In-Home Video Monitoring for Caregivers of Dementia Patients

Santosh Gondi, Mohammed J.F. Alenazi, James P. G. Sterbenz – KU EECS ITTC 
in collaboration with Steven H. Fennel, Lemuel R. Waitman, Kristine Williams, Dan Connolly - KUMC

I. INTRODUCTION

• Motivation

Technological advances in multimedia, computing devices, communication networks and web based applications can be effectively used to address many problems in the health sector. Dementia, a serious health problem currently plaguing 35 million of US population is estimated to affect 115 million people by 2050. Family caregivers currently provide $135 billion of care. Caregivers of dementia patients face many physical and psychological challenges including, stress, depression, and insomnia leading to morbidity and mortality. This is recognized as one of the growing health problems. This also has an effect on frequent hospitalization of patients resulting in increased cost of health care. Using technological advances such as ultra high speed internet connections, web based rich interactive applications, and high resolution networked cameras, a high end monitoring system can be built to assist the caregivers of dementia patients. A clinical pilot project conducted by The University of Kansas Medical Center, using a laptop assisted webcam to monitor autism school children, has shown to have positive impact in health care and service.

• Idea

In this project we aim to develop, integrate, and test an advanced high-definition video monitoring system, integrated with cloud based video processing and storage. When a caregiver elects to capture video of behavioral changes in a patient, they will utilize a browser-based application accessible via a cell phone or handheld device. The generated video clip that has past and future recorded video from the click event, is securely stored in the cloud, and made available to clinical experts after proper authorization by caregivers. Those experts can do visual observation of behavioral changes and give feedback to care takers accordingly.

II. MOTIVATION

• Improvement in care and treatment of dementia patients in home or hospital based settings.
• Avoidance and reduction of frequent hospital admissions and readmissions.
• Improvement in the quality of life of caregivers.
• Overall efficiency in the health care system.
• Possible extension to other health care, telemedicine sectors.
• Availability of ultra high speed internet connection to residential homes, through the recently launched Google fiber to home project.
• Large, Programmable national wide GENI network testbed for evaluation and prototyping of innovative network applications and services.

III. SYSTEM ARCHITECTURE

• System Description

The recording front end consists of high resolution COTS network enabled camera. An in-home or cloud-based video processing system receives the video stream from the camera and stores them securely. Based on the caregiver’s capture event, the video-processing system annotates the relevant portions of video and uploads it to an online cloud storage. After obtaining notification and authorization from caregivers, the clinical experts play back the stored content from cloud, analyze, consult, and provide feedback to caregivers.

• Enablers

We assume that future systems will have personal digital record at control of families. Either provisioned as commercial off the shelf infrastructure such as 1 TB Google Drive storage included for Google Fiber customers, or as cloud-based video monitoring services such as Dropbox.

Google’s first ultra high-speed fiber-to-the-home network (1 Gb/s), which is being deployed in the Kansas City beginning in October 2012.

• GENI, GpENI, InstaGENI rack, and OpenFlow-enabled GENI infrastructure to help in real-time performance evaluation.

• Primary use-case

A caregiver establishes the provider relationship authorizing review by providers, marks the event, transmits the event, receives the feedback and ends the relationship.

A provider establishes the relationship with the patient, receives the event requests, consults events to a multidisciplinary team, and sends feedback.

• Secondary use-case

A caregiver can establish a real-time continual monitoring and initiate request for real-time coaching.

A provider can accept or request real-time sessions, and initiate requests for real-time session based monitoring.

IV. SOFTWARE ARCHITECTURE

• Video Processing System

The media recording module continuously records the media stream from camera, using RTSP/RTP protocol. It makes use of open source ffmpeg libraries and utilities for recording media into a circular buffer. The media editing module also makes use of ffmpeg utilities for creating media clips of required size. Both the modules will be developed as python scripts. The web server framework will be developed using python pyramid, an open source web development framework. The user will be able to interact with a video processing server through a simple web interface, and initiate a capture event by pressing a button on the browser application. The system will be able to handle multiple capture requests at any point of time. The media editing module can annotate the content and upload it securely to the storage management system. We will use public-domain security solutions such as OpenSSL for secure transport. This system could be physically located in-home or in the cloud. The camera interfaces with video processing system either by wired or wireless mediums.

• Storage Management System

The media files could be securely stored using standard AES encryption. A clinical expert goes through access control modules to access uploaded videos. We will use well known media container formats such as MP4, AVI, and codecs such as H.264/AAC for media to be compatible with many web-based media players. The feedback capture module gets the input from clinical experts. Notification and feedback can be accomplished through email or SMS. Notifications between the systems can be implemented using SOAP/REST based protocols.

V. EVALUATION with GpENI/GENI

• GpENI/GENI

International testbed for “at scale” flexible experiments in networking.

Programmable node cluster at each institution.

Programmability at each layer.

• InstaGENI Rack

GENI Racks serve as programmable routers, distributed clouds, content distribution nodes, caching or transcoding nodes, etc. Federated with GENI control framework and aggregate managers.

• Evaluation

GpENI/GENI slice will be used for conducting experiments to evaluate the tradeoffs such as local vs. cloud storage/streaming, and measurement of key network parameters such as delay, jitter, and bandwidth. We will evaluate the GENI OpenFlow/OpenStack options for programmability of our experiments.

VI. PROJECT PLAN

• Phase 1 will include requirements definition, the development of use cases, and creation of solution platform for primary and secondary applications.

• Phase 2 will include deploying infrastructure, developing the applications, recruiting subjects, and defining metrics and measurement strategies for the evaluation phase.

• In phase 3 we will deploy the solution, conduct qualitative evaluation of enhanced technology upon typical case scenarios, and provide quantitative measurement of network performance and scalability.

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