Home Fire Prediction smartphone app for the elderly that alerts them when there is fire/smoke in their home

Patricia La Madrid
20002594
Western Sydney University, Australia
20002594@student.westernsydney.edu.au

INTRODUCTION AND MOTIVATION

Senior citizens, people aged 60 years old and above, (Cassidy et al., 2021, Salman et al., 2022) have higher risks of dying or being injured by fire in their houses due to poor physical condition, mental health, or behavioral causes (Karemaker et al., 2021) like the use of sub-standard household electrical devices/equipment (Karemaker et al., 2021, Cassidy et al., 2021). Necessary precautions should be in place to keep safe elderly people from being victims of fire-related incidents (Karemaker et al., 2021). Alarms used should be functional aided by advanced technologies and should be in the living room or bedroom as most fire fatalities occur in these locations (Cassidy et al., 2021). Smartphones play an important role in older people's lives but available smartphones have user interface that are complicated as they were not created for older people but primarily for youngsters (Awan et al., 2021). The elderly have difficulty in using recent technologies due to sensory functions, mental models, memory decline, physical abilities, cognitive, and age-related problems (Awan et al., 2021). Furthermore, the software design of the smartphone apps was not based on the user needs and requirements of older people (Awan et al., 2021). The purpose of this project is to create a home fire prediction smartphone app for the elderly using Artificial Intelligence techniques and will alert older people when fire occurs in their homes or that of their neighbor's; thus, preventing fire-related injuries or deaths.

LITERATURE REVIEW AND RELATED WORK

According to Karemaker (2021), senior citizens have little information regarding house fire safety as their know-how is limited on what can cause fire or the time fire might happen. Psychological factors including habits, self-efficacy, perceived barriers, and risk perception are discovered to affect older people's behavior regarding fire safety measures (Karemaker et al., 2021). They install smoke alarms in their homes or prepare escape route plans as fire safeguards (Karemaker et al., 2021). The study of Cassidy (2021) showed that fire usually started in the bedroom or living room where most dead victims were found. Most of the elderlies who died had working smoke alarms in their homes which made individuals in the area knew of the fire but they failed to alert the fire service quickly (Cassidy et al., 2021). This means that people nearby can help by alerting the fire service immediately once they become aware of a fire in their property or that of their neighbor (Cassidy et al., 2021). Moreover, there was proof that the elderly had constant communication with at least one person in the neighborhood before the fire occurred (Cassidy et al., 2021). The most known contacts were the elderly's carers, neighbors, and family members, and in 43.4% of the incidents these people discovered dangerous behaviours before the deadly fire (Cassidy et al., 2021). These behavioural aspects which are frequent sources of home fires are cooking, smoking, and utilizing defective electrical appliances (Cassidy et al., 2021). Almost 50 percent of the elderlies who died were in the room where the fire occurred (Cassidy et al., 2021). Fire safety strategies fail at times when the attitude of the elderly are hard to change or physical smoke detectors are not available (Cassidy et al., 2021). Those people who have constant communication with older people should become fire safety advocates and should have the proper training and education to prevent fire fatalities among the elderly (Cassidy et al., 2021).

The progress in smartphones is essential in people's daily lives for their computational power and connection (Awan et al., 2021). A smartphone is touch-based mobile phone/gadget that provides telephony functions as well as offers modern features and services that are used for integral functions such as voice-and-and-text-communication and up-to-date functions including photo taking and web surfing (Salman et al., 2022). It is the most-used gadget worldwide and consists of adaptive features wherein the interface of the mobile phone adjusts by itself with no human control and helps the user such as LED notifications, face recognition, voice commands, screen rotation, drive mode, kid mode, swift keyboard, S-health, gesture recognition, and fingerprint (Alghamdi et al., 2022). For a user to communicate with smartphone devices, the user interface (UI) is designed to be the space where users can perform numerous activities (Salman et al., 2022). Majority of the existing smartphones have complex user interfaces (UIs) that the aged population find hard to navigate (Salman et al., 2022). Older people want to use smartphone apps for maintaining quality life but due to the complicated interface, they are unable to enjoy the benefits (Awan et al., 2021). Technology has limitations in evaluating the elderly users' needs, lifestyle, and expectations; it is essential to carefully examine the requirements and needs of older people in the development

