Testimony Before the Senate Special Committee on Aging

Aging-in-Place

Carol Kim, Ph.D.

Vice President for Research, University of Maine

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Good afternoon Chairman Collins, Ranking Member McCaskill and Distinguished Members of the Senate Special Committee on Aging, my name is Dr. Carol Kim, and I am appreciative of the opportunity that you have provided for me to share with you the technologies that the University of Maine is developing to allow older individuals to age and thrive in place.

The University of Maine commends the Senate Special Committee on Aging for convening this special session on aging-in-place. It could not be any timelier. On May 14th, the University of Maine and its Center on Aging will also be holding a special full day clinical geriatrics colloquium entitled *There's No Place Like Home!,* that will explore the latest advances in aging-in-place.

We are convinced that the aging and thriving in place movement is destined to benefit greatly from the rapid deployment of technologies, products, and devices that: maximize human performance; improve mobility, navigation, home environments, and intelligent living; improve emergency detection and response; and contribute to older adult falls prevention, mitigation, and response. These are prominent and complementary research and development themes at the University of Maine. We have launched a major cross-campus aging research initiative in partnership with community agencies, organizations and businesses.

UMaine scientists are designing and testing products that maximize quality of life at home and in the community regardless of life stage, and that maximize the ability of older adults to:

1. Stay in touch with families, friends, and neighbors
2. Stay physically and mentally active
3. Maintain structure, identity and meaning in life
4. Engage in satisfying activities
5. Plan for secure and healthy futures
6. Preserve safety and well-being

Anyone can fall, but falls are a particularly significant issue for adults 65 and older. Medical and health conditions such as glaucoma and age-related macular degeneration, osteoporosis, poor balance and lack of physical conditioning, the effects of medication, and physical and mental frailty negatively impact older adult visual acuity, postural stability, and balance. In 2010, the National Center for Injury Prevention reported that 9,146,026 people were treated in emergency rooms for unintentional falls, with individuals 75+ experiencing the highest rate. Among the 65+ population, 30% to 40% experience a fall each year. There are major physical and financial costs associated with older adult falls. Injuries sustained commonly include hip fracture and can hamper independent living and result in an increase in the risk of depression, premature institutionalization, and death. For older adults, falls are the leading cause of injury-related death. By 2020, injuries that result from falls will cost the U.S. almost $54.9 billion dollars. UMaine research aims to have a positive impact on older adult quality of life, well-being, and safety while reducing the frequency and severity of falls, thus lessoning the burden and financial cost placed on hospital emergency rooms, primary care, and the long-term care system. UMaine has established an interdisciplinary gerotechnology research incubator that is responding to this and other major public health issues that affect aging Americans.

1. <u>Home Safety Optimization and Falls Prevention</u>

We are developing technologies to promote mobility, avert falling, increase contrast sensitivity, improve proprioception and balance, and foster proper medication adherence and management, incorporating the use of wireless detection sensors. We are also developing new delay-tolerant, wireless networking technologies with wireless

detection and vital sign sensors to accelerate response time and access by first responders after a fall has occurred.

a. Edge Detection

One of the most common challenges that occurs with age is a loss of visual contrast sensitivity. This can be extremely dangerous for older adults as it turns commonplace low-contrast features, such as cement stairs, curbs, or benches into falling hazards. Indeed, accidental falls lead to more than 20,000 deaths per year and medical and healthcare costs of over $30 billion annually. Current solutions to the low-contrast falling problem involve using bright, high-contrast markings to distinguish potential hazards, e.g. the edges of subway platforms. While these techniques are an excellent solution for drawing attention to the hazard and limiting falls for older adults and travelers, who are usually multi-tasking as they walk, it is simply not practical or cost effective to paint high contrast lines on all potentially dangerous edges in the environment. Our goal is to improve safety and reduce falling via a cost-efficient solution that can be implemented without any infrastructure build-out. To do this, we are exploring the use of computer vision to detect low-contrast edges in the environment and improve their visibility. This is done using an algorithm that analyzes the contrast of a live video feed, and once a relevant edge is detected, superimposes virtual highlighted edges onto the physical environment so they now “appear” to have a salient high-contrast marker. This augmented reality solution relies on cameras mounted on the front of a head-mounted display, but as camera and display hardware become smaller we can mount the augmenting hardware on simple glasses. This system provides an extremely cost effective solution to the growing and costly problem of accidental falls by allowing older adults to easily identify and avoid obstacles that they may otherwise fail to observe while walking. As our system is augmenting the visual information that is perceived from the physical environment, it can also be used to convey and enhance other environmental cues that are hard for an older adult to access, such as magnifying text on signs. The novelty of our early-stage solution is that it is self-contained, meaning that it does not require any resources to implement in the environment, and it has a high likelihood to solve the falling problem as it is optimized to address known perceptual

