Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [**Hybrid ARQ for WBAN with Different QoS**]

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Abstract: [We propose some useful technologies in PHY for wireless body area network (BAN) to satisfy various requirements for both high QoS such as medical and other applications, which is uniqueness of .IEEE802.15.6. In PHY, pulsed chirp UWB is proposed because of its interference immunity for BAN. In particular, hybrid type of ARQ and FEC is proposed to satisfy both requirements of high QoS such as medical and other applications in a sense of highly reliable for medical use and higher data rate for other uses. This combined error-controlling scheme can keep uniqueness of IEEE802.15.6 differ from 15.4a to guarantee highly reliable services for medical use while maintaining a low power consumption. We hope this can contribute to improve system performance by harmonizing with others. This is a revised version of our proposal with a new scheme in addition in March and May, 2009.]

Purpose: [Update of doc. IEEE802.15-09-0164-02-0006 and 802.15-09-0353-01-0006 to responding to "TG6 Call for Proposals" (IEEE P802.15-08-0811-02-0006).]

Hybrid ARQ for WBAN with Different QoS

- Revision of a part of doc. IEEE802.15-09-0164-02-0006 in March 2009 and doc. IEEE802.15-09-0353-01-0006 in May 2009-

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Combined hybrid ARQ and FEC for error-control satisfying different requirements for high QoS (medical use) and other QoS applications

Choose decoding scheme either hybrid ARQ or simple FEC according to QoS while transmitting signals are the same in transmission device

- Requirement for High QoS (Medical etc) use: Accept a certain level of delay for improvement of quality
- Requirement for other uses : Decrease delay in moderate quality

For High QoS (Medical) use: Hybrid ARQ
For other uses: FEC only

Use **Rate Compatible Punctured Convolutional code (RCPC)** or **Invertible RS code** according as a purpose

The combined error-control method can keep uniqueness of IEEE802.15.6.

Uniqueness of IEEE802.15.6 must be to guarantee highly reliable service for high QoS applications, e.g. medical use while to keep low power consumption for most of applications

Hybrid ARQ for WBAN with Different QoS - QoS, Configuration, Procedure-

Table 1 QoS Requirement

Catgory	Medical	Non-medical
Main usage	Data storage	Fitness/Games (Real-time)
Bit error rate	$\leq 10^{-6}$	$\leq 10^{-3}$
Data rate	$kbps$	$M bps$
Key requirement	Relliability	Timeless

