

Developing Next-Gen IoT Solutions with Contiki OS and Cooja Simulator

Project: Smart Bands System Analysis and Simulation Using Cooja

Team Details

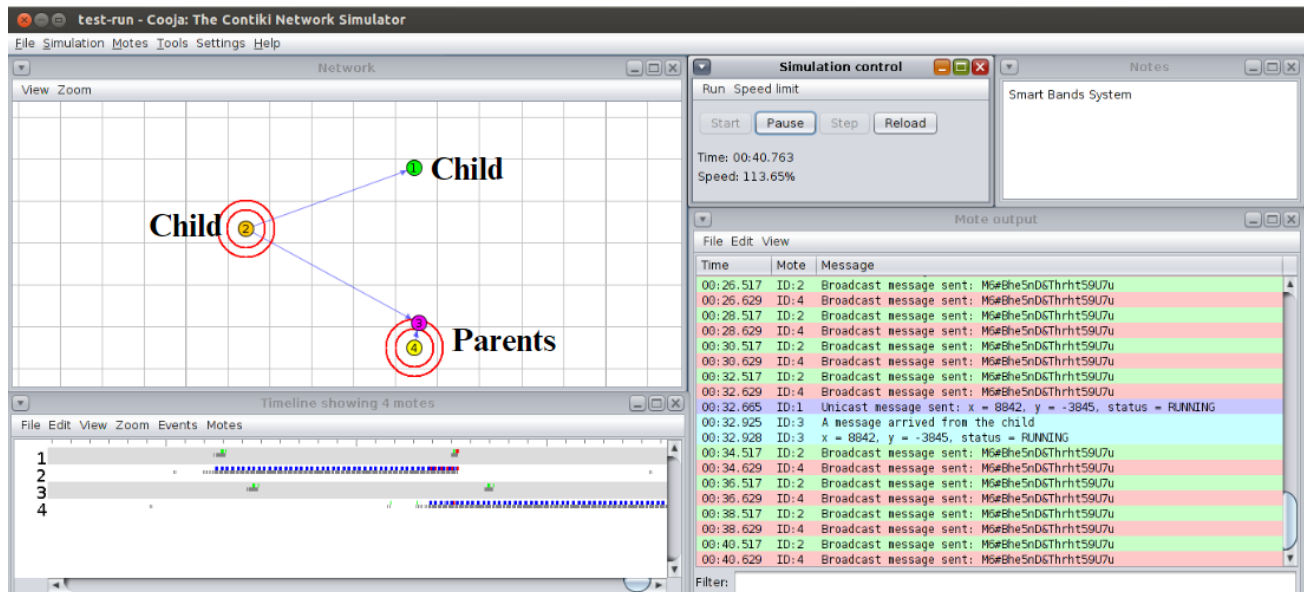
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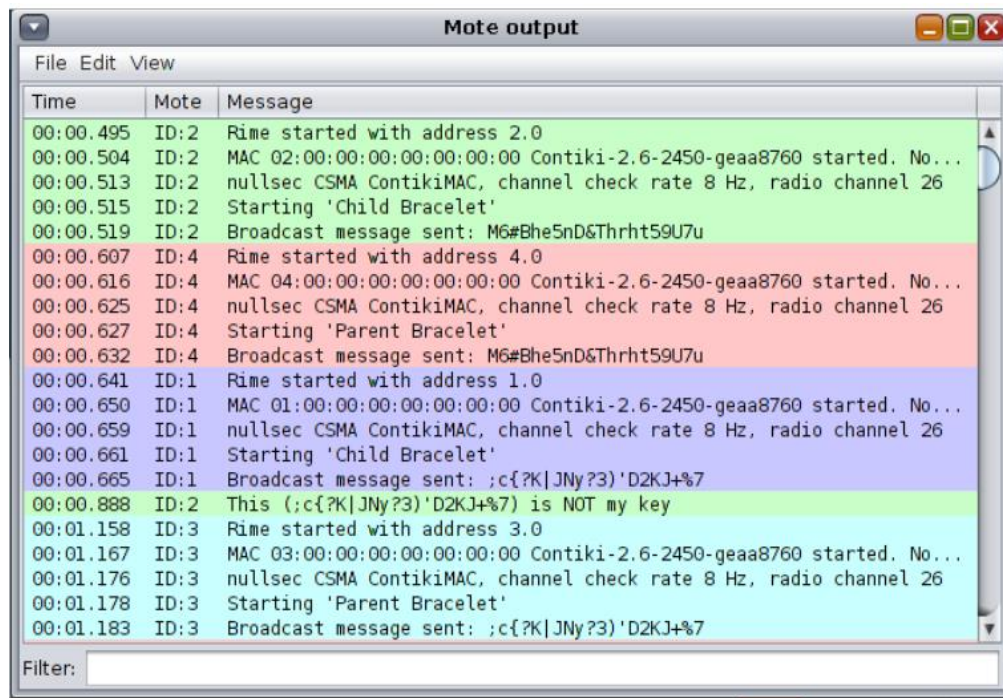
Problem Statement

