# Minimising false alerts in telecare with the use of Augmented Communication Technologies

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**Abstract:**
The use of augmented communication technologies is well established in retail and entertainment, however their application within the health and social care sectors is still emerging. Amongst other things, augmented communication technologies have the potential to improve telecare services and address challenges faced including minimising the number of false alerts generated. This methods paper explores the development of a defined function (skill) for the Amazon Alexa which is integrated within an existing at-market health and social care software platform. The skill was developed to enable users to vocally trigger an alert. However, in its current form, this development was limited by a lack of provision for push notifications which would enable the user to confirm an alert is genuine to minimise the number of false alerts triggered. Further capabilities are also explored including self-reported health tracking. Future development must address technical and social barriers including privacy and security concerns, integration and user identification.

**KEYWORDS:** Augmented Communication Technologies, Telecare, False Alerts, Health and Social Care

## 1. Introduction

Augmented communication technologies are integrated software and device applications that have the ability to recognise and understand natural language, offering an intuitive way to interact with technology [1]. Examples of augmented communication technologies include smart speaker-based systems such as Amazon Alexa, Google Home and Apple HomePod which users can interact with using their voice and access a variety of functions [2-3]. In the UK, almost four million of these devices were sold in 2017, with Amazon Alexa holding the largest market share [3, 8]. Ownership of these devices in the UK has continued to grow, with the devices mostly used to play music, answer general questions, set alarms/reminders, and receive live news/weather updates [4]. Whilst the use of devices is well established in retail and entertainment, there are many opportunities for leveraging the technology for health and social care [2, 5-7].

Though these systems cannot currently be used as clinical devices [5] there are already some instances of successful uses of augmented communication technologies in healthcare. Web MD have utilised Amazon Alexa to allow users to vocally self-report their symptoms to gain insightful information about them. AstraZeneca have also announced an Amazon Alexa skill in development which will coach someone suffering from a heart attack, aimed at patients who have a history of heart problems, and can also coach family members when their relative is having a heart attack [9].

However, security and privacy concerns are reported relating to the use of these devices including device access [3], information security associated with vocal reporting [10], device hacking, and lack of control over the information stored by the device [7, 11]. These concerns are likely to be amplified with application to health and social care, particularly in relation to the accuracy and security of personal data.

Despite these concerns, there is great potential for augmented communication devices to be utilised within health and care monitoring and response services to improve the quality and cost-effectiveness of services. Social care monitoring and response, otherwise known as telecare, systems provide a framework for remote monitoring of an individual or their environment to manage the risks of independent living [12]. Telecare monitoring is generally continuous, automatic and involves the use of sensors [5] to detect movement, falls and flooding [12]. However, telecare systems in their current state produce a high number of false alarms, with reports of up 79% in some services in the UK [13]. False-positive alerts, where alerts are raised and a situation of concern does not exist, can be raised due to high sensitivity of telecare alarm devices [14]. False-positive alerts require resource and create noise in the system which can prevent real alerts from being addressed [13].

Telecare alerts currently require manual resolution which can be resource intensive including scenarios such as the unnecessary deployment of trained personnel in a vehicle to a remote community setting. Use of augmented communication devices such as the Amazon Alexa have the potential to provide an inexpensive solution to support telecare services and minimise the number of false alerts triggered. The devices can be used to interact with patients to determine whether alerts are likely to be genuine before an alert is acted on. Further uses could also include interaction between patients and healthcare professionals, integration with Internet of Things (IoT) devices [15], medication reminders, health tracking [9], health information and improving independence [17].

This methods paper describes the technical development of an augmented communication solution integrated into an at-market health and social care platform to improve telecare services and minimise the number of false alerts incurring costs.

## 2. Methods

A prototype solution was developed for Amazon Alexa and integrated into an at-market health and social care platform, Lincus. Lincus is a CE Marked Class 1 medical device which is used for health and care management. Lincus also enables alerts to be configured, with this feature leveraged for Amazon Alexa integration to allow users to control alerts remotely.

