|  |  |  |
| --- | --- | --- |
| logo5 | Communicating as We  Age-In-Place  Proof-of-Concept  Proposal  **September 25, 2017** |  |

**Technical Proposal Overview**

Human Interactive Design, LLC, in partnership with Phil West, propose to produce an Aging-in-Place proof-of-concept prototype. The purpose of the prototype is to demonstrate the viability of applying modern communication technology to support older and/or ill individuals or couples to continue living in their home environment.

As this proposed effort is evolving, obtaining a fully functioning multi-platform software development environment is critical to mitigating the considerable risk of producing an agile software product that can be used in the full range of hardware platforms. Embarcadero appears to have in Delphi the multi-platform software development platform that will address this risk issue. However, as should be understood at this early stage of concept and prototype development, the schedule is notional provided as a preliminary step towards a full proposal once the precise risk elements concerning development time towards multi-platform software is fully understood. In other words, time estimates for tasks may be underestimated. The proposal which follows should be considered in the light of this evaluation for access to the best product suite which you deem appropriate and responsive.

The prototype multi-media design will consist of visual and auditory screens for general purpose communications including orienting and alerting tasks, such as upcoming appointments and reminders of scheduled medications as well as social, health, and safety alerts. This prototype will be used to establish the specific requirements for these communication interfaces and also to evaluate the overall design for home automation. Verification of notional designs will be continuously evaluated during the performance period. As a result, a refined notional design will be produced at the end of the requirements analysis, which will be formally evaluated. This proposal is comprised of five sections: benefits of communications technology support, program objectives, a technical proposal, a risk analysis, and a recommended schedule. Throughout the proposal the term “communication prototype” will be used to describe the Aging-in-Place proof-of-concept communication design.

**Benefits of Communications Technology Support**

Testifying to the Senate Special Committee on Aging in 2010, Dr. Mohit Kaushal, Health Care Director for the Federal Communications Commission reported that:

“Improving America’s health and America’s health care system is one of the most important tasks for the nation. Health care already accounts for 175 of U.S. gross domestic product (GDP) and by 2020 it will top 20%. This is due to many factors but one of the most important is that America is aging. There is a direct correlation between the elderly and chronic disease, which already account for 75% of the nation’s health care costs (citation). 5% of Medicare beneficiaries, who in most cases have one or more chronic conditions, constitute 43% of Medicare spending. By 2040, there will be twice as many Americans older than 65 as there are today …[in terms of reducing the cost of care while improving clinical outcomes] One study claims that remote monitoring could generate net savings of approximately $200 billion over 25 years from just four chronic conditions…Even though these technologies hold great promise, the US lags behind other developed countries in health IT adoption, with one study ranking it in the bottom half (out of 11 developed countries) on every metric used to measure adoption.” (Senate Report No. 111-17 (2010).

**Creating a Tailor-Made Technology and Integration for Communication**

In addition to health care benefits for aging Americans, providing the necessary tailor-made technology and integration for communication with friends and family will restore/maintain the social network bonds that contribute to dignity, personal effectiveness, and growth as people age, in addition to combating social isolation.

Just as important as creating a supportive environment as we age is to create an environment in which we as individuals and the collective community of family and friends thrive as we age. This distinction of thriving in our environment is the key difference between a traditional environment designed for the aged (i.e., nursing home) and the proposal here for aging-in-place. The key to such an environment is communication and the understanding of the pathways of communication by which we engage throughout our life to produce an intentional environment that supports these same pathways of communication when we are limited by living in a less mobile, more restrictive if you will, locale. Finally, we must create and support missing elements of situational awareness that we naturally loose as a consequence of aging (e.g., sense-losses of: short-term memory, processing speed in decision making, executive decision functions, auditory, haptic, etc.).

**Program Objectives**

A conceptual information processing model of aging-in-place defines pathways of communication by which a person engages in activities within the home. These communication pathways occur by discrete informational transfers from the external environment and via communication, within the community of family and friends. The figure below illustrates this.