- The advancement of wearable technology has led to the development of smart bands capable of monitoring various safety parameters.
- This project focuses on the analysis and simulation of a smart bands system using the Cooja simulator within Contiki OS. The system consists of parent and child bands that communicate wirelessly to monitor the child's status and alert the parent in case of emergencies such as falls or prolonged absence.
- Each band undergoes a pairing process to establish secure communication, followed by an operation mode where the child band sends periodic updates to the parent band.
- The system is designed to trigger alarms for events like missing signals or detecting a fall, ensuring timely alerts for the parent.

Implementation



Pairing of Bands



- The code simulates two bands (parent and child) communicating via broadcast and unicast messages.
- The bracelets pair using a preloaded or generated key.

Processes

- **Parent Band:** The parent band sends a pairing message every 2 seconds while it is in the Pairing Phase. When pairing is complete, it closes the broadcast connection, sends a “Stop Pairing” message, and enters the “Operation Mode”. In this mode, if it does not receive any unicast message from the child’s address for 60 seconds, it prints a “MISSING” alarm.
- **Child Band:** The child band behaves similarly to the parent during the Pairing Phase. Once it enters the “Operation Mode”, it sends a unicast message containing its INFO to the parent every 10 seconds.
- The child represents its activity through four different statuses, STANDING, WALKING, RUNNING and FALLING.

Operation Mode

```
00:01.183 ID:3 Broadcast message sent: ;c{?K|JNy?3)'D2KJ+%7
00:01.252 ID:4 This (;c{?K|JNy?3)'D2KJ+%7) is NOT my key
00:01.263 ID:2 This (;c{?K|JNy?3)'D2KJ+%7) is NOT my key
00:01.285 ID:1 Paired device -> key found, Address: 3.0
00:02.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:02.553 ID:3 This (M6#Bhe5nD&ThrhT59U7u) is NOT my key
00:02.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:02.661 ID:1 Closed broadcast connection
00:02.663 ID:1 Message unicast sent
00:02.664 ID:1 Start op mode
00:02.676 ID:3 This (M6#Bhe5nD&ThrhT59U7u) is NOT my key
00:02.927 ID:3 Paired device -> unicast message received, Address: 1.0
00:03.178 ID:3 Closed broadcast connection
00:03.179 ID:3 Start op mode
```

- When the pairing ends, closes the broadcast connection, sends the “Stop Pairing” message and starts the “Operation Mode”.
- In operation mode, the parent bracelet monitors the child's position and status, triggering alarms if necessary.