The initial build of the solution was developed using Amazon Web Services (AWS) in Java to allow collection of input and output data. A library was created in PHP to read and verify the input and structure the output. A codebase was created in PHP to authenticate and process the JSON message sent from the Amazon Alexa device, and this was directly integrated into the Lincus platform.

An application ID [18] was developed to authenticate the skill accessing the Amazon service, with unique request verification signatures being passed alongside application IDs to minimise risk of brute force attacks and credential stealing.

In addition, an OAuth 2.0 server was used to provide Access Token/Refresh token grants to Alexa from user accounts on Lincus. An access token relates to a specific user and grants 24 hours access to the Lincus platform. The access token is sent with every request sent from the Amazon Alexa, if the access token is missing then the user is not authenticated and must login to Lincus to access the system. This reduces the risk of data being attributed wrongly to a Lincus user.

An account linking card is provided by Amazon and this must be shown to the user if the user has not yet linked their account. A card is a visual representation that is used to enhance a voice experience [16]. Cards appear in both the Alexa app or on an Echo Show device. Users enter their Lincus credentials, whereupon an authorisation grant is created in Lincus to trigger the creation of an access and refresh token. These tokens are passed into Alexa, and the access token must be sent back to Lincus with every piece of data passed into the system from Alexa, to tag the data to the correct user and prove that Alexa has permission to insert data into their record, effectively tying together the Lincus and Alexa accounts of teach user. Once the access token has expired, Amazon will make a request to refresh it using the refresh token. If the refresh token is still valid, a new access token and refresh token pair is returned to Alexa for use.

As seen in figure 1, a user is able to trigger an alert using an Amazon Alexa. The user is required to link their Alexa account with their Lincus account. Then they are able to say the following phrase to trigger an alert on the Lincus Platform: *“Alexa tell Lincus to trigger an Alert”.* Alexa will then prompt the user to give the alert a name. This name can be any value however, it must be noted that it will be transmitted in plain text (with no security) so should not include personally identifiable information.

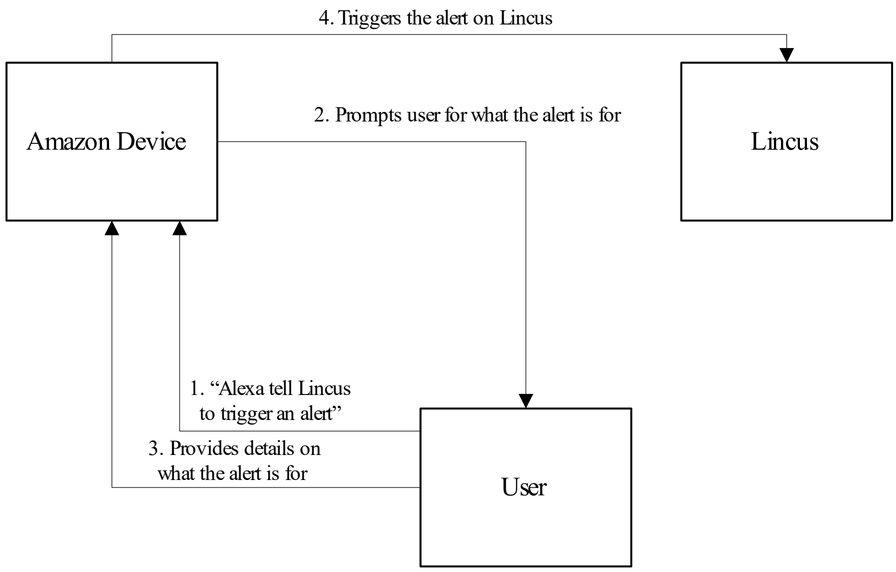


**Figure 1: The workflow of initial prototype created. A user triggers an alert followed by the Alexa system enabled device prompting the user for more information. The user provides further detail so the alert can populate a health and social care application such as Lincus, used in this implementation. Depending on functionality the health and social care application can then inform permitted and relevant stakeholders so the reason for the alert can be addressed and resolved.**

Formal or informal carers that have access permissions are also able to see and resolve alerts which have been setup by an Alexa device on behalf of users on Lincus. They are able to see if the alert has been triggered using an Alexa device, or has been triggered through algorithms running inside the Lincus system, and can decide whether an intervention is needed. They are also able to resolve the alert on behalf of the user if they have the required permissions.

