UNIVERSIDADE ESTADUAL DO PIAUÍ – UESPI CENTRO DE TECNOLOGIA E URBANISMO – CTU COORD.DO CURSO DE BACH. EM CIÊNCIA DA COMPUTAÇÃO

PROGRAMAÇÃO SEM FIO

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1 Resumo

Este relatório tem o objetivo de passar instruções suficientes para realizar a transferência de um código hexadecimal para um Arduíno duemilanove através de um sistema de transmissão sem fio utilizando dois xbee.

2 Tecnologia OTAP

Processo de transferência de firmware através de uma transmissão sem fio em uma frequência específica. Tem como objetivo, a reprogramação de placas embarcadas em locais de difícil acesso, economizando tempo e dinheiro.

3 Princípio de funcionamento



Figure 1: Transferência do código por radiofrequência.

4 Materiais utilizados nos testes.

- 02 Xbee de mesmo modelo; 01 Arduino duemilanove; 01 Conversor usb/TTL; 01 Protoboard; 01 Capacitor cerâmico de 0.1uf nº 104; 01 Transistor NPN BC548;
- 01 Resistor de 1k;

5 O Transmissor

O transmissor utilizado será um XBee Pro 60mW Fio Antena - Série 1 (802.15.4).



Figure 2: XBee PRO S1.



Figure 3: Pinagem.

6 Conectando o XBee transmissor

Para conectar o XBee ao computador será usado um conversor USB/TTL.





Figure 4: Conversor USB/TTL.



Figure 5: Forma correta de conectar o XBee, Figura circulada.

7 Configurações do transmissor

O transmissor será configurado em dois níveis, hardware e via software.

7.1 Configuração hardware

A configuração de nível hardware do transmissor se resume a soldar um jumper, entre os pinos RTS e DI03 do conversor USB/TTL.



Figure 6: Ligação dos pinos RTS e DI3.

8 Configuração software

As configurações de nível software do transmissor, serão feitas através do programa XCTU. Os prints das configurações seguem abaixo.

		R 🕑 🔅 🔛 🐇	
Radio Modules	Radio Configuration [Emissor - 0013A2004071BE	096]	
Name: Ernissor Function: XBEE PRO 802.15.4 Port: COM17 - 57600/8/N/1/N - AT	 . .<	(Paramet	er 🕂 🗇
MAC: 0013A20040718D96	Firmware information Product family: XBP24 Function set: XBEE PRO 802.15.4 Firmware version: 10ec	Written and Written and Writte	default not default t not written ng
	 Networking & Security Modify networking settings 		
	() CH Channel	C	۱ ک
	() ID PAN ID	3332	۱ ک
	() DH Destination Address High	0	۱ 🖉
	(j) DL Destination Address Low	0	۱ ک
	MY 16-bit Source Address	0	۱ ک
	(j) SH Serial Number High	13A200	٢
	SL Serial Number Low	4071BD96	٢
	() MM MAC Mode	802.15.4 + MaxStream header w/ACKS [0]	۱ ک
	() RR XBee Retries	0	۱ ک
	(i) RN Random Delay Slots	0	۱ 🖉
	() NT Node Discover Time	19 x 100 ms	۱ ک
	(i) NO Node Discover Options	0	۱

Figure 7: Configuração do módulo transmissor no xctu.

		R ? •] \$	F 🛄 🎸	
Radio Modules	Radio Configuration [Emissor - 0013A2004071BDS	96]		
Name: Emissor Function: XBEE PRO 802.15.4 Port: COMU7 - 57600/8/N/1/N - AT	- 🔊 🔊 🕍 🚵 -		Paramet	ter 🗭 🖨
MAC: 0013A2004071BD96	(j) NT Node Discover Time	19	x 100 ms	🔊 🥙 🔺
	NO Node Discover Options	0		۱ ک
	(j) CE Coordinator Enable	End Device [0]	•	۱ 📀
	(j) SC Scan Channels	1FFE	Bitfield	ے 📎
	(j) SD Scan Duration	4	exponent	۷ 🖉
	() A1 End Device Association	0000ь [0]	•	= 📎 📀
	A2 Coordinator Association	000ь [0]	•	۱ 🖉 🍘
	(i) AI Association Indication	0		\$
	() EE AES Encryption Enable	Disable [0]	•	۱ ک
	🛞 KY AES Encryption Key			۱ ک
	() NI Node Identifier	Emissor		۱ ک
	 RF Interfacing Modify RF interfacing options 			
	PL Power Level	Highest [4]	•	۱ 📀
	() CA CCA Threshold	2C	-dBm	۱ ک
	 Sleep Modes (NonBeacon) Configure low power options for NonBeacon systems 			
	(j) SM Sleep Mode	No Sleep [0]	•	۱ ک
	-			· · ·

Figure 8: Configuração do módulo transmissor no xctu.