OzCHI '15 , December 07 - 10 2015, Melbourne, VIC, Australia
Copyright © 2015 ACM 978-1-4503-3673-4/15/12... $15.00
http://dx.doi.org/xx.xxxx/xxxxxxx.xxxxxxx.DO NOT DELETE BOX

and design stage of a smartphone app (Awan et al., 2021). The study of Awan (2021) shows fifteen usability barriers concerning older people in the use of smartphones which include: 1) Small font size, color contrast, buttons, font type, and screen size; 2) Problems concerning menu and navigation; 3) Not having enough knowledge and experience; 4) Soft keys, drag and drop, and multitap; 5) Design of the smartphone device; 6) Visual feedback from the system; 7) Icons not having labels and unrecognized icon size; 8) Smartphone text entry and text input; 9) Menu with excessive choice and navigation problems; 10) Insufficient evidence in the smartphone's reliability and effectiveness; 11) Not enough understanding; 12) Difficulty to read and understand the content due to poor readability and visibility issues; 13) Internet connection and the price of the smartphone device; 14) QWERTY keyboard and touchscreen; and 15) Complicated interface and operations. For these issues, it is essential to have software update, enhanced interface of the navigation objects, training programs with the mobile apps that deal with the unique needs of the elderly, adding the semantic details of the icons and putting labels on them using words to describe their functions, user-friendly touch screens for the elderly, bigger font size for the text button while text input button must be aligned for readability purposes, make the elderly familiar with the technology, make the elderly overcome their fear of being "scientific-programming-awkward" as well as fear of making errors and help them to utilize new technologies (Awan et al., 2021). Out of the 15 barriers, the greatest critical values belong to the 1) color contrast, buttons, font type, screen size, and small font, and 2) complex interface and function which means that these two issues must be taken seriously to lessen the usability problems in smartphone apps for elderly users (Awan et al., 2021).

Video-based-fire-detection is used as the model technology today because of Artificial Intelligence (AI), computer vision, and image processing and it has quick feedback as well as larger coverage of detection (Saponara et al., 2021). Conventional fire or smoke sensors that are developed using chemical detection/thermal/photometry have the ability to respond within a few minutes but need a huge quantity of smoke or fire to activate the alarm (Saponara et al., 2021). Furthermore, these sensors are unable to give details concerning the fire size as well as fire location and are unable to operate on the outside setting (Saponara et al., 2021). The advancement of state-of-the-art camera-based-solutions enhances the ability of the system not to fail and the quality of being trustworthy by adding what is needed from the existing detection systems to make them complete (Saponara et al., 2021). Saponara (2021) suggested a smoke-and-fire-detection video-camera-based using YOLOv2 Convolutional Neural Network (CNN) model which has a quicker performance when it comes to image processing. Through this type of speed, fighters are notified of smoke/fire incidents in real-time and they will be able to act immediately (Saponara et al., 2021). The aim of their study was to create smart Internet of Things (IoT) devices that recognize/detect smoke/fire inside and outside a building or home (Saponara et al., 2021). Monedero (2019) also proposed Wildfire Analyst Pocket (WFA Pocket), a fire prediction smartphone app to be utilized by the firefighters to help avoid human deaths, enhance the purpose of the starting attack and comprehend better the probable behavior of fire, and lessen the multitude risks for the fire fighters. It detects fire spread and the progression of the fire in the field precisely in real-time. It uses famous mathematical models including: a) surface fire spread, b) basic surface fire spread, c) flame length and fireline intensity, d) fireflame residence time, e) maximum spread direction, f) ellipse model, g)adjustment factor of the midflame wind , h)thirteen standard fire-behavior-models, i)forty standard fire-behavior-models, j)crown fire spread, k)critical surface intensity, l)crown-fire-rate-of-spread, perimeter, and area , m)crown fire flame length, n)power of the fire and wind, o) separation distance and safety zone size, p)crown scorch height, q)ignition probability, r)other models, s)fire-dead-fuel-moisture-tables, and t)canopy data. WFA Pocket is available for both android and iOS users and can be used offline or online (Monedero et al., 2019). While these technologies for predicting fire looks promising, further research is needed. Saponara (2021) will expand their studies to connect their suggested system to iCloud storage facilities to check the visual status of smoke or fire virtually and the research study of Monedero (2019) will be used to examine the fire regime and ecological processes.