and cognitive changes that occur with age, such as reduced visual contrast and limited attentional demands, which are two of the main causes of falling.

b. Indoor Navigation

People want to remain in their home as they age, however, this can pose problems as the normal loss of sensory, cognitive, and motor function as people age can lead to many safety risks for an older adult living independently. These risks are magnified for people who are geographically separated from their support network as it is difficult for a friend or family member to check in on an older adult living on their own. This is especially true in Maine, which is large and sparsely populated. Current responses to this concern involve installation of expensive and obtrusive video monitoring technology or an alarm trigger such as LifeAlert that requires the user to be conscious and physically able to activate the device. Our goal is to develop a low-cost system that is non-intrusive and allows the older adult to retain their dignity without feeling that they are being watched, while still giving their support network a mechanism to check in and monitor their behaviors and important daily activities. We have recreated a typical apartment setting in which we test a new extensible system. Our system makes use of miniaturized and low-cost technology such as RFID tags and Arduino controllers. RFID tags emit no signals and require no power, so they can easily be embedded into the physical structure of an apartment — under carpets, behind the paint on walls and ceilings, etc. Typical RFID reading devices are used in commercial applications and so are typically large, with individual units the size of a hair-dryer, but our device is small and designed to be worn comfortably by an individual. The system tracks the user's location as they move about their home and sends alerts if a problem is detected. For example, if the user hasn't moved in several hours a text notification is sent to the caregiver. With the addition of an accelerometer we can detect if the user falls and whether or not they get back up, allowing alerts to be sent to caregivers even if the user is unconscious or otherwise unable to communicate their situation.

Because this system does not rely on cameras or visual tracking, it maintains the user's privacy and dignity. Databases can be used to monitor regular activity and to better

identify causes for concern, and preferences can be set to alert multiple contacts. When integrated with other household items and embedded sensors, the older user could be further assisted in other facets of daily living. For instance, if the stove is left on and unattended for a set amount of time it will automatically shut off and send an alert to the user or a caregiver. The next iteration of development is to implement a hazard detection component to the system to assist users with finding objects or avoid hazards in the house. For instance, RFID tags can be affixed to many objects in the house and individually tracked. For instance, a remote interface could be used to find misplaced keys based on the unique RFID tag and let the individual know where they are located within the home. Alternatively, the system could be used to warn the older adult of in-home obstacles — pets, shoes, cords, moved furniture, etc. This system could greatly reduce in-home falls and improve safety, well-being, and independence.

UMaine's ongoing programs in the research and development of new technologies and products to assist aging individuals are critical to the needs of our aging population. The participation of older adults in consumer focus groups and continuous field testing will insure that the technologies developed are responsive to the needs and wants of this target demographic and the settings in which these products will be utilized. Consultations with medical specialists in geriatrics will insure that technology development is informed by the physical/mental health dimensions of the aging experience and clinical geriatrics best practices.

