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Smart Phone App to Prevent Sharing Microphones in The Covid-19 Era

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Abstract: Any smart phone can now be turned into a sound capturing device because of its built-in microphone. The ubiquity of smart phones expands the number of people able to participate in meetings. This paper presents methods and results of a sound capturing system capable of functioning as an ad-hoc microphone that feeds into a public address system. The Recursive Waterfall approach guided the design and implementation. The system comprises of Wi-Fi-Mic mobile app and Wi-Fi-Mic server app, both developed using Java. The Wi-Fi protocol was adopted to link the two apps so as to accommodate many participants. The traditional cables can be used to channel sound from the server app into a public address system for additional sound amplification. Results show that, when used with an external microphone (mouth-piece), this system can achieve performance nearing that of a typical wireless microphone.

Key words: Acoustic sensing, Audio systems, Bring Your Own Device, Mobile computing, Meeting support system.

I. INTRODUCTION

Meetings are a crucial component of human existence. Meetings provide avenues for man to communicate verbally and nurture social relationships with other meeting attendees (Xu, Yu, Wang & Ni, 2014). In a large gathering, a public address (PA) system is usually needed to obtain input sound from microphones, musical instruments, acoustic sound source, or recorded sound.

Thereafter to amplify the sound; and finally project the sound through loudspeakers. A microphone is the sensing unit that captures human voice or other acoustic sound source. Without amplifying the input sound other meeting attendees would have difficulty following what is going on. In some large meetings, the microphones provided are:

- Not portable – thus requiring meeting attendees wishing to make contributions to manoeuvre to the nearest microphone stand.
- Fewer than the number of speakers/participants – thus requiring microphones to be passed around to whosoever wishes to speak per time.

Such practices can lead to: a lot of time being wasted trying to access a microphone so as to make a contribution; participants jousting for attention thereby disturbing the audience; loss of audience control; and possible disruption of the underlying meeting. In this era of COVID-19 pandemic, such practices can lead to an increase in the risk of exposure.

In several countries, COVID-19 outbreaks have been linked to large gatherings, such as religious events, sporting events, social events, youth camps, conferences, and exhibitions. In the absence of a vaccine, event organizers must take reasonable steps to reduce the risk of infection. As part of the measures necessary to reduce the risk of infection, the government and public health authority in several countries demanded that event organizers of large gatherings comply with the following (NCDC, 2020 Jun 13):

- Attendance should not exceed 1/3 of sitting capacity.
- Attendees should be made to sit and maintain two metres distance from each other.
- Practices that require direct contact (e.g., handshakes, hugs, and kisses) should be discouraged.
- Practices that require sharing of materials (e.g., microphones, communal cups, ablution kettles, and offering trays) should be limited.

There are two established media through which audio signals are channelled: wired (corded) and wireless (cordless). In the wired media, sound waves are transmitted as pulses through cables (wires); whereas in the wireless media, sound waves are transmitted as radio waves through air. All the processes that enable audio signals to be sent or routed over a media to a receiver over a given distance is referred to as sound channelling (Abubakar, 2009; Zhu, Liu, Yu, Pfeffer, Dave & Nam, 2004). Basically, sound channelling refers to the uni-directional transmission of sound from transmitter to receiver.

A typical wireless microphone uses radio waves that operate in the Very High Frequency (VHF) or Ultra High Frequency (UHF) band. One common problem with wireless transmission, especially in the VHF band, is noise. The audio quality is susceptible from interferences from nearby electronic devices that have transmitters such as other wireless microphones and mobile phones. This can be overcome by switching to relatively newer options for wireless communication over a short range, such as Wireless Fidelity (Wi-Fi) and Bluetooth.

There is an abundance of personal smart mobile communication devices in the market at the present time. The term 'smart' is used here to denote that an end user can install his/her preferred mobile applications in addition to the bundled mobile applications. Examples of such smart mobile communication devices include: smart phones, personal digital assistants (PDAs), tablets, notebook computers, and laptop computers. Many of these devices come with Wi-Fi and Bluetooth communication capability as a standard feature.