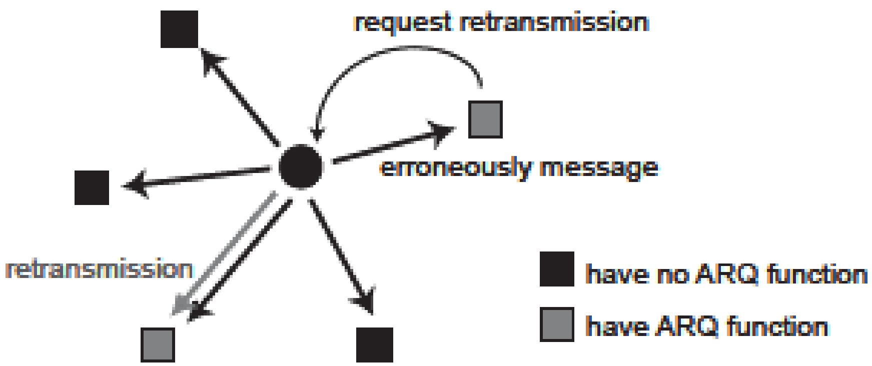


Fig. 1 The formation of the star topology for Wireless BANs

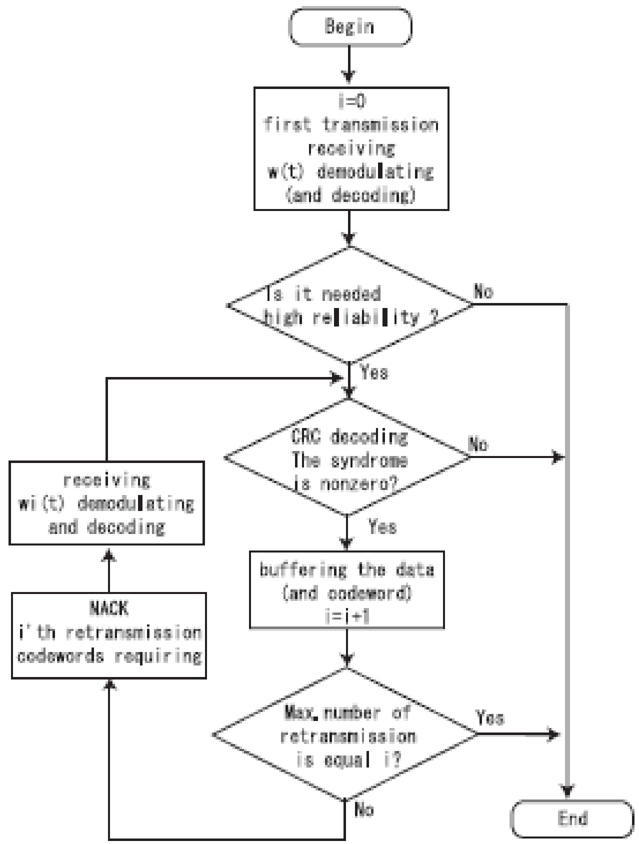
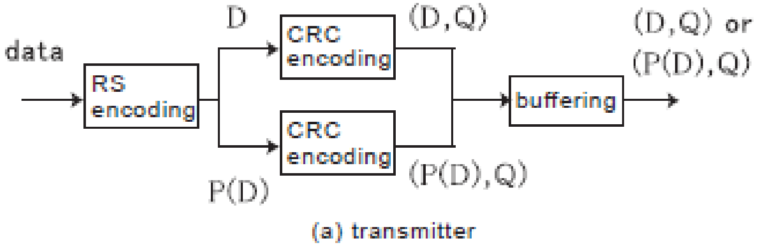


Fig. 2 The flow chart of the proposed system

TX and RX for FEC and HARQ

Table 2 *HRO-RCPC codes of parent code rate 1/3*

K	(g_0, g_1, g_3)	$P_{2/3}$	$P_{1/2}$	$P_{2/5}$
7	(133,165,171)	1 1 0 0 0 1	1 1 0 0 1 1	1 1 0 1 1 1



High Rate Optimized Rate Compatible Punctured Convolutional codes (HRO-RCPC).