BENCHMARK DESIGN

There are fire prediction apps for bushfires and smart home fire prediction apps in the playstore and appstore but there are no fire prediction mobile apps for home fire created specifically for the elderly. There are also safety apps for senior citizens but they are not really intended for home fires. The services these apps offer are for the elderly's medical issues, physical injuries, and other emergency matters. The smartphone applications that will be the benchmark of my software design are Google Nest, Snug Safety, and Fire Guard.

Google Nest

The Nest app of Google through its Nest Protect feature (2nd generation) can detect smoke/fire using the Split Spectrum smoke sensor. The carbon monoxide and smoke alarm can think, talk, and notify the smartphone. This app is available in the App Store and in Google Play. Nest Protect has the following functions: 1) gets a notification if Nest Protect detects carbon monoxide or smoke but an internet connection is necessary for this feature, 2) safety history that records the notifications and the reason for the notifications, 3) Safety Checkup that checks all the user's alarm at the same time, 4) presents the status of the sensors, internet connection and batteries, 5) voice and light notifications, and 6) Pathway light. Other features of the Google Nest App are: 1) Nest Thermostats – they program themselves and allow users to conserve energy, 2) Nest Secure Alarm System – 24/7 home security and provide homeowners notifications on their smartphones if a window/door was opened or a someone is entering a room inside the house, 3) Nest Cam IQ Indoor and Outdoor – security cameras that allow homeowners to check the inside and outside of their homes 24/7, 4) Nest Hello – has an audio detection and 24/7 video streaming feature to

inform homeowners know who is knocking at the door or who rang the doorbell, and allow homeowners to quickly reply to the visitors using pre-recorded audio messages, and 5) Nest x Yale Lock – a lock that ensures that the house is locked and it also provides notifications if a person locks/unlocks the door. The app does not constantly track the GPS of the homeowner but only receives alerts if the homeowner is already at home or is still away using Home/Away Assist. One user complained that the smoke and carbon monoxide sensor is great but the app is not working completely and customer support is not good. Other users also complained that Google Nest: 1) has a terrible user interface as it contradicts itself, 2) is constantly buggy, 3) facial recognition is inconsistent and inaccurate, 4) costly, 5) camera keeps on freezing due to internet connection problems. The developers should reduce the price of the app so that other people can try the product. Also, for the app to attract users, additional sensors are needed to make it work. The developers should also fix the complicated user interface and the small fonts to make the app elderly-friendly.

Snug Safety

It is a free smartphone app that consistently checks the situation of elderly people living alone by texting them daily. If the elderly will not reply and check in at their regular time, emergency contacts are notified to check on the concerned senior citizen/s. The users complained of signing up issues, poor integration, lack of advanced features; app is only available for the North American market, poor usability, and poor UX design. It has the following issues: 1) Consistency – the app is unresponsive to some customers, especially the new ones. It should text the customer once the customer is registered in their system and check on them daily but the app is not doing what it is supposed to do, 2) Feedback– when the user uninstalls the app, it still sends messages to the user. The app has a problem of feedback because even if the user does not like to use the app anymore by requesting that the app be uninstalled, the app does not stop texting the user, and 3) Affordance – the app has a poor UX design and the elderly have difficulty using the app. Senior citizens are old already so the app should have icons that give visual hints so that they find the app very easy to navigate. It could have been better if the: 1) The app should verify the phone of the user either by sending a code to the user's phone number or email or using an authenticator app, 2) the developers should fix the installation process to fix the integration and use of the app, 3) Advanced features should be added. UI design should be redesigned. There should be a live chat box so that if there are problems, the user will be able to reach the customer support in real-time, 4) Fix updates so that it will be able to recognize the number registered, 5) Fix the system updates and provide a clear instruction regarding the use of the app depending on location. If possible, it should be available to other countries outside North America, 6) User should be able to receive notification/s once he signed up for use of the app. Make sure that notifications being sent to users are valuable to them, 7) The app should automatically stop texting the user if the user uninstalls the app, 8) Should be able to work on android and apple, 9) The app is designed for senior citizens so it should consider senior citizens' needs and behavior. Familiar navigation patterns and recognizable icons should be used. Users should be able to know where they are just by looking at the screen, and 10) The app should stop messaging the user after the app is uninstalled. Must also provide clear instructions regarding user information after app uninstallation or app inactivity.