For several years now, the practice referred to as Bring Your Own Device (BYOD) has witnessed an increase in adoption in several organizations. Employees are provided with avenues to use their own personal smart mobile communication devices in formal work environments to carry out several tasks including syncing with their work emails, syncing with their work calendars, editing Word documents, compiling Excel spread sheets, preparing PowerPoint presentations, and assessing corporate data (Ogie, 2016). This enables the organization to derive various benefits, such as: increased productivity, improved employee satisfaction, cost savings, and increase in revenue (Pelino, 2012).

Although smart mobile communication devices are ubiquitous, they are largely under-utilized. Many users focus on the primary functions and ignore or are ignorant of the derivative or ancillary capabilities. A typical smart phone is packed with several sensors that can be re-purposed to meet diverse needs with the use of clever software applications (apps). This research work explores sound channelling from a smart phone's built-in microphone sensor to a Wi-Fi connected personal computer (PC) for onward amplification through a public address system.

II. STATEMENT OF PROBLEM

Many of us walk around with sophisticated mobile devices which are equipped with diverse sensors. However, we hardly exploit the capabilities of these sensors to tackle some of the common challenges that confront us. One challenge we frequently face is the need to capture, channel, amplify and project sound in large gatherings. This work seeks to tackle this challenge by developing an app that extends the functionality of our smart phone's in-built microphone beyond merely enabling telephone conversations.

III. OBJECTIVE

The aim of this research is to develop a system for capturing sound through a smart phone's microphone sensor and channelling of the sound through a wireless connection to a computer acting as the server for onward transmission to the amplifying and loudspeaker units of a public address system.

The proposed system comprises of a mobile app developed on Android Studio and native app acting as the server developed using Java.

IV. RELATED WORK

This section details some of the efforts by researchers to re-purpose the built-in microphone in smart phones for derivative or ancillary capabilities. Xu, Yu, Wang and Ni (2014) proposed a smart phone-based meeting support system, named *SmartMic* that connects to a wireless speaker via Bluetooth connection or directly to an amplifier using the 3.5mm jack port. Meeting attendees were to speak through their smart phone instead of the traditional public address microphone. The system was designed to readily integrate with common facilities available meeting venues. Their preliminary experiment results showed that the system supported easy participation of meeting attendees, enhanced user experiences, facilitated social interactions, and increased the meeting productivity.

As a consequence of its use of the Bluetooth communication protocol, only 10 meeting attendees can connect per time; and the coverage area is restricted to 100m. This work attempts to resolve these challenges by proposing a system that utilizes the Wi-Fi communication protocol. Celestina, Hrovata and Kardous (2018) observed that there are many sound measuring apps for various mobile platforms in the market but only a fraction of these apps achieve results near enough to that obtained from professional sound level measuring instruments.

In their paper, they developed a sound level meter app and also presented methods and results of calibrating the app according to relevant ANSI (American National Standards Institute) and IEC (International Electrotechnical Commission) sound level meter standards. They reported that, when used with an external microphone, their sound level meter app can achieve compliance with most of the requirements for Class 2 of IEC 61672/ANSI S1.4-2014 standard. Picaut, Fortin, Bocher, Petit, Aumond and Guillaume (2019) proposed an open crowd-sourcing method for the assessment of noise in an environment.

This solution comprised of a smart phone application and a spatial data infrastructure specifically developed to collect physical data (noise indicators and GPS positions) and perceptual data (pleasantness) from the environment. Although any number of contributors could use the proposed system, results of higher relevance were achieved when the approach was restricted to a limited number of supervised contributors.

V. METHODOLOGY

The Recursive Waterfall Model guided the sequence of processes and procedures relied upon for the design and development of this work. The Recursive Waterfall Model was adopted because it allows a loop to the previous levels of operations so that changes can be effected whenever the need arises.

VI. CONCEPT DESIGN

The proposed system, called *Wi-Fi-Mic*, consists of two components as shown in Fig. 1: the Android-based mobile app that captures sound using the built-in microphone or a mouth-piece attached to it through the 3.5mm jack port; and the native app acting as the server that resides on a laptop/PC to receive the audio signal transmitted wirelessly to it from the smart phone for onward transmission to the amplifying and loudspeaker units of a public address system.