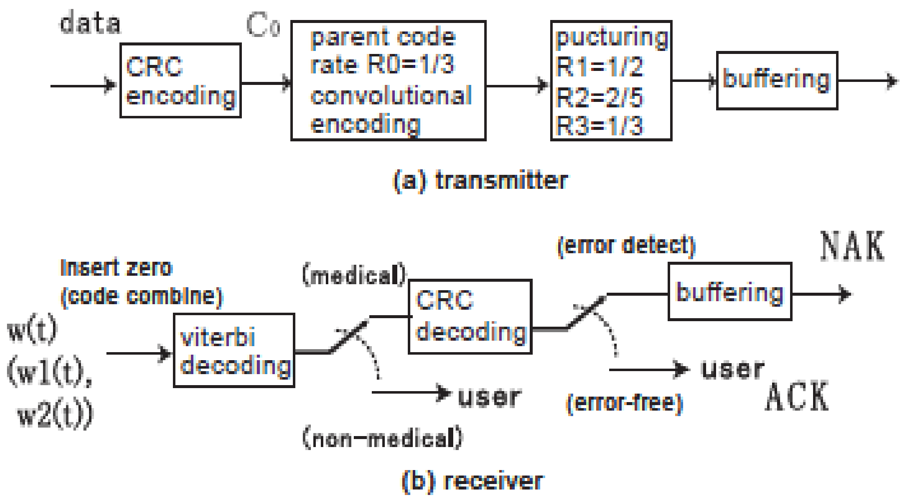


Fig. 3 System model of Hybrid ARQ protocol using HRO-RCPC codes

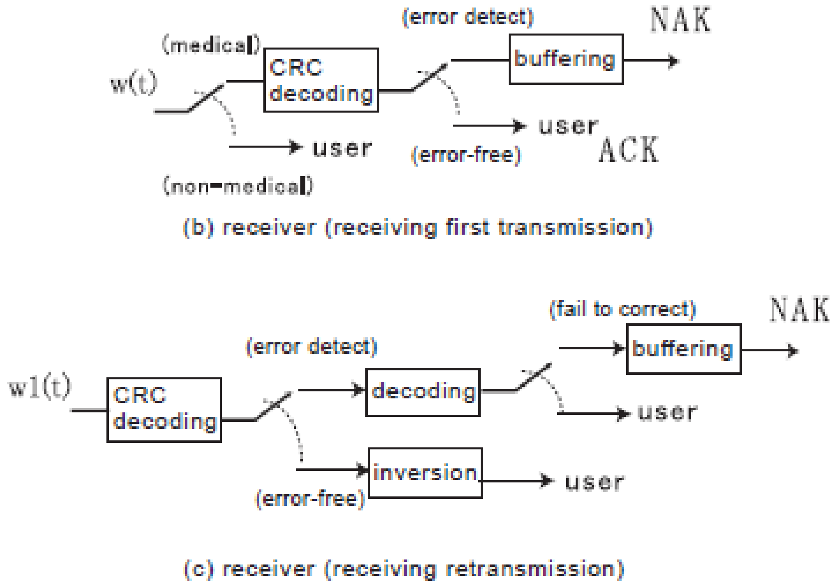


Fig. 4 System model of Hybrid ARQ protocol using invertible codes

Channel Coding for FEC and HARQ

Simulation parameters for RCPC-based H-ARQ and invertible codes-based H-ARQ are given in Table 3.

Table 3 *Simulation parameters for RCPC-based H-ARQ.*

Channel	IEEE802.15.6 CM3 and CM4
Modulation	2PPM
Demodulation	Energy detection
Pulse shape	modulated RRC
Pulse duration	2 nsec
Bit rate	4 Mbps
CRC	CRC-CCITT parity length 16 bits
FEC (RCPC-based)	RCPC codes constraint length K=7 parent code rate 1/3 Code rates : R_k=1/2,2/5,(1/3)
FEC (RS-based)	RS codes GF(2^3),(7,3)RS codes GF(2^4),(15,7)RS codes GF(2^5),(31,15)RS codes Code rates : 1/2
Decoding	RCPC-based : Hard Dicision Viterbi decoding RS-based : Euclid Algorithm
Block length (containing CRC)	RCPC codes: 316 bits (7,3)RS codes: 312 bits (15,7)RS codes: 314 bits (31,15)RS codes : 316 bits
Max. No of transmissions	RCPC-based : 3 RS-based : 2