This integration also enables the user to track their wellbeing by vocally completing a "wellbeing survey" with the Amazon Alexa. These surveys measure the user's subjective view of their own wellbeing in different areas of their life by answering questions rating for example their mood, energy levels and quality of sleep from bad to good. To do this, the user would start a Wellbeing Survey by saying the following to an Amazon Alexa: *"Alexa tell Lincus to start a wellbeing survey".* The user is then prompted with a set of questions which they must answer with a numerical value – often between 0 and 10.

With the current integration, the user must start the alert process by triggering the alert on the Alexa device (the alert is triggered if the answers to the numerical questions are below a certain level). This limits the integration to only be able to alert when the user is capable to trigger the alert. If they cannot verbally communicate, no alert will be triggered. Alerts can also be triggered automatically inside Lincus, based on sensors in the user's house on or their person, but there is no way to then trigger Alexa to ask the user for their feedback.

In the latter case, to trivially trigger a notification remotely on a custom device, a cURL message could be sent to the device from the partner system. cURL is a library designed to allow the transfer of data over multiple different protocols [18]. This message will contain the location of a sound file for the device to play. When the device receives the message, it will play the sound file to alert the user using the device. This sound file could be a recording of someone talking. For example, it could be someone saying: *"You have triggered an alert on your telecare system. Do you require help?"*.

Once the user receives this notification, they can start processing the alert by confirming, denying or ignoring the notification. If, however, the Alexa device receives no response, it must be decided that the patient is unable to communicate, and the alert should be triggered regardless, or in some circumstances escalated. This method can in effect be used as an initial triage of the user's situation.

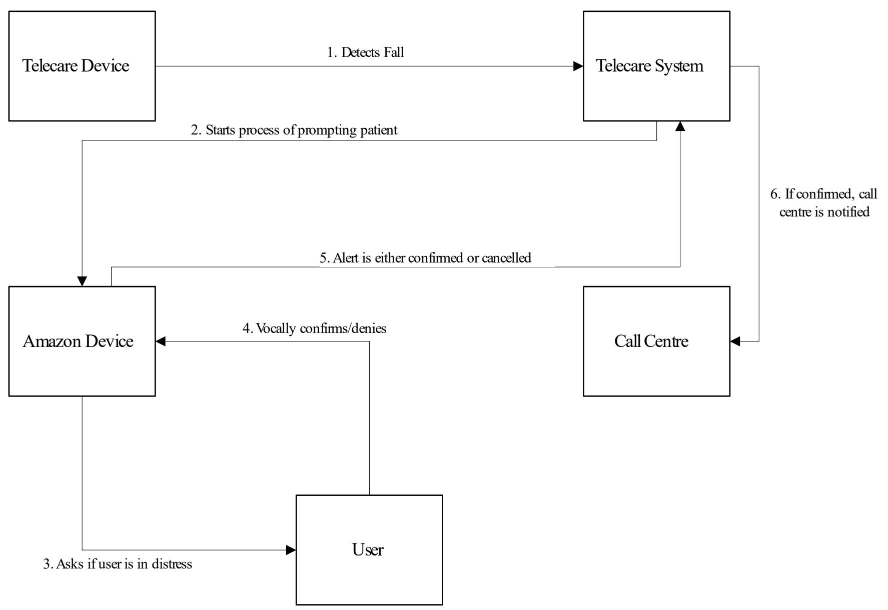


**Figure 3: Workflow of a more optimised solution using Augmented Communication Devices. The example as illustrated pertains to fall detection utilising a telecare device which detects a fall. This triggers a fall event within the telecare system which then relays the message to the Amazon Device where a skill has been implemented to confirm whether the user has had a real fall event. If there is either a positive response, no response or an ambiguous response the alert is triggered. If the user states it was a false alarm then the alert is cancelled and the call/response centre not notified.**

## 3. Discussion

This paper has documented a potential application of augmented communication devices to improve telecare services by offering an intuitive way for patients to interact with technology [1]. The solution extends the capabilities of augmented communication devices, which are well established in retail and entertainment [4] to provide a cost-effective and scalable solution for telecare. However, alongside the benefits associated with this development, there are also numerous technical and social limitations which must be addressed [10].