The objectives below take into account each of the areas of functionality involved in aging-in-place, illustrated above, within the home environment.

* Provide the continuing stimulation of face-to-face interaction via video communication with family and friends
  + Feeling of “just around the corner” combats isolation and changes expectations, a sense that “my friends can stop by even though they are hundreds/thousands of miles away”
  + Impromptu conversations are possible
  + Advice seeking both from children and parents
  + Enriching day-to-day events and observations (e.g., “did you notice how cold it is out?” or “how about we cook a meal together?”)
  + Continuous appraisal of mental status
* Create a seamless communication dialog with family and friends
  + Lower technology threshold would allow parents to make and receive video/voice calls that achieve reliable contact
  + A ubiquitous consistent interactive display throughout the home would respect personal privacy and promote mutual trust between parents and children
* Provide remote training/retraining and development of skills for activities of daily living, as well as social sharing
  + Parents may need training in basic cooking techniques
  + Parents and children may set up the TV to watch a show together
  + Children might assist parents in browsing the internet for topics of interest – develop the skills to seek information
  + Loved ones may need retraining in previously mastered skills (i.e., forget how to use microwave, forget order / tasks involved in hygiene; selecting clothes to wear)
* Promote safety
  + Higher fidelity fall detection can combine home location / visual check and off-the-shelf fall detection systems (e.g., Philips Lifeline)
  + Intervention in potentially hazardous situations
    - Remote control of stove & emergency shut-off
    - Remote monitoring refrigerator/freezer (e.g., to prevent food spoilage)
    - Remote control/monitoring of heating, A/C
    - Remote monitoring for fire/C02
    - Remote monitoring for intrusion
  + Developing awareness of potentially unsafe conditions
    - Fuel oil might be low and depleted during very cold weather
    - Food stuffs could be low or improperly stored
    - Activity monitoring could indicate significant changes in pattern, which could mean a change in health status
* Promote heath
  + Physical/Nutritional
    - Providing dinner plans (e.g., “hey, let’s check out what you have in the fridge and come up with a dinner plan”)
    - Checking on activity level (e.g., “show me how that stationary bicycle is working out for you”
  + Medical
    - Troubleshooting side-effects of medications and difficulties in meeting compliance requirements
      * Suggestions in response to difficulty in swallowing pills (e.g., “it might be easier with Ensure”; “how about taking a small piece of ice and practice swallowing it first”)
      * Reminders of past effective strategies (e.g., “I think trying to take the pills with Ensure would work – you tried it yesterday and liked it”)
    - Maintaining contact with medical and other caretakers
    - Reminding about upcoming appointments
    - Verification of medical compliance – RFID authenticates dispensing of correct medication at the correct time of day with verification that medication is actually taken. For example, Tracking system verifies individual is at pill despensor, RFID authenticates and dispenses that individual’s medication and image capture at the time pills are taken showing placing in hand, then mouth, then swallowing.
  + Orientation to time, place, and situation
    - On-line large format calendar with today’s goals/appointments, which also indicates TOD (e.g., analog clock with AM/PM), interior/exterior temperature with forecast and environmental alerts (e.g., heating / air conditioning offline, fire, CO2)
    - Critical warnings (e.g., heating, A/C, fire, intrusion) could require acknowledgement within a prescribed time or help would be automatically dispatched. Warnings/ alarms, although handled by security systems, should integrate local / remote (e.g., cellphones) displays
* Promote enjoyment and goal setting
  + Encouraging engagement in targeted activities, based on measures of personal independence and desires for assistance/training structured by activities of daily living
    - A writer might want to compose a poem, read poetry, revise past work
    - A reader might plan to read a book chapter, browse through books, or read aloud to another (e.g., either in person or remotely)
    - A movie lover might plan to watch specific movies
  + Engaging in goal setting activities/training with decision supports, such as automated report of last action taken (e.g., “You left off this poem with…”), bookmarks, or a video message from a friend/family member (e.g., “I just read your latest draft and I like the direction you are taking with the image of snow falling at sunrise…perhaps next…..”)