		₿ 🙊 ? •)	🔅 🛄 🕹	•	G)
Radio Modules	Radio Configuration [Emissor - 0013A2004	1071BD96]			
Name: Emissor Function: XBEE PRO 802.15.4 Port: COML7 - 57600/8/N/1/N - AT MAC: 0013A2004071BD96	× Sleep Modes (NonBeacon)] -	Paral	neter	ÐE
	Configure low power options for NonBeacon sy SM Sleep Mode	vstems		-	
	ST Time before Sleep	1388	x1 ms		
	SP Cyclic Sleep Period	0	x 10 ms	\$	
	DP Disassociated Cyclic Sleep Period	3E8	x 10 ms	٢	
	() SO Sleep Options	0		٢	Ø
	 Serial Interfacing Modify modem interfacing options 				
	() BD Interface Data Rate	57600 [6]		- 3	Ø
	() NB Parity	No Parity [0]		- 🔇	۲
	RO Packetization Timeout	10	x character times	٢	Ø
	() AP API Enable	API disabled [0]		- 🔄	۲
	 I/O Settings Modify DIO and ADC options 				
	() D8 D18 Configuration	Disabled [0]		- \$	۲
	① D7 DIO7 Configuration	CTS flow control	[1]	- 3	Ø
	① D6 DIO6 Configuration	Disabled [0]		- 3	Ø
	D5 DIOS Configuration	Accessisted indice	+or [1]		

Figure 9: Configuração do módulo transmissor no xctu.

		K · 🖹 🙊 ? · 🕽 🔅 🛛	P 🛠 🗇
Radio Modules	Radio Configuration [Emissor - 0013A2004071BD96	5]	
Name: Emissor Image: Emissor	 VO Settings Modify IDD and ADC actions 		Parameter
	() D8 DI8 Configuration	Disabled [0]	- (2)
	(i) D7 DI07 Configuration	CTS flow control [1]	• 🕲 🖉
	() D6 DI06 Configuration	Disabled [0]	• 🕲 🤌
	① D5 DIO5 Configuration	Associated indicator [1]	• 📀 🥏
	D4 DI04 Configuration	Disabled [0]	- 😒 🧭
	D3 DI03 Configuration	DI [3]	- 😒 🤌
	D2 DIO2 Configuration	Disabled [0]	- 😒 🤌
	D1 DI01 Configuration	Disabled [0]	- 😒 🧭
	D0 DI00 Configuration	Disabled [0]	- 🔇 🤌
	PR Pull-up Resistor Enable	FF	۷ ک
	() IU I/O Output Enable	Enabled [1]	- 🕲 🧶
	() IT Samples before TX	1	S 🖉 🗉
	IC DIO Change Detect	FF	۷ ک
	(j) IR Sample Rate	0 X1 ms	۲
	() P0 PWM0 Configuration	RSSI [1]	- 🔇 🖉
	() P1 PWM1 Configuration	Disabled [0]	• 📀 🥏
	() PT PWM Output Timeout	FF x 100 ms	۵ ک
	RP RSSI PWM Timer	28 x 100 ms	۵ ک

Figure 10: Configuração do módulo transmissor no xctu.

