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ULTRASOUND MEDICAL VIDEOSTREAMING OVER M-WIMAX ON CROSS LAYER DESIGN

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ABSTRACT

Mobile telecommunication systems from 3G to WIMAX technology will facilitate the provision of such faster data transfer rates and high quality video streaming. It provides real time adaptability of the rate of quality control in the transmitted ultrasound images and provides better performance in terms of m-QoS like frames per second, peak signal-to-noise ratio and frame size. WiMAX technology provides a Quality of Service (QoS) system that allows system operators to configure a network to provide maximum performance compared to conventional Best Effort (BE) systems. In this paper, we address the increase the Qos over a m-WiMAX network. We present the results of application testing using WiMAX protocol where the main focus is to show how utilizing a QoS system can benefit streaming real time multimedia. The results show how WiMAX technology is beneficial to multimedia applications.

KEYWORDS-WiMAX, CLD, Quality of Service, Base Station, Subscriber station, Best Effort, Unsolicited Grant Service, , Wireless Multi Media.

INTRODUCTION

Mobile healthcare (m-health) is a new paradigm that brings together the evolution of emerging wireless communications and network technologies with the concept of connected healthcare anytime and anywhere. However, there are two critical issues affecting the successful deployment of m-health applications from the wireless communications perspective. The Quality of Service (QoS) issues from the healthcare perspective and their required levels to guarantee robust and clinically acceptable healthcare services need to introduce a new sub-category of the traditional QoS that is customized for medical applications and critical wireless telemedical scenario focus on the concept of medical Quality of Service. m-QoS can be defined as the augmented requirements of critical mobile healthcare applications with respect to traditional wireless QoS requirements providing end-to-end QoS in real time medical video delivery in wireless networks is becoming an increasingly important requirement. The evolution of 4G-based mobile multimedia network systems will contribute significantly to future m-health applications.

MEDICAL VIDEO STREAMING

The evolution of emerging wireless communication network technologies and multimedia applications is bringing multimedia applications into every day usage, anytime and anywhere and on any mobile device.

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Due to the stochastic nature of wireless media and channel conditions there are several challenges such as bandwidth variation, end-to-end delay limitations, battery power consumption, and high error rate. The main qualities of service metrics in video streaming environment Packet loss*,* end-to-end delay, delay jitter. Video quality is changed in terms of frames per second, frame size, and peak signal to noise ratio to optimize the QoS against varying wireless condition streaming system. m-health mainly focus on impressive data rates increase and extended coverage of wireless infrastructure telemedicine frameworks with increasing system robustness and objective of providing adequate quality video diagnostics

CROSS LAYER DESIGN

CLD is a co-operation between the multiple layer to combine the resources and create a network that should highly adaptive It meets the challenging data rates, high performance gain and QOS service for various real time and non real time application.

M-HEALTH MEDICAL VIDEO COMMUNICATION SYSTEMS DESIGN APPROACHES

Beyond standard video compression methods, clinical video compression is also, diagnostically driven. Previously, in [1], [2], m-health studies were categorized into methods that employed diagnostic regions-of-interest (ROIs), and studies that did not use ROIs. In this paper, we generalize this concept by referring to diagnostically relevant encoding.

DIAGNOSTICALLY RELEVANT ENCODING

Diagnostically relevant encoding exploits the properties of the incorporated medical video modality and its specific clinical application [3]-[4], [5], [6]. Such approaches can significantly improve coding efficiency [4], [5], [7], [8], using robust transmission mechanisms [2], [4], [8], or sophisticated error-resilience and concealment techniques [13], as described next.

DIAGNOSTICALLY ROBUST TRANSMISSION

Diagnostically robust transmission schemes employ adaptive algorithms for maximizing the clinical capacity of the communicated medical video modality. Such algorithms range from adapting to the wireless network's varying state [9], applying unequal error protection (UEP) schemes for protecting more strongly the diagnostically important video regions, such as forward error correction codes (FEC) [10], [4], employing selective retransmissions of clinically sensitive regions, using customized, clinically oriented protocols [5], etc.