c. Assistive Jogger

Although durable medical equipment (DME) such as walkers, crutches and canes is available to those who need it, DME is minimally functional for outdoor exercise, and is perceived as stigmatizing and inconvenient. Therefore, many people who would be unsafe without such equipment abandon it, withdrawing from exercise and movement, the primary and sometimes only strategies that can benefit them. Created to fill an unmet need for populations who, without adequate mobility support would be less likely, fully unable, or unwilling to participate in ambulatory exercise, the assistive jogger was developed and is currently in the early phase of commercialization. The assistive jogger

is an aesthetically designed, convenient, foldable, actively steered, three-wheeled standing support device that provides balance and weight bearing assistance during walking, jogging/ and or running. It is fitted with biofeedback and innovative load sensing technology.

d. Mattress Pad

This collaborative research explores early sleep-related movement (SM) dysregulation as a sentinel marker of emerging cognitive decay in the aging population, with the goal of identifying individuals in need of sleep disorder intervention to halt this process. Accurate analysis of body movements, changes in heart rate and respiratory patterns and identifying subtle periods of arousals during sleep reveals important information about brain activities and cognitive changes. Collaboration between Psychology and Electrical Engineering departments led to development of a highly sensitive prototype to wirelessly record high frequency, ultra low amplitude time series of the aforementioned indicators for mild traumatic brain injury (TBI) diagnostics. This early prototype was funded by the US Army for veterans and is now being expanded for athletes. This research project builds on the same concept to create a new product for an aging population. Sleep fragmentation associated with aging dampens the brain's protective system, making its monitoring and early detection a priority. Another consequence of brain hypo-perfusion during sleep is cognitive loss, particularly in aging individuals when neurological decay of sleep-wake function is progressive. Elderly adults (60-80 years) with a recent (< 6 months) history of fall, and diagnosis or rule-out for TBI, will comprise the study sample. The proposed home sleep study can be conducted over two nights in the participant’s bed using our noninvasive device embedded in a mattress cover, eliminating the need for costly and invasive sleep lab studies. Data collected and transmitted wirelessly for analysis with our patented time series algorithms can identify changes in brain activities and cognitive degradation at early stages. This low cost, innovative device is capable of detecting signs that are not observable otherwise, while lowering health care cost and improving the quality of place-based aging.

2. Falls Mitigation and Impact Minimization

We are developing technologies, including advanced protection gear and energy-absorbing clothing, that employ non-stigmatizing designs to minimize injury as a result of falls.

a. Head protection

According to the U.S. Center for Disease Control more than one third of adults 65 and older fall each year. Although fall prevention in the elderly population is one of the major public health initiatives, in 2013 over 2.5 million people over the age of 65 were treated in hospital emergency departments for moderate to severe injury from falling. In 2010, direct medical costs of falls was approximately $30 billion. Every year, between 700,000 and 1.0 million patients suffer a fall during their hospital stay (Agency for Healthcare Research and Quality), and the average increase in hospital operational costs due to these fall injuries exceeds $13,000 and patient lengths of hospital stay (LOS) increases by an average of 6.27 days. With the average charges for a TBI hospitalization at about $17,500, which may not be reimbursed if Medicare deems the fall-related injury as a preventable event; an estimated cost of more than $1 billion in direct hospital expenses will result.

The team at the University of Maine is currently working to develop non-stigmatizing protective gear as a viable method to mitigate injury for persons at risk for falls. We are working in conjunction with James R. Ferguson of Alba-Technic, LLC, Winthrop, Maine, who holds U.S. and European patents on the highly effective impact resisting material system that is used in protective gear to mitigate the deleterious effects of impact due to falls. Alba-Technic, LLC and the University of Maine are currently focusing on the development of protective headgear and have recenlty initiated an effort on non-stigmatizing hip protection. The development of the headgear was supported by a National Institutes of Health/National Institute on Aging SBIR Phase I/II award, the Maine Technology Institute (MTI) and currently by a National Science Foundation STTR Phase I award under the small batch manufacturing program. We were also awarded a showcase at the upcoming Techconn event in June 2015. Under the NSF award,

advanced manufacturing techniques are being used to create a contoured impact-resistant structure for the headgear, where the shape of the internal impact resisting system is designed for fit, aesthetic appeal, function and comfort and then covered with a fabric material that can be selected by the end user.