BER of FEC for Low QoS and HARQ for High QoS

In case of CM3

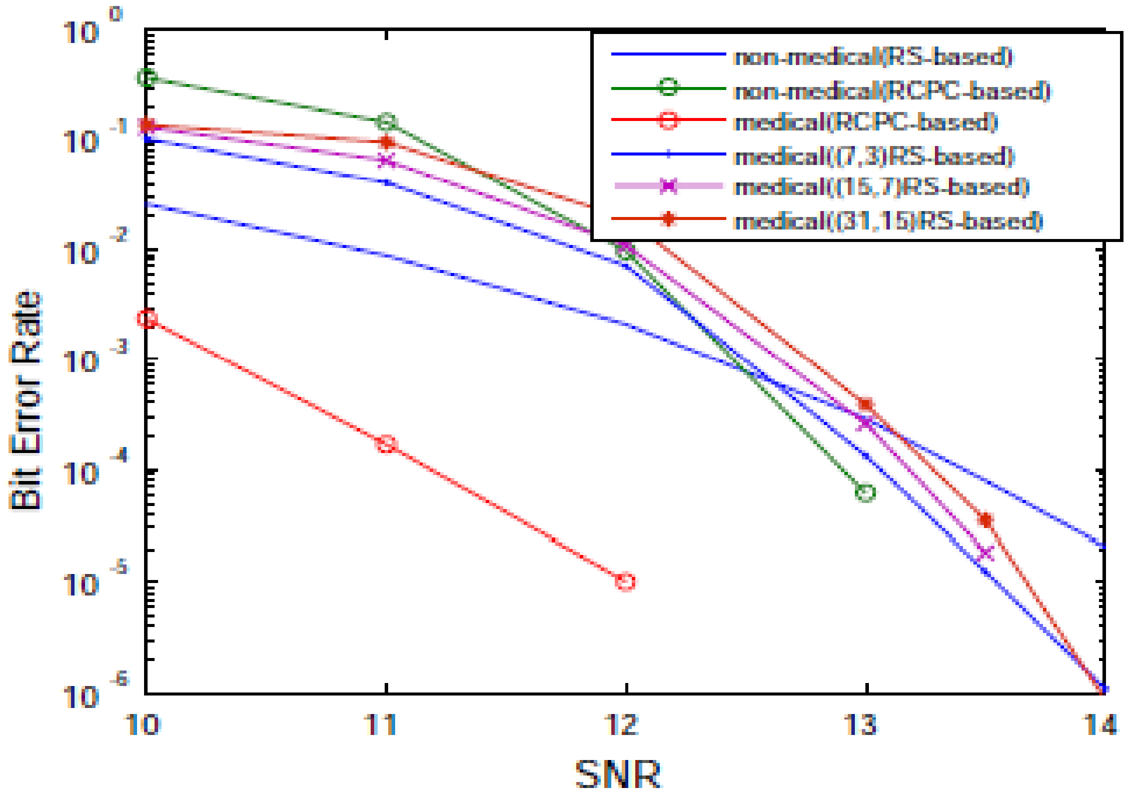


Fig. 5 Bit error rate when using RCPC-based H-ARQ and RS-based H-ARQ for medical and non-medical applications in the CM3 channel.

Throughput and No of Retransmission

In case of CM3

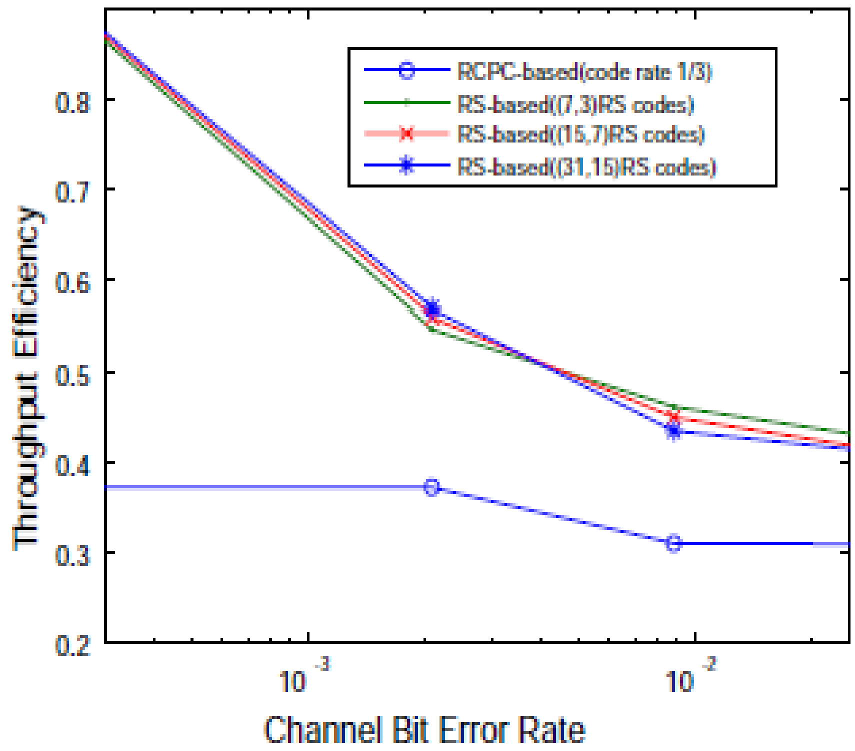


Fig. 6 Throughput vs Channel BER when using RCPC-base H-ARQ and RS-based H-ARQ for medical and non-medical a plications in the CM3 channel.