Fire Guard

Fire Guard is an effective and easy-to-understand fire risk assessment smartphone app. It is only available for iOS users and is specifically designed for iPad that enables users to evaluate their full fire risks. It can be used without an internet connection but if a user has completed his assessment and wants to export it using PDF, only then that an internet connection is required. It was created through the help of people with exceptional knowledge in the field to make certain that the app is competent and has excellent quality. Users can add information such as location, type of building, and floor space. For additional information, users can add photos. After a user has finished answering all the questions, he will be taken to the "Final Severity" section providing him a score for his final assessment. He can pdf export his fire risk assessment for his records or can send it to anyone as an email. It is a great app with great features, but is expensive, only available in the UK specifically designed for the workplace, and is not created for the elderly. It could have been better if the app has the following attributes: 1) the fonts are larger so that it will be readable and helpful to the older people, 2) one question at a time with straight-to-the-point details, as well as multiple-choice style of answering questions, 3) easy to use interface, 4) the elderly should be able to see the content because of the good choice of colors used, 5) free app, 6) available in other countries as well as to both android and iOS users, and 7) could be used to assess the fire risks in resident homes. According to reviews, the app has several bugs that destroy the user experience. One user explained that after he filled the address and information of a new premise, Fire Guard suddenly crashed on the home screen of his iPad. He reinstalled the app multiple times, and the developer addressed the bug and updated the latest version. The developers of the app listen to their users and correct errors accordingly.

My desired system is a smartphone app that can effectively notify the elderly of the presence of fire/smoke in his home or nearby surroundings. The app will help them to take proper. The app should be simple and easy to understand as the senior citizens are already old. It should notify them before the fire becomes big. Some senior citizens are living alone so when there is a fire, there's no one to alert them. Due to mobility issues, they might not escape the fire quickly. It becomes a problem when the fire causes injuries or death to them. I would like to add the following features in the app:

1) Smoke-and-fire-detection video-camera-based using YOLOv2 Convolutional Neural Network (CNN). When a smoke/fire is sensed by the app, it will send a real-time notification message to the elderlies, their families, or their carers. Voice command adaptive feature can also be used for faster alerts.

2) Features found in Nest Protect such as the a) voice and light notification features if smoke fire is sensed, b) safety history, and c) safety checkup.
3) Audio detection like the feature found in Nest Hello but this feature will examine and recognize sounds related to fire such as sounds of smoke alarm or those coming from what are being burned
4) Should be able to track the location of the elderly using GPS (global positioning statement)
5) Messaging app that daily checks the condition of the elderly and asks the situation of the home similar to the features of Snug Safety but advanced features will be added. If the homeowner is not responding in the regular check in, emergency responders will check them physically in their homes. Even if advanced features will be added, the app will be user-friendly to the aged population using simple and easy to use interface, familiar icons labeled with words, friendly touch screens, larger font size, easy to read fonts, good color contrast, and larger buttons. Live chat should also be found so that anytime/anywhere when the elderlies need help, they will be able to contact the customer service of the app.
6) Fire risk assessment app upon installation of the app to evaluate the condition of the elderly's home and fire tips will be included to prevent future fire. The content of this assessment is clear and concise; thus, enabling the elderly to understand it.

DESIGN STATEMENT

To design a home fire prediction smartphone app for the elderly using AI that will alert them of a fire in their home or in their neighbour's property to prevent fire-related injuries or deaths.

PERSONAS

Name	Lauren Smith
Age	73 years old
Gender	Female
Education	Business graduate
Motivation and Frustrations	Lauren is a widow living alone in an aged-care housing area in NSW. She had only one son who unfortunately died at the age of 10 years. She has a brother and a sister who together with their families visit her a few times a month. At her age, being a senior citizen, she knows how to operate a smartphone as the granddaughters and grandsons of her brother and sister taught her how to use her very first smartphone and fix tech problems concerning her smartphone or computer. She is close to them. She suffered from a mild stroke 7 years ago but she is doing okay now. She religiously checks the food that she eats and every day she walks around her neighborhood. She goes to the shops to buy her daily needs. She also cooks, does the laundry using a washing machine, washes dishes, and cleans her house. She only knows little about fire safety and does not know how to act when a fire will happen in her own house. Lauren is scared that a fire might start in her home due to a short circuit, a stove she forgot to turn off after cooking, or a burning neighbour's house. No one will be able to help her instantly because she lives alone. She wishes for an app that will alert her of a smoke in her home before the actual fire engulfs her house. The app will be a big help for her to escape injuries or death.