Alba-Technic's SMARTY® concept offers a headgear option for older adults that is designed to be integrated into fashionable headwear, while providing protection against head injury. The fact that this technology is lightweight and can be incorporated into caps, scarves, hats, etc. is important, given that commercially available products are bulky and draw attention in an undesireable manner. Additionally, focus groups of experts in healthcare of older adults and end-users expressed that the technology would only be worn if it looked like typical headwear. In a recent social marketing and consumer preference trial conducted by UCLA in a Southern California older adult community, the prototype SMARTY® product demonstrated a significant increase in acceptance as measured by a pre-post attitudes questionnaire.

Performance of the headgear is of utmost concern. At UMaine, a test apparatus based upon the Hybrid II head/neck assembly was fabricated to assess head protection. Performance tests demonstrated a significant potential for reduction in head injury, as indicated by the Head Injury Criteria (HIC). This study predicts that an unprotected impact resulting in a HIC value of 1854 reduces to 533 and 231 for Smarty Designs A and B, respectively. Measuring the likelihood of injury based on the anatomical injury scale, the headgear reduces from AIS-5 (Severe head injury and possible coma) to AIS-2 (concussion) or AIS-1 (headache and dizziness) depending on design. In summary, use of the headgear reduces a significant injury to a relatively minor one.

b. Hip protection

Falls are the most common cause of traumatic brain injury, however, falls also result in a significant number of hip fractures. For example, in 2013, 258,000 patients were admitted for treatment of hip fracture. Hip fracture in older adults is one of the major causes of death and disability. The Hip Project proposes to expand the benefit of our

current research and development in head protection to innovative, wearable hip protection for elders. Although fall prevention in the elderly population is one of the major public health initiatives, over 2.5 million people over the age of 65 were treated in hospital emergency departments for moderate to severe injury from falling. Of those, 258,000 were admitted for treatment of hip fracture in 2013. Within one year post-insult, 20% die and 30% of community dwellers are placed in nursing homes. Protecting the hip from fracture is therefore a critical need not only to preserve aging-in-place but for many, to avoid secondary injury, illness, and fatality. Current hip protective gear is bulky and unsightly, leading to its non-use. The objectives of this research and development agenda are the development, fabrication, testing, and commercialization of an aesthetically pleasing hip protection system consisting of undergarments and a changeable, fashionable shell for women and men that will be accepted and regularly donned by older adults at risk for falling.

3. <u>Driving</u>

a. Driving Simulator

Driving is one of the most important aspects of an individual's independence. Unfortunately, it is also one of the most dangerous practices for older adults, with people over 85 being four times more likely to be involved in a fatal accident than teenagers, the next highest group. To address this growing problem, we are exploring ways to keep drivers in our aging populations safer by: 1) better characterizing the situations where accidents and other dangerous driving events occur; and 2) developing new compensatory techniques to provide key information to help reduce these events. To this end, we have built a driving simulator specifically designed for aging adults. Using a combination of actual vehicle hardware and a head-mounted display we immerse the driver in a virtual car and driving environment. Our research has shown that driver behavior in these simulated, virtual environments resembles driver behavior in actual situations in that results gathered by conducting classic driving tests and experiments in the driving simulator match those found for actual drivers. One outcome is that potential answers to problems faced by aging drivers can be tested virtually before being physically produced, allowing for faster, safer, and less expensive

research and development. Our current area of testing examines the use of augmented reality to overcome the problem of older adults being unable to see or identify road signs and markings. By superimposing highlighted and higher-contrast edges on these signs and magnifying them, they become easier for the driver to see and identify. These augmentations can be projected onto the windshield and focused in accordance with the perspective of the driver. Continuing research will determine what specific method of augmentation is best. The next major step in our research in aging and driving is studying how augmented reality can assist in location and identification of landmarks which will put our work on the leading edge of this curve.

In closing, I would like to thank the Committee for the opportunity to describe some of the exciting and much needed technologies we at the University of Maine are pursuing to improve the quality of life for our older population – and I am ready to answer any questions you may have regarding this national imperative.