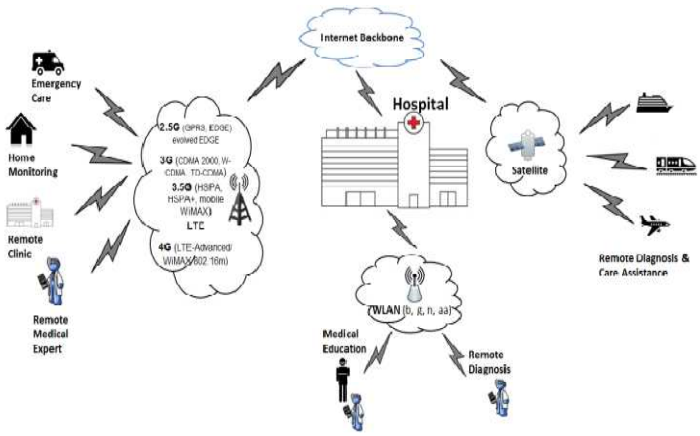

Figure 1.M-Health Medical Video Communication Systems Applications Scenarios. Scenarios range from remote diagnosis and care in emergency incidents, home monitoring for the elderly and people with mobility problems, mass population screening, medical education, etc [2]

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DIAGNOSTICALLY RESILIENT ENCODING AND DECODING

This approach includes customizing the use of error resilience and concealment tools for enhancing the diagnostic robustness of the communicated medical video [7]-[3]. Intra-updating to match the beginning of each cardiac cycle, selective macroblock intra-refreshes within the diagnostic ROIs, redundant slices (RS) insertion only for slices that describe the diagnostic ROIs, as well as applying sophisticated error-concealment algorithms (as post-processing) for protecting more strongly the clinically important regions are some of the incorporated techniques.

RECENT ADVANCES IN M-HEALTH MEDICAL VIDEO COMMUNICATION SYSTEMS

In this section we discuss the latest advances in m-health medical video communications systems since the publication of [7], which reviewed 3G-based studies. The emergence of new 3.5G wireless channels have had considerable impact on the incorporated source encoding parameters, and hence the clinical quality of the communicated medical video. Higher upload data rates accommodate higher resolutions and frame rates that can now rival the clinically acquired setups. Table I depicts the most important and recent studies in the field of wireless medical video communications systems. These studies can be further categorized according to the afore-described diagnostically driven approaches. Here, we differentiate between diagnostically relevant encoding and systems that do not use diagnostic information.

DIAGNOSTICALLY DRIVEN M-HEALTH SYSTEMS

Flexible macroblock ordering (FMO) error resilience technique of H.264/AVC standard was used to define diagnostic ROIs for cardiac ultrasonography [2] and common carotid artery (CCA) ultrasound videos [7], [8]. FMO type 2 mode was modified accordingly to allow for variable quality slice encoding, subject to the slice's diagnostic importance.

In [6], UEP mechanisms based on FEC channel encoding schemes were employed to protect the clinically sensitive regions more strongly. Simulations performed over mobile WiMAX networks verified the error resilience of the proposed scheme.

The authors in [3] proposed the use of a sophisticated post processing error-concealment technique over the diagnostic ROI, for improving the diagnostic performance of the communicated ultrasound video. The method was evaluated over a simulated mobile WiMAX topology, and was found to achieve higher PSNR scores, at the expense of slightly higher computational complexity.

A very interesting study was described in [4] where a new transmission protocol was defined for the transmission of clinical ultrasound video, based on read-solomon (RS) FEC codes and retransmissions, termed real time clinical transmission protocol (RTCTP). Promising results were recorded during the experimental evaluation.

Exploiting the properties of B-Mode and M-Mode echocardiogram ultrasound video, the authors in [5] proposed a diagnostically relevant technique which reduced bitrate requirements for wireless transmission. Source encoding recommendations and associate bitrate demands for diagnostically lossless ultrasound videos were provided using a modified version of the clinical distortion index introduced in [6]. The modified clinical distortion index reduced assessment time while it maintained the efficacy of the clinical criteria's evaluation process.

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In [7], [8], diagnostic ROIs were identified using automated segmentation algorithms for atherosclerotic plaque ultrasound video. The proposed diagnostically relevant encoding setup in the aforementioned studies documented significant bitrate demands savings for scalable resolutions. Toward this end, extensive experimentation in [7] showed that error resilient tools such as intra-updating and redundant slices insertion can deliver acceptable diagnostic performance even at high packet loss rates. Moreover, correlation investigation between subjective and objective ratings showed that new, diagnostically driven video quality assessment (VQA) algorithms are needed, since existing methods fail to correlate with clinical quality. Efficient mobile WiMAX network parameter selection for maximizing transmitted videos' clinical capacity was considered in [8]. Different scenarios were simulated for medium access control (MAC) and physical (PHY) layer characteristics, including service prioritization classes, modulation and coding schemes, fading channel's conditions, and mobility. Recommendations of use were based on clinical VQA.