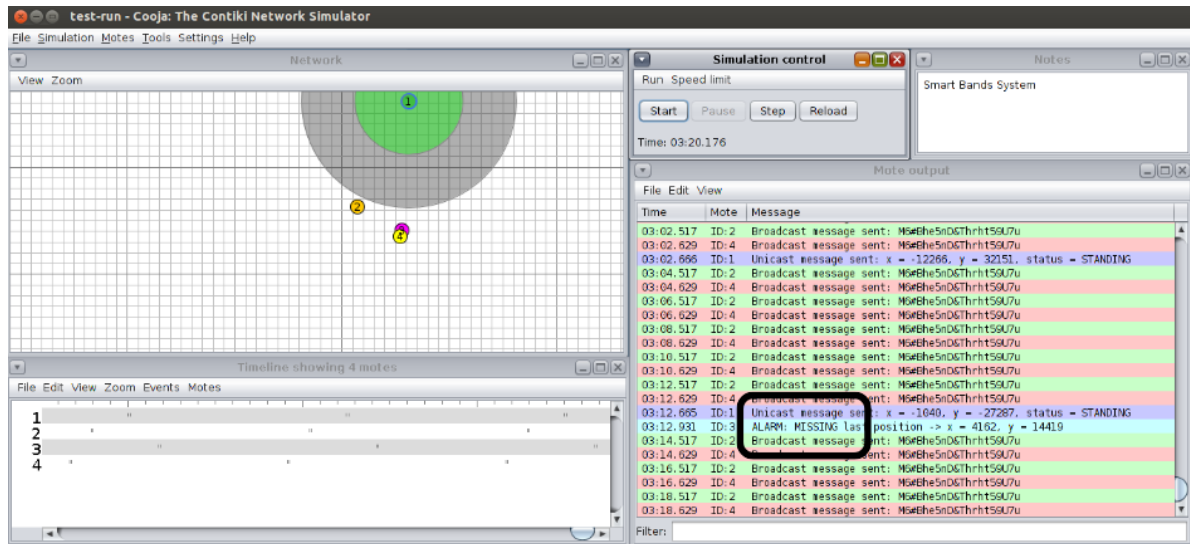
```
00:32.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:32.665 ID:1 Unicast message sent: x = 8842, y = -3845, status = RUNNING
00:32.925 ID:3 A message arrived from the child
00:32.928 ID:3 x = 8842, y = -3845, status = RUNNING
00:34.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:34.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
```

```
00:22.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:22.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:22.666 ID:1 Unicast message sent: x = -17282, y = -10785, status = WALKING
00:22.925 ID:3 A message arrived from the child
00:22.928 ID:3 x = -17282, y = -10785, status = WALKING
00:24.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:24.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
```

```
00:42.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:42.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:42.665 ID:1 Unicast message sent: x = -8874, y = -24105, status = STANDING
00:42.925 ID:3 A message arrived from the child
00:42.928 ID:3 x = -8874, y = -24105, status = STANDING
00:44.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:44.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
```

```
00:12.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:12.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:12.665 ID:1 Unicast message sent: x = -8398, y = 29827, status = FALLING
00:12.925 ID:3 A message arrived from the child
00:12.928 ID:3 x = -8398, y = 29827, status = FALLING
00:12.931 ID:3 ALARM: FALL x = -8398, y = 29827
00:14.517 ID:2 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
00:14.629 ID:4 Broadcast message sent: M6#Bhe5nD&ThrhT59U7u
```

Missing Alarm



In Operation Mode, if the mote doesn't receive the unicast INFO message within 60 seconds, it fires a MISSING ALARM.

Analysis with Wireshark

The screenshot shows the Wireshark network traffic analysis tool. The main window displays a list of captured packets. The packet list on the left shows the following entries:

No.	Time	Source	Destination	Protocol	Length	Info
42	0.206000	0x0003	0x0092	ZigBee	45	Ack
43	0.207000	0x0003	0x0092	ZigBee	45	Ack
44	0.207000			IEEE 802	5	Ack
45	1.247000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
46	1.335000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
47	1.337000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
48	1.340000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
49	1.342000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
50	1.342000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
51	1.342000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
52	1.342000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
53	1.343000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0
54	1.432000	0x0004	0x0092	ZigBee	45	Ack, Dst Endpt: 07, Src Endpt: 0

The packet details pane on the right shows the following information for the selected packet (No. 48):

- Frame 48: 45 bytes on wire (360 bits), 45 bytes captured (360 bits)
- IEEE 802.15.4 Data, Dst: 0x0092, Src: 0x0004
- ZigBee Network Layer Data, Dst: 0x0092, Src: 0x0004
- ZigBee Application Support Layer Ack, Dst Endpt: 07, Src Endpt: 0

The packet list on the right shows the following entries:

Group	Protocol	Summary	Count
▼ Undecode ZigBee APS		Encrypted Payload	267
Packet:	45		1
Packet:	46		1
Packet:	47		1
Packet:	48		1
Packet:	49		1
Packet:	50		1
Packet:	51		1