**Technical Proposal**

**Task 1 – Conduct requirements analysis for interface prototypes**

**Duration –5 months**

In Task 1, the requirements for the communication prototype will be collected from a group of potential users who may be described as living socially apart from significant others or are socially isolated. Operationally the following factors will be evaluated for study inclusion: currently, or within several months, they are living alone for some or all of their day; they live at a distance from relatives and friends, that is, where travel to their living location is more than 10-30 minutes or is impractical (e.g., must be on duty at work or have practical limits in their ability to travel for face-to-face visits); they report a desire to be able to have a face-to-face communication with family and friends. It may also be the case that remote healthcare access would improve the individual’s quality of life and peace of mind.

Although there is no specific age requirement for inclusion, many, if not all, of the potential users will be likely be over 60 and some may be over 70-80. In addition, to be involved in the evaluation, potential users will need to meet entry level requirements for hearing, sight, mobility, and manual dexterity necessary to engage in the anticipated communication tasks (e.g., respond to visual and verbal cues, orient to sound direction, read and comprehend text presented on a computer display, adjusted to their visual acuity.)

A pool of ten individuals will be selected from the study members’ family and friends. Formal screening information will include, but not be limited to, tests of visual, auditory, haptic acuity, survey of activities of daily living, and a telephone, video and/or face-to-face semi-structured interview.

To guide the creation and critique of notional designs, a set of critical elements to the evolving design reference scenarios have been identified. These elements include the performance of tasks deemed critical to health and safety of the aging individual cared for within the aging-in-place framework. These will include:

* Waking up and preparing for the day
* Bathing and dressing appropriate to the environmental conditions
* Preparing meals and maintaining sanitary food preparation and storage conditions
* Responding to abnormal conditions and emergencies
* Responding to routine social contacts (e.g., answering the door, telephone, etc)
* Maintaining a safe environment in the locale (e.g., discriminating between friendly and potentially unfriendly callers and making appropriate social responses to unwanted help/contact and asking for help and alerting others of need for help in making decisions).
* Maintaining safe movement throughout the locale for self and not inflicting harm or harmful conditions that could impact others within the locale (e.g., rotting food left out; starting fires and/or releasing harmful chemicals into the locale).
* Responding to routine requests for status and location throughout the day
* Requesting timely aid and coordination with others to ensure personal goals are met
* Preparing for and successfully leaving the locale and informing others of intentions if that is part of the agreed upon shared commitments/communications with others.
* Preparing for rest and sleep periods.

Notional designs for the communication prototype will be evaluated by interviewees to help clarify requirements and may be produced jointly as part of the intake activities during the interviews. Initially, these will consist of paper-and-pencil notional designs and evolve to limited interaction designs. Specific test protocol content is TBD at the kick-off meeting.

At the conclusion of Task 1, the initial design concepts and approach to requirements for the communication prototype will be presented at a critical design review meeting with the research partners. The intention of this review will be to evaluate the initial design concepts and obtain the lessons learned from any comparable systems identified from existing systems developed by the research partners. Issues deemed critical for continuing work to fully develop the initial limited interaction interface with, at a minimum, the appearance and arrangement of the communication prototype will be identified and addressed.

**Task 2– Develop Prototypes  
Duration 5 Months**

In Task 2, an initial proof-of-concept, working prototype of the communications interface will be developed. This usable interface will employ a user-centered design approach that will involve proven techniques in identifying user information requirements through analysis, design, interface mockup, and revision cycles with key users. Major activities during this period will include:

* Review of operation requirements for existing communications, home automation, and security products (both off-the-shelf [e.g. Skype] and past work products of the research partners)
* Incorporation of the communication prototype user information requirements developed in Task 1

A method agreed upon with the research partners will be developed to obtain user feedback on the proof-of-concept. For example, a selected subset of the users initially visited on site and preferably within one day’s travel to Atlanta, Georgia, may be used to evaluate and refine this initial mockup. A second possibility is that key users supplied by the research partners may visit for a two or three day period of iterative design evaluation. From my experience, several rounds of evaluation and revision of the mockup would be typical. At the conclusion of the revisions, there will be three deliverables:

1. Operational hardware prototype beacon and gateway technology framework
2. A fully interactive prototype of the communications interface that runs stand-alone or with limited integration into existing home automation and security system work products
3. A draft design document summarizing the user needs analysis, functional description, and information requirements supported by these mockups

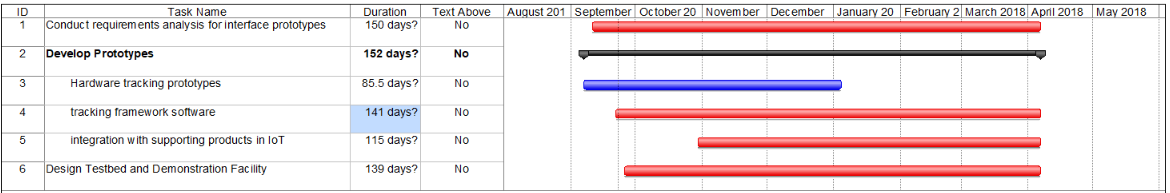
These deliverables will be presented at a formative design review with the research partners.

**Task 3. Design Testbed and Demonstration Facility**

**Duration –4.6 Months**

A design testbed may be developed to support Tasks 1-2 as a coordination and “what-if” interface software demonstration environment at a location to be agreed upon by the research partners. Early interactive concepts involving active portions of the communications prototype may be evaluated with scenario run-throughs defined in Task 1 and fielded for limited functionality, formative evaluation at a study participant’s home location. It will also be possible for this testbed to be included in a yet to be determined Demonstration Facility Homein a capacity agreed upon by the research partners.

**Proposed Schedule**

**Project Duration – 5 Months**

**Risk Analysis**

Each task has been reviewed for risks to product development on the critical path. In this section, each of these risks/risk areas are discussed.

* Selection of human interface multi-platform development environment (e.g., Windows ([x86](https://en.wikipedia.org/wiki/IA-32) and [x64](https://en.wikipedia.org/wiki/X64)), [OS X](https://en.wikipedia.org/wiki/OS_X) (32-bit only), [iOS](https://en.wikipedia.org/wiki/IOS) (32 and 64-bit), [Android](https://en.wikipedia.org/wiki/Android_(operating_system)) and [Linux](https://en.wikipedia.org/wiki/Linux) (64-bit Intel) will impact the time to development, cost of development, manpower requirements and feasibility.
* Definition of publish and subscribe messaging for beacon location updates within the operational space for the location-based tracking system can be based on more extensive P/S products by Gerth (IPC CAMX <https://en.wikipedia.org/wiki/CAMX>). Computer Aided Manufacturing using XML (CAMX) is a set of communications standards used to exchange data among manufacturing equipment and applications on the electronics manufacturing floor. CAMX defines both XML messages for encapsulating data as well as a protocol for exchanging those messages.
* Manufacture of beacons and gateways are expected to be produced in a low cost package where individual items will be less than $50 each as a target goal.

**Current Status of the Program Deliverables:**

* Fully functional hardware prototype tracking system has met its initial operational requirement and now is now being developed for 24/7 performance.
* Fully functional publish and subscribe message exchange with MQTT based on CAMX standards exceeds information requirements for message exchange. A down-selection of messaging is now being defined.

**References**

Center for Medicare & Medicaid Services, National Health Expenditure Projections 2008-2018, retrieved from <http://www.cms.hhs.gov/NationalHealthExpendData/downloads/proj2008.pdf> (last visited Jan. 21, 2010).

Darkins, Adam, et.al., (2008), Care Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions, 10, Telemed. & e-Health, 1118. Available at: <http://www.liebertonline.com/doi/pdf/10.1089/tmj.2008.0021>

Hearing on Aging in Place: The National Broadband Plan and Bringing Healthcare Technology Home,