		X · E 🙊 ? ·) 🌣 📃	2 🖓
Radio Modules	Radio Configuration [Emissor - 0013A2004071BD	96]		
Name: Emissor Image: Emissor	 ₩ 100 Line Passing 		۲	Parameter 🕂 🖨
	(i) IA I/O Input Address	FFFFFFFFFFFFFFFF	•	S 0
	① T0 D0 Output Timeout	FF	×100 ms	۷ ک
	① T1 D1 Output Timeout	FF	×100 ms	۷ ک
	① T2 D2 Output Timeout	FF	×100 ms	۷ ک
	① T3 D3 Output Timeout	FF	×100 ms	۱ ک
	① T4 D4 Output Timeout	FF	x100 ms	۱
	(j) T5 D5 Output Timeout	FF	x 100 ms	۱ ک
	(i) T6 D6 Output Timeout	FF	x 100 ms	۷ ک
	(i) 17 D7 Output Timeout	FF	x 100 ms	۷ ک
	 Diagnostics Access diagnostic parameters 			
	(i) VR Firmware Version	10EC		۲
	(i) HV Hardware Version	1846		۲
	(j) DB Received Signal Strength	0		٢
	(j) EC CCA Failures	0		\$
	(j) EA ACK Failures	277		٢
	(j) DD Device Type Identifier	10000		S 🖉
	 AT Command Options Modify AT Command Mode behavior 			E
	() CT AT Command Mode Timeout	64	x 100ms	۷ ک
	(j) GT Guard Times	3E8	x 1ms	ے ک
		-		

Figure 11: Configuração do módulo transmissor no xctu.

(i) BD Interface Data Rate	57600 [6]	- 🔇 🌘
NB Parity	No Parity [0]	- 🔇 🧶
RO Packetization Timeout	10 x character times	چ 📀
(i) AP API Enable	API disabled [0]	- 🕲 🧭
 I/O Settings Modify DIO and ADC options 		
(j) D8 D18 Configuration	Disabled [0]	- 🔇 🧭
(i) D7 DIO7 Configuration	CTS flow control [1]	- 🔇 🧭
() D6 DIO6 Configuration	Disabled [0]	- 🕲 🧕
() D5 DIO5 Configuration	Associated indicator [1]	- 🕲 🧔
D4 DIO4 Configuration	Disabled [0]	- 🕲 🧭
D3 DIO3 Configuration	DI [3]	- 🕲 🧔
(i) D2 DIO2 Configuration	Disabled [0]	- 🕲 🎑
() D1 DIO1 Configuration	Disabled [0]	- 🕲 🧔
() D0 DIO0 Configuration	Disabled [0]	- 🕲 🥖
() PR Pull-up Resistor Enable	FF	S (
() IU I/O Output Enable	Enabled [1]	- 🕲 🧔
① Π Samples before TX	1	S (2
() IC DIO Change Detect	FF	
(i) IR Sample Rate	0 X1 ms	۵ کې
P0 PWM0 Configuration	RSSIII	-

Figure 12: Configuração do módulo transmissor no xctu.

9 O receptor

O receptor utilizado será um XBee Pro 60mW Fio Antena - Série 1 (802.15.4).



Figure 13: Xbee PROS1.

10 Configurações do receptor

Configuração software

As configurações de nível software do receptor, serão feitas através do programa XCTU. Os prints das configurações seguem abaixo.

		🗶 · 🖹 🙊 🕑 · 🗳 🖳 🕹	ද ඉ
Radio Modules	Radio Configuration [receptor - 0013A2004071B	D2F]	
Name: receptor Function: XBEE PRO 802.15.4 Port: COM17 - 57600/8/N/1/N - AT		(Parat	meter 🕂 🗐
MAC: 0013A2004071BD2F	Firmware information Product family: XBP24 Function set: XBEE PRO 802.15.4 Firmware version: 10ec	Written a Wirtten a Wirtten a Wirtten a Wirtten für States Error in s	nd default nd not default but not written etting
	 Networking & Security Modify networking settings 		
	① CH Channel	c	۱ ک
	() ID PAN ID	3332	۱ ک
	() DH Destination Address High	0	۷ ک
	DL Destination Address Low	0	۱ ک
	MY 16-bit Source Address	0	۷ ک
	() SH Serial Number High	13A200	٢
	SL Serial Number Low	4071BD2F	٢
	MM MAC Mode	802.15.4 + MaxStream header w/ACKS [0]	- 🔇 🦉
	RR XBee Retries	0	۷ کې
	RN Random Delay Slots	0	۱ ک
	NT Node Discover Time	19 x 100 ms	۱ ک
	NO Node Discover Options	0	۱ ک
	① CE Coordinator Enable	End Device [0]	• 🔇 🧭
	① SC Scan Channels	1FFE Bitfield	۱ ک
	SD Scan Duration	4 exponent	۱ ک
	A1 End Device Association	0000b [0]	• 🔄 🧭
	A2 Coordinator Association	000b [0]	- 🔄 🥖

Figure 14: Configuração do módulo receptor no xctu.