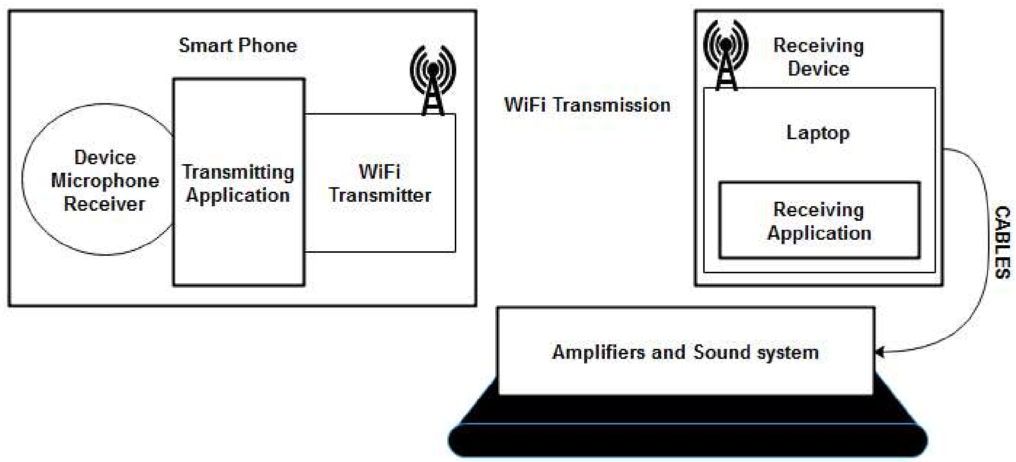

Fig. 1: Architecture of *Wi-Fi-Mic* System

Although Unified Modelling Language (UML) is not a method or procedure for system development, it can be used with any software development methodology to simplify the overall comprehension of a proposed system. Fig. 2 details the flowchart that guided the development of the *Wi-Fi-Mic* system.