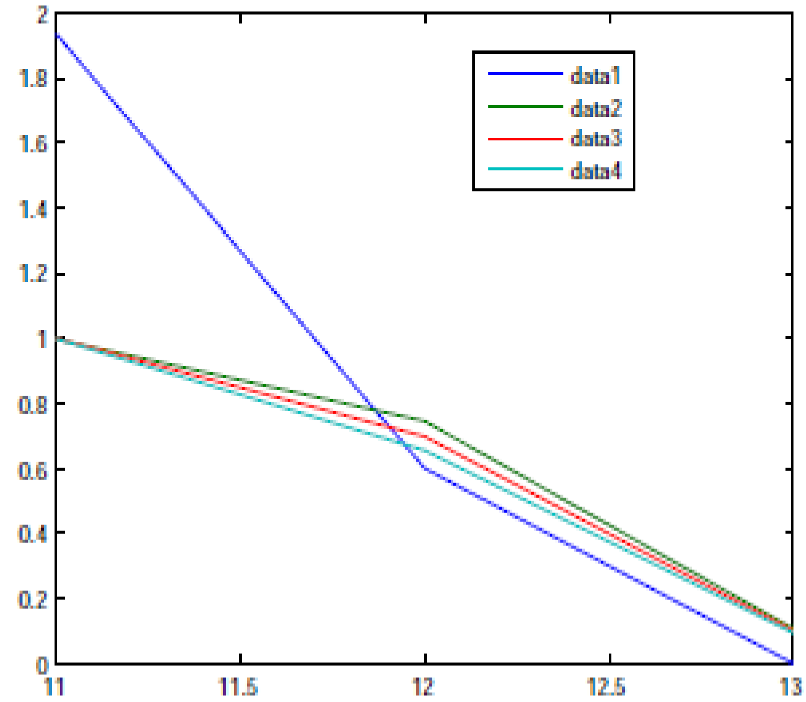


Fig. 7 Number of Retransmission using RS-based H-ARQ for medical and non-medical applications in the CM3 channel.

BER of FEC for Low QoS and HARQ for High QoS

In case of CM4

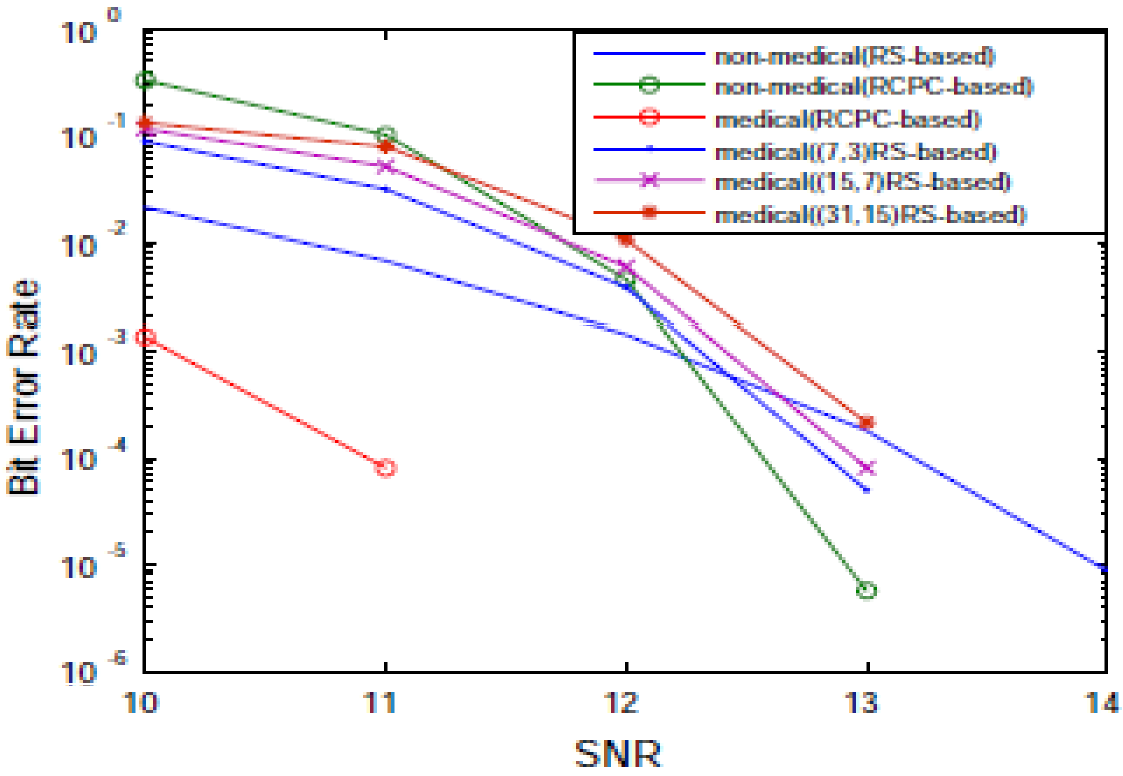


Fig. 8 Bit error rate when using RCPC-based H-ARQ and RS-based H-ARQ for medical and non-medical applications in the CM4 channel.