Following the development of the prototype solution, it is clear the use of this technology would not replace existing telecare systems but build on and enhance the capabilities of these systems. In its current form, the solution requires the user to start the alert process by triggering an alert vocally using the Alexa device or manually using the Lincus platform. This limits the usability of the Alexa system for confirmation of alerts from third party devices, such as fall detectors.

The lack of provision for push notifications at the date of publication means the device cannot be used to request confirmation of alerts once they are triggered. This significantly limits the utility of the solution for minimising false alerts within telecare systems. To fully realise alert confirmation functionality, the system must accept third party generated notifications. This will lead to enabling users to confirm whether an alert is genuine before it is triggered to telecare services. Alternatively, a custom device must be created that can accept both Amazon Alexa commands and calls from other systems. Factors such as whether the user is able to respond to a request in an emergency, and appropriate escalation of the alert in response must also be considered.

Barriers associated with the implementation of the solution are both technical and social, including privacy concerns, user identification, verification and security. Security and privacy are key concerns reported with smart speaker devices such as Amazon Alexa as anyone with access to the device can gather information and ask it to perform tasks [3]. Amazon Alexa also has the provision for multiple users to use the same device which may impact the accuracy and security of data. Though changing users can be done vocally [19] there may be wider data privacy and security implications. One method to address this issue is using voice recognition, where users are able to set up and teach Alexa their voice to detect which user is using the device. Utilisation of this feature would partially address user verification. Amazon Alexa also provides the option to set voice passcodes [20], however passcode security may be compromised when saying the passcode out loud.

A more comprehensive system verification is required to be developed for health and care applications that will seamlessly yet robustly confirm the individual who is commanding the system is the correct individual whilst minimising the risk they have had their privacy compromised. We suggest that fusing a combination of active, such as vocal responses, and passive, such as voice, wearable or biometric, verification techniques could be a promising area of development to pursue to address subject identification issues.

For full health and social care monitoring function smart speaker devices would ideally be listening at all times to allow user response. Whilst these devices are not recording unless a command is spoken [3] there are concerns relating to data privacy including unauthorised access, device hacking and lack of control over what information is stored [7, 11]. There must also be consideration around the information that can be accessed using the device and ensuring personal information is not revealed in public. Users may not want to reveal personal information vocally, which may impact their use of the device including lack of or inaccurate reporting of information [10]. Physical and technical controls must be applied prior to implementation and use with personal information [3].

Further barriers include user adoption and resistance to using the device which may be impacted by usability of the solution, privacy and security concerns [10]. However, ownership of devices such as Amazon Alexa continues to grow [4] which may suggest increasing acceptance of the devices.

Integration with existing telecare systems and smart devices to enhance telecare monitoring. and reliability of the devices must be considered for future developments [10]. Further developments may also benefit from trigger escalation, alert triage, and user identification and verification methods.

Realisation of this solution in its fully integrated form would improve telecare services and reduce the cost and resource associated with a high number of false alerts generated which require human intervention, and ensure availability of resource to address real alerts [20]. Additional development of augmented communication technologies including device integration, health tracking, patient and health professional communication, and information provision have the potential to transform health and social care services further.

## 4. Conclusion

Adaption of augmented communication devices for health and social care monitoring and response services has considerable potential improve their quality and efficiency. In this paper, the development of a prototype solution to improve monitoring and response services by minimising the number of false alerts triggered has been described. The paper outlines a method for triggering alerts with integration into an at-market platform for health and care management. However, in its current form, the solution lacks provision of push notifications which limits the utility of the solution for minimising false alerts. Whilst there are benefits associated with the development, there are other technical and social barriers and limitations including privacy and security, user identification, and integration which must be addressed prior to implementation for health and social care services.

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