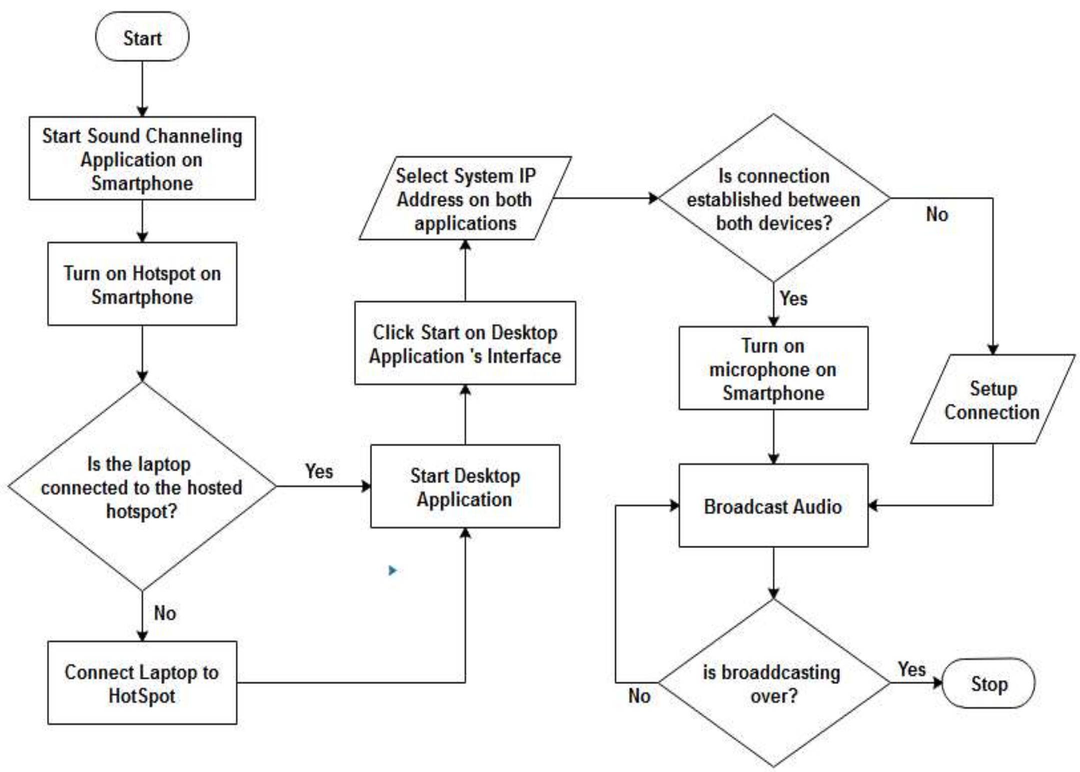

Fig. 2: Flowchart of *Wi-Fi-Mic* System Operations

The *Wi-Fi-Mic* server app (see Fig. 3) was developed using Java on the NetBeans Integrated Development environment (IDE). The server app will run on a computer which has the following minimum requirements: 32-bit or 64-bit Windows Operating System, 1.0 GHz of processor speed, 1 GB of random access memory (RAM), and screen resolution of 800 x 600 pixels. The *Wi-Fi-Mic* mobile app (see Fig. 4) was developed using Java on the Android Studio (version 3.3). The smartphone app will run on Android phones with a minimum requirement of: Operating System – Ice Cream Sandwich, Android Version – 4.0, Memory (RAM) – 500MB, CPU Frequency – 1.3 GHz, Internal Storage – 1 GB, Screen Resolution – 854 x 480.

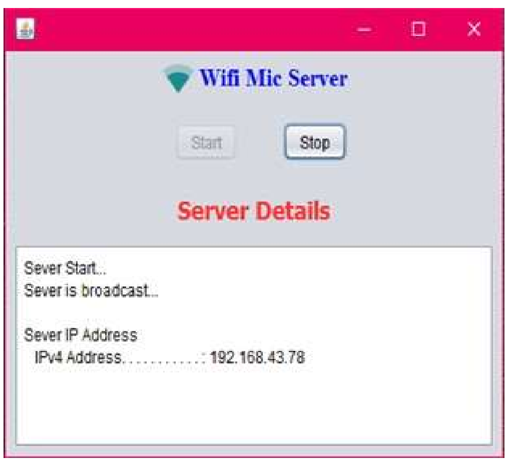

Fig. 3: Wi-Fi-Mic Server Set-up

Fig. 4: Wi-Fi-Mic Smartphone Set-up

VII. DISCUSSION OF FINDINGS

Upon launching the *Wi-Fi-Mic* server app, the user is taken to the server set-up screen. Similarly, upon launching the *Wi-Fi-Mic* mobile app, the user is taken to the client set-up screen which prompts the user to establish a connection with the server by either connecting with available servers that have been automatically discovered or by providing the Internet Protocol (IP) Address of a hidden server. User authentication was not incorporated in this prototype. The system is designed to allow any meeting attendee with access to the Wi-Fi network to connect.

Experimental findings showed that more than 10 participants were able to connect simultaneously to the Wi-Fi-Mic system than would have been possible if the Bluetooth communication protocol was used. In addition, the audio quality was comparable to that of a standard wireless microphone despite some of the meeting attendees being more than 20 meters from the Wi-Fi router.

VIII. CONCLUDING REMARKS

Most people today carry around their own personal smart mobile communication devices. These devices can be made to serve as *ad-hoc* wireless microphones that channel acoustic sound into a public address system so as to encourage and enable active participation of meeting attendees in small, medium or large gatherings, either through speech or singing. By choosing to use Wi-Fi as the communication protocol, the system was able to accommodate a larger number of meeting attendees simultaneously; a wider coverage area; and greater flexibility in the freedom of movement of meeting attendees.

IX. CONTRIBUTIONS TO KNOWLEDGE

This study has demonstrated that utilizing a smart phone's built-in microphone as an ad-hoc wireless microphone for channelling sound into a public address system is readily achievable. The study has also highlighted the possibility of scaling up the number of active meeting attendees by deploying a Wi-Fi connection rather being restricted by the limitations of Bluetooth connection.

X. RECOMMENDATION AND FUTURE WORK

In compliance with the measures necessary to reduce the risk of exposure to infectious diseases such as COVID-19, the use of a smart phone's microphone as an *ad-hoc* microphone can serve as a means of limiting the sharing of microphones in large gatherings. In this prototype, user authentication was not incorporated. In future work, it should be incorporated to ensure that only authenticated meeting attendees are allowed to connect to the server app. This will prevent the meeting from being usurped by detractors.

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