Throughput and No of Retransmission

In case of CM4

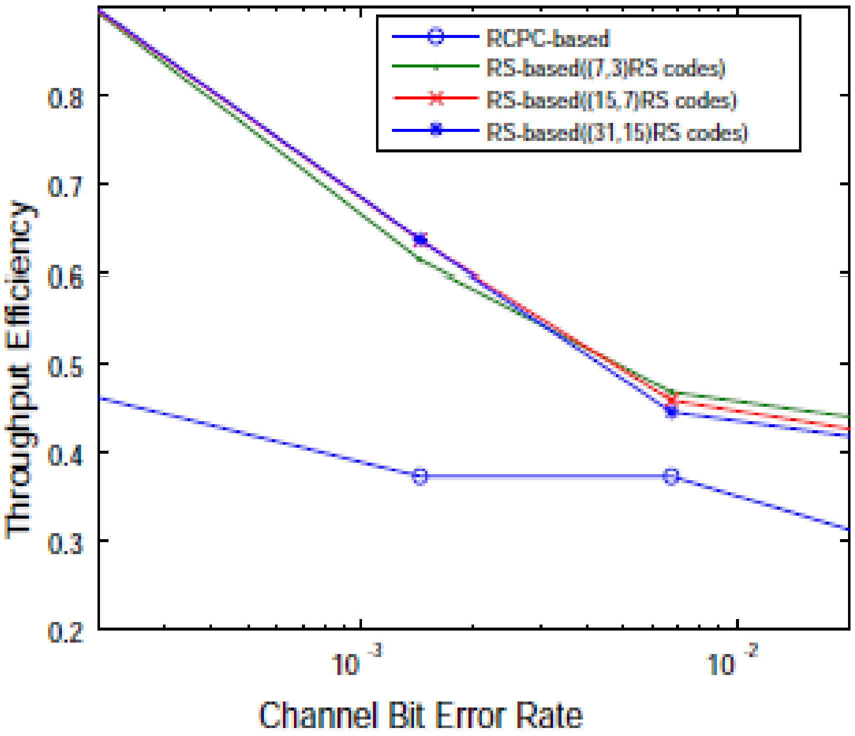


Fig. 9 Throughput vs Channel Bit error rate when using RCPC-based H-ARQ and RS-based H-ARQ for medical and non-medical applications in the CM4 channel.

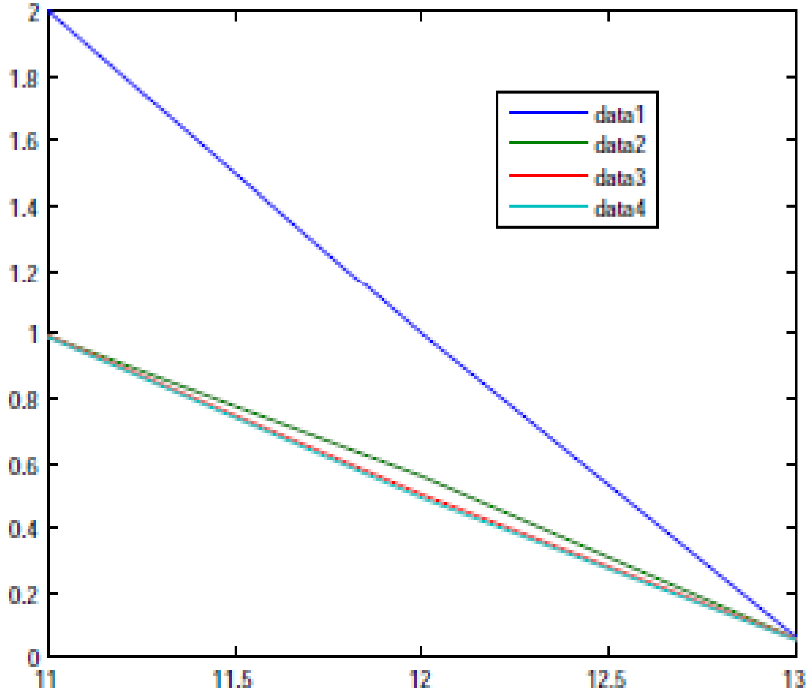


Fig. 10 Number of Retransmission using RS-based H-ARQ for medical and non-medical applications in the CM4 channel.

Conclusions

- The error controlling scheme is employed to choose hybrid ARQ and FEC only corresponding to different QoS requirement such as high QoS (medical use etc) and other QoS, respectively while transmitted signals have the same channel coding for both medical and non-medical uses.
- The scheme could satisfy the demand of both medical and non-medical simultaneously.
- Rate Compatible Punctured Convolutional (RCPC) code and rate 1/2 Invertible Reed-Solomon(RS) code have been considered.
- We can choose a super orthogonal convolutional code with much lower code rate but much higher error-correcting capability as well as the same concatenated code between RS code and convolutional code as IEEE802.15.4a in option.