NON-DIAGNOSTICALLY DRIVEN M-HEALTH SYSTEMS

Alinejad*et al*. [9] described a cross-layer approach for real-time adaptation to the wireless channel's varying state based on minimizing a cost function. The cost function was composed of source and channel encoding parameters, as well as objective VQA measurements. The approach was validated over commercially available HSUPA mobile cellular networks in the UK and mobile WiMAX wireless network using own equipment in a controlled environment. The latter wireless network achieved better objective VQA ratings while it provided for higher resolution medical video communication.

ALGORITHM AND METHODOLOGY

QoS CONSTRAINTS

Parameter	Definition	Requirement
Throughput	Packet arrival rate	Min 323 kbps
Delay	Delay the time taken by a packet to reach its destination	Max 100 ms
Jitter	Time of arrival deviation between packets	Max 50 ms
Packet loss	Percentage of non-received data packets	Max 5 %

ULTRA SOUND MEDICAL VIDEO STREAMING

Ultrasound images are captured in real time and show the structure and movement of body internal organs. The ultrasound image sent through the network by using encoding technique successfully streamed packets are mapped back to the original RTP files are decoded and evaluated by the relevant medical expert. The key challenge in mobile multimedia streaming optimization is congestion control whereby video quality is changed in terms of FPS, FS, and PSNR to optimize the QoS against varying wireless conditions.

The lower layer is the link layer that includes the media access control layer and physical layer these depend on the type of wireless QoS classes with supported modulation and coding schemes. The upper layer is used to decode/encode video streaming and has rate control to provide optimal video traffic making a decision in one layer sometimes affects QoS parameters in other layers, in this situation cross layer can be in charge of making a decision and giving a QoS solution. Hence, the cross-layer approach is used to combine the

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parameters and mechanisms at different layers optimally to find a solution for improved QoS support at given network dynamics and limited resources

REINFORCEMENT LEARNING ALGORITHM

1. Initialize the Q-values table, **Q (s, a)**.
2. Observe the current state, **s**.
3. Choose an action a, for that state based on one of the action selection polices
4. Take the action and observe the reward r, as well as the new state s
5. Update the q-value for the state using the observed reward and the maximum reward possible for the next state.
6. Set the state to the new state and repeat the process until the terminal state is reached.

3D medical video encoding using H.264/MVC (multi-view coding) and transmission over LTE wireless networks was attempted in [10]. Preliminary results suggested that 3D medical video communication is viable using current compression and wireless transmission advances. The platform was based on widely used open-source software tools and was evaluated over commercial HSPA wireless networks in Cyprus. Rigorous testing involving a plethora of source encoding parameters concluded that diagnostically acceptable medical video communications can be realized using open-source software. The clinical evaluation showed that while clinical motion was affected by temporal freezes introduced by real-time communications, error-free cardiac cycles allowed confident diagnosis. Toward this end, variable frame delay (VFD) algorithm which removes temporal mismatch between compared frames was used as a pre-processing step for objective VQA measurements.

DISCUSSION AND FUTURE WORKS

This paper reviews the major advances in m-health medical video communication systems. The leading trend is the use of diagnostically driven methods. Diagnostically driven systems exploit the properties of the underlying medical video modality to provide for increased coding efficiency, while maximizing error robustness. In most cases, the H.264/AVC video coding standard was used.

The new HEVC standard is expected to replace the current use of the H.264/ AVC. Similarly, 3.5G wireless networks were used in the majority of the reviewed studies as mobile WiMAX, and especially HSPA cellular networks are the current best available wireless channels.

With 4G systems already deploying, m-health medical video communication systems are likely to enter a decisive new era in the near future, utilizing HEVC encoding over 4G networks. The latter is expected to aid the adoption of such systems and services in daily clinical practice. Already, currently reviewed studies materialize medical video transmission at the clinically acquired resolution and frame rates. More specifically, reviewed studies documented high resolution, high frame rate, and high bitrate communications. This is attributed to the considerably increased 3.5G upload data rates compared to the 3G upload data transfer rates. With HEVC targeting beyond high definition (HD) medical video streaming and 4G rates more than doubling the available bandwidth, m-health systems that can approximate the in-hospital experience are foreseen in standard clinical practice.

FUTURE WORKS

The enhanced cross layer design algorithm (CRL), based on reinforcement learning algorithm that provide better m-QoS over m-WiMAX environment. It provides the real time adaptability of the rate and quality control in the transmitted ultrasound images and provides better performance in terms of m-QoS

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requirements like FPS, PSNR, and frame size with an average uplink throughput that is acceptable for remote clinical diagnostics**.** The effect of coding efficiency and network performance can be improved through PSNR and FPR Furthermore the effect of non-LOS performance can be tested and performance can be improved.

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