		* 🖹 🎅 ? •)	🗘 🕸 🛄	4	$\langle \rangle$
Radio Modules	Radio Configuration (receptor - 0013A2004071BD	02F]			
Name: receptor S Function: XBEE PRO 802.15.4 C Port: COMI7 - 5760//8//VI/N - AT C			۲) Parameter	ÐÐ
MAC: 0013A2004071BD2F	(i) A2 Coordinator Association	0006 [0]		-	s 🧭 🔒
	(i) AI Association Indication	0			3 3
	EE AES Encryption Enable	Disable [0]		-	s) 🕖
	KY AES Encryption Key			6	\$ ()
	Value must have at least 32 characters. Sets key used for encryption and decryption. This	s register can not be read.		*	
	NI Node Identifier	receptor		6	ء 📎 🔹
	 RF Interfacing Modify RF interfacing options 				
	PL Power Level	Highest [4]		•	🕒 📎 🔇
	① CA CCA Threshold	2C	-dBm	6	۷ 🧶
	 Sleep Modes (NonBeacon) Configure low power options for NonBeacon systems 				
	(j) SM Sleep Mode	No Sleep [0]		•	۷ 🖉
	() ST Time before Sleep	1388	x1 ms	6	۷ 🖉
	SP Cyclic Sleep Period	0	x10 ms	6	۷ 🖉
	DP Disassociated Cyclic Sleep Period	3E8	x10 ms	6	۷ 🥑 📀
	SO Sleep Options	0		6	۷ 🖉
	 Serial Interfacing Modify modem interfacing options 				
	(i) BD Interface Data Rate	57600 [6]		• (۷ 🖉
	NR Darity	No Davity (0)		- 6	 (a) •

Figure 15: Configuração do módulo receptor no xctu.

		🗶 · 🖹 @ ? ·) 🔅 🖳 💈	ද ඉ
Radio Modules	Radio Configuration [receptor - 0013A2004071B	D2F]	
Name: receptor Function: XBEE PRO 802.15.4 Port: COM17 - 57600/8/N/1/N - AT MAC: 0013A2004071BD2F	 Serial Interfacing Modify modem interfacing antions 	Paran	neter 🗭 🗖
	BD Interface Data Rate	57600 [6]	- 🕲 🖉
	NB Parity	No Parity [0]	• 🔇 🖉
	RO Packetization Timeout	10 x character times	S @
	() AP API Enable	API disabled [0]	- 🕲 🧭
	▼ I/O Settings Modify DIO and ADC options		
	D8 DI8 Configuration	Disabled [0]	• 🕲 🥥
	① D7 DIO7 Configuration	CTS flow control [1]	• 💿 🥥
	① D6 DIO6 Configuration	Disabled [0]	• 🕲 🥥 🔄
	① D5 DIO5 Configuration	Associated indicator [1]	• 🕲 🧭
	D4 DIO4 Configuration	Disabled [0]	• 🕲 🧭
	① D3 DIO3 Configuration	DO High [5]	- 🕲 🥥 🗉
	① D2 DIO2 Configuration	Disabled [0]	• 🕲 🥥
	① D1 DIO1 Configuration	Disabled [0]	- 🕲 🧶 🗌
	① D0 DIO0 Configuration	Disabled [0]	• 🕲 🧶
	PR Pull-up Resistor Enable	FF	۱ ک
	① IU I/O Output Enable	Disabled [0]	- 🕲 🥥
	① IT Samples before TX	1	۱ ک
	① IC DIO Change Detect	0	۱ ک
	① IR Sample Rate	0 X1 ms	۲
	P0 PWM0 Configuration	RSSI 111	- 🕲 🕢 -

Figure 16: Configuração do módulo receptor no xctu.