Table 1. Persona 1.

Name	Peter Park
Age	82 years old
Gender	Male
Education	High School Graduate
Motivation and Frustrations	Peter is an 82-year old living with his 80-year-old wife in their own home in NSW. He is a responsible husband and a father. They have 3 daughters who are married and have their own families. Two of them are in Western Australia while one of them lives in another suburb near their home. Both Peter and his wife do not know how to operate smartphones. Peter only uses a mobile phone to contact his daughters and their families. But recently, a daughter bought him a smartphone that he can use for a video call. The daughter is teaching him basic information on how to navigate the smartphone easily. Peter's wife developed dementia 2 years ago so he takes care of her. Peter is not that strong as well. He has mobility issues and cannot walk fast. He has high blood problem as well. But he does not have any serious illnesses. Peter does not know what to do when a fire breaks out inside their home as his wife loves candles. Every night she lights a candle.

	Peter is afraid that their home might be burned because of the candle. So he makes sure that when his wife is in her deep sleep, he turns off the candle to prevent any fire from happening. If there is an app that will alert him that there is fire in their home or notifies 000 immediately so that the fire service can help them right away and he and his wife will be spared from being fire victims.

Table 2. Persona 2.

CONCLUSION AND FUTURE WORK

Since elderly people are exposed to fire hazards, there is a need to be constantly aware of the surroundings, whether physical, social, or behavioral for the elderly and those who are concerned about their safety. On iOS and Android, there are no home fire prediction apps intended for the elderly to help and protect themselves when fire occurs in their homes. A small number of research studied the usability of smartphone apps for the elderly but no research article really dwelt on fire prediction app for home fires of the elderly. What were found were only those for fire prediction app intended for bushfires and home fires for the general users. This fire detection smartphone app being designed is intended to alert the elderly of the presence of fire inside the his home or nearby surroundings to prevent injuries or death. To solve the problem of the elderly, the smoke-and-fire-detection video-camera-based using YOLOv2 Convolutional Neural Network (CNN) will be adopted. The voice and light notification features, safety history, safety checkup, audio detection, location-based services, messaging features, live chat, real-time notifications, fire risk assessment, fire prevention tips, emergency contact information will also be adopted from Google Nest, Snug Safety, and Fire Guard. Usability smartphone app features such as elderly-friendly user interface, friendly touch screens, larger buttons, easy to read fonts, bigger font size, familiar icons labeled with words, and good color contrast will also be implemented. For future studies, researchers and app developers can further improve user interfaces and advanced artificial intelligence methods that will better accommodate the elderly when there is fire in their home.

REFERENCES

ALGHAMDI, A. M., RIASAT, H., IQBAL, M. W., ASHRAF, M. U., ALSHAHRANI, A. & ALSHAMRANI, A. 2022. Intelligence and Usability Empowerment of Smartphone Adaptive Features. *Applied sciences,* 12**,** 12245.

AWAN, M., ALI, S., ALI, M., ABRAR, M. F., ULLAH, H. & KHAN, D. 2021. Usability Barriers for Elderly Users in Smartphone App Usage: An Analytical Hierarchical Process-Based Prioritization. *Scientific programming,* 2021**,** 1-14.

CASSIDY, P., MCCONNELL, N. & BOYCE, K. 2021. The older adult: Associated fire risks and current challenges for the development of future fire safety intervention strategies. *Fire and materials,* 45**,** 553-563.

KAREMAKER, M., TEN HOOR, G. A., HAGEN, R. R., VAN SCHIE, C. H. M., BOERSMA, K. & RUITER, R. A. C. 2021. Elderly about home fire safety: A qualitative study into home fire safety knowledge and behaviour. *Fire safety journal,* 124**,** 103391.

MONEDERO, S., RAMIREZ, J. & CARDIL, A. 2019. Predicting fire spread and behaviour on the fireline. Wildfire analyst pocket: A mobile app for wildland fire prediction. *Ecological modelling,* 392**,** 103-107.

SALMAN, H. M., WAN AHMAD, W. F. & SULAIMAN, S. 2022. A design framework of a smartphone user interface for elderly users. *Universal access in the information society*.

SAPONARA, S., ELHANASHI, A. & GAGLIARDI, A. 2021. Real-time video fire/smoke detection based on CNN in antifire surveillance systems. *Journal of real-time image processing,* 18**,** 889-900.