Using Multimedia, Wireless and Sensor Technology to Develop Novel Healthcare Solutions

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Presentation Roadmap

Introduction

Use Case Scenarios

Components

Implementation and Demo
Vision and Mission

• To make Cardiac Health Care more patient centric than hospital centric
• To apply advances in the areas of Multimedia, Mobile Technology and microelectronics to bring expert cardiac health care to rural masses.
• To design and develop a prototype of TCS Cardionet as proof of concept
• To conduct field trials at various hospitals in the country and arrive at comprehensive product specifications
Motivation

• Lack of specialized cardiologists at primary health centers
• Need of a low cost solution for the rural masses
• Need for constant cardiac monitoring
The Solution

• A low cost secondary e-consultation service
  • Augmented by a centralized Decision Support System (DSS)
  • Assists medical practitioners to expedite interpretation and
    diagnosis of cardiac ailments
• Intended to provide life saving gadgets at low cost
• Aims at providing low cost telecardiology services
  • To the rural masses of the country at their door steps
  • To the ambulatory patients
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Intelligent Cardionet

There is need for collaboration with doctor

- In real-time
- In a cost-effective manner
- Using low-bandwidth
Patient @ Home

Patient at Home

Hospital

Minds in Motion

Technology for Innovators™
Patient @ Ambulance

Audio/Video and ECG data from ambulance

Audio data from doctor

Hospital

Doctor’s View at his laptop/desktop

Patient in Ambulance

Minds in Motion
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Components

1/3/12 Lead Wearable ECG Recorder

12 Lead, ECG Recorder

Remote Video Consultation System

ECG Decision Support System
1/3/12 Lead Wearable ECG Recorder

- MSP430F149: 16 bit Ultra low-power microcontroller from TI
- Sampling rate of 360 samples per second
- 12 bit A/D Converter
- 32 MB Flash for data storage
- 3.7V mobile battery
- Low Power
- Low-cost
- Lightweight
12 Lead Recorder

- 12 Lead ECG System
- Leads: I, II, III, aVR, aVL, aVF, V
- Standard Calibration pulse
- Gain adjustment in ½ and 1 gain modes
- Acquisition of ECG @ 256 samples per second
- Thermal Printer for printing ECG on graph (at std rates of 25mm/sec, 50mm/sec)
- Battery powered and Internal battery charging
- Portable
Remote Video Consultation System

- H.264 based video, AMR based audio
- Constant bit-rate (CBR) and Variable bit-rate (VBR) support
- Low-bandwidth/High-quality
- Proprietary error resilience algorithms for robust performance
- On-way or two-way video
- Instrumentation Signals / any other application data can be shared remotely
DSS - Cardiac Ailments

- Tachycardia (Supraventricular and Ventricular)
- Bradycardia
- Premature Ventricular Contraction (PVC)
- R-on-T
- Various types of blocks (SA block, AV block, LBBB, RBBB)
- ST segment changes (Ischemia, MI)
- Fibrillation
- Electrical Axis Deviations
DSS for PVC

- Premature Ventricular Contraction (PVC)
- This implies Ventricular Contraction takes place before Atrial finishes its function (Premature)
- The algorithm is based on single lead of information (Modified lead II information from MIT Arrhythmia data base)
  - Record Length 30 minutes
  - Sampling rate: 360/samples/sec
Features of PVCs

- Change in RR interval
- Absence of P wave
- Bizarre Wave shape
- Unifocal or Multifocal
- Can occur in groups of one’s or two’s
Occurrence of PVCs in groups of one’s
Occurrence of PVCs in groups of two’s
Detection Strategy

- Arrhythmia Detection (Tompkin’s Algorithm)
- Detection of Absence of P waves
- Detection of Bizarre Wave shape using Hermite transforms
- Similarity measurements using coherence function
Hermite Basis Functions
DSS Agents

The functions of various DSS agents

- Detection of QRS complex
- Measurement of RR interval and detection of Arrhythmia
- Detection of bizarre QRS complexes
- M-shape detection
- Negative peak detection
- Detection of bi-phase QRS complexes
- Detection of fibrillation related oscillations
- Computation of Hermite transform of QRS complexes
- ST segment measurements
- Computation of KL Transform

One or more agents facilitate detection of cardiac ailments
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Implementation

• Stand-alone DSS (PVC) on MATLAB, PC and 64x
• Remote Video Consultation System on PC and DM642

Patient @ Ambulance

• Ambulance side system on
  1. DSS on Laptop with Video Camera
  2. DSS on DM642 with Video Camera
• Doctor’s Viewer on PC
DSS on MATLAB/Simulink
Value-Add

- 90% to 95% sensitivity and specificity on MIT-BIH database
- Embedded DSS optimized to work with low resource requirements
- Analysis by Embedded DSS in real-time and meant to pre-warn catastrophic and premonitory arrhythmias
Future Work

Implementation
• Porting of other cardiac disease detection functionalities of DSS on DSP
• Porting of DSS on DA224 Ultra-low-power DSP

Research
• Application of wavelet transforms and Hermite functions in the detection of more cardiac ailments
• Application of Self Organizing Maps in the classification of cardiac ailments
• Agent based DSS
Future Work - Agent Based DSS

• A set of sensor nodes
  • Each element of the set executing the function of a specific agent
  • Will aid in the detection of cardiac ailment through collaborative processing

• Coordination through high level Petri Nets
  Supporting dynamic changes
Reference Database

- MIT Database – www.physionet.com
- European ST Database - www.physionet.com
Thank you!

Any questions, please?

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