		ו E @ ? •	🗘 🌣 📃	2
Radio Modules	Radio Configuration [receptor - 0013A2004071	BD2F]		
Function: XBEE PRO 802.15.4 Port: COMI7 - 57600/8/N/1/N - AT MAC: 0013A2004071BD2F	⊗		۲	Parameter 🗭 🖨
	IA I/O Input Address	FFFF		۲
	(i) TO D0 Output Timeout	FF	×100 ms	۵ ک
	(i) T1 D1 Output Timeout	FF	x100 ms	۵ ک
	(i) T2 D2 Output Timeout	FF	x 100 ms	۷ ک
	() T3 D3 Output Timeout	FF	x 100 ms	۱ ک
	(j) T4 D4 Output Timeout	FF	x 100 ms	۷ ک
	() T5 D5 Output Timeout	FF	×100 ms	۷ ک
	(i) T6 D6 Output Timeout	FF	×100 ms	۵ ک
	(j) T7 D7 Output Timeout	FF	x 100 ms	۱
	 Diagnostics Access diagnostic parameters 			
	() VR Firmware Version	10EC		۲
	HV Hardware Version	1846		۲
	() DB Received Signal Strength	0		۲
	EC CCA Failures	0		۲
	EA ACK Failures	1		۲
	() DD Device Type Identifier	10000		۷ ک
	 AT Command Options Modify AT Command Mode behavior 			E
	() CT AT Command Mode Timeout	64	x100ms	۷ ک
	() GT Guard Times	368	x1ms	. 🖉 🕲

Figure 17: Configuração do módulo receptor no xctu.

(i) BD Interface Data Rate	57600 [6]	
(i) NB Parity	No Parity [0]	- 🕥 🥖
(i) RO Packetization Timeout	10 x character times	چ چ
(i) AP API Enable	API disabled [0]	- 🔇 🧶
I/O Settings Modify DIO and ADC options		
(i) D8 DI8 Configuration	Disabled [0]	- 🔇 🦉
(i) D7 DIO7 Configuration	CTS flow control [1]	- 🕥 🦉
(i) D6 DIO6 Configuration	Disabled [0]	- 🕥 🥖
(i) D5 DIO5 Configuration	Associated indicator [1]	- 🕥 🥖
(i) D4 DIO4 Configuration	Disabled [0]	- 🕲 🥖
(i) D3 DIO3 Configuration	DO High [5]	- 🕲 🥖
(i) D2 DIO2 Configuration	Disabled [0]	- 🕥 🥖
(i) D1 DIO1 Configuration	Disabled [0]	- 🕲 🦉
(i) D0 DIO0 Configuration	Disabled [0]	- 🕲 🥖
() PR Pull-up Resistor Enable	FF	S (2
() IU I/O Output Enable	Disabled [0]	- 🕲 🥖
 Π Samples before TX 	1	۷ کې
(j) IC DIO Change Detect	0	Sector 1
(i) IR Sample Rate	0 X1 ms	۷ کې
BO DW/M0 Configuration	DECT [1]	

Figure 18: Configuração do módulo receptor no xctu.

			0
O Line Passing			
() IA I/O Input Address	FFFF		•
(i) T0 D0 Output Timeout	FF	x100 ms	٢
(j) T1 D1 Output Timeout	FF	x100 ms	٢
(i) T2 D2 Output Timeout	FF	x 100 ms	۲
(i) T3 D3 Output Timeout	FF	x 100 ms	٢

Figure 19: Configuração do módulo receptor no xctu.

11 Esquema eletrônico

O esquema abaixo deve ser implementado em uma placa de ensaio (Protoboard).



Figure 20: Esquema elétrico Xbee ==> Arduino.

OBS: O módulo receptor deverá ser conectado a um conversor Xbee/TTL.



Figure 21: Xbee conectado ao módulo TTL.

12 Esquema eletrônico implementado na protoboard



Figure 22: Esquema elétrico na protoboard.

13 Configuração da porta Serial do sistema

USB Serial Port (COM5) Properties	?	×
General Port Settings Driver Details		_
Bits per second:	9600 🗸	
Data bits:	8	
Parity:	None	
Stop bits:	1	
<u>F</u> low control:	None	
	vanced <u>R</u> estore Defaults	
	OK Cancel	

Figure 23: Propriedades da porta serial.

COM5		OK
USB Transfer Sizes		Cance
Select lower settings to correct performance problems at lo Select higher settings for faster performance.	ow baud rates.	Default
Receive (Bytes): 4096		
Transmit (Bytes):		
BM Options	Miscellaneous Options	
Select lower settings to correct response problems.	Serial Enumerator	
Latency Timer (msec):	Serial Printer	
	Cancel If Power Off	
Timeouts	Event on purplise memoral	í
	Set RTS On Close	
Minimum David Timera (march)		

Figure 24: Seleção da opção Set RTS On Close.

13 Abra a IDE Arduino e envie o código

Selecione a porta USB correta e a placa Arduino Duemilanove. Faça o upload do código.



Figure 25: Envio do código.