Y-Axis Address of 3

3. Confirm the Chess Piece on D2 is a pawn. Scan RFID to confirm.

UART Transmit [0 1 1 1 1 0 1 0]
Scan RFID Command

UART Receive [0 1 1 0 1 0 0 1]
Receive RFID Value from the Chess Piece. The Pi will be use this to confirm if the piece is a white pawn. If not, an error message will display on the GUI.

4. Turn on Electromagnet. Now that the piece is verified and the gantry is underneath, it is time to turn on the electromagnet before the movement.

UART Transmit [1 0 0 1 1 1 1 1]
Turn on Electromagnet.
UART Receive [1 0 0 1 1 1 1 1]
Confirmed Electromagnet is ON.

5. Move Gantry to final point D4 which corresponds to (11,7) in the position map.

UART Transmit [0 0 1 0 1 0 1 1]
X-Axis Address of 11

UART Transmit [0 1 0 0 0 1 1 1]
Y-Axis Address of 7

UART Transmit [1 0 1 X X X X X]

GO Command – The gantry will then proceed to move to (11,7)

6. Upon Arrival, the Pi will receive an ARRIVED command along with two data bytes of the gantry's current position.

UART Receive [1 1 0 X X X X]
ARRIVED Message

UART Receive [0 0 1 0 1 0 1 1]
X-Axis Address of 11

UART Receive [0 1 0 0 0 0 1 1]
Y-Axis Address of 3

7. EM OFF and confirmation