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Smart earphone: Controlling tasks by earphone in smart phone by gesture of the user

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Abstract

Earphones are widely used to listen to audible sound. Various researches to improve sound quality are in process like noise reduction etc. But in this invention earphone has capacitive touch sensors which can detect the skin of the user, and from the various combinations of output coming out of the sensors many task can be operated in the host device. Authors propose that in this invention various tasks of the host devices can be controlled by the earphone on movement of the speaker of earphone, on touching the speaker of the earphone by finger, on plugging the speaker of the earphone in the ears, on plugging out the speaker of the earphone in the ears. Using this technique Authors have implemented that a smart earphone system can be used to make the earphone from task oriented to multitasking by different gestures of the user.

Keywords: Android app, ATMEGA 8, Capacitive touch Sensor, Microcontroller, Smart phone.

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1. Introduction

Technology is the key to enhancing the quality of life for everyone in the continuum of life (Park and Jayaram, 2003). Earphones, computers, smart phone have become common in our life in various forms with ubiquitous and wearable technology and devices (Kidd *et al.*, 1999). Earphone are used very commonly in general life now, even it is a very essential part of the mobile phone, but earphone only changes signal into audible sound to the user. Authors propose that in this invention many of the general tasks which are important while speakers of the earphone are plugged in the ears performed smartly by the user without opening the host device and also without pressing any external input button (Brumitt *et al.*, 2000). For example if a user is listening to music via earphone now if user wants to pause the music user has to open the host device or press a button given in some earphones but in smart earphones user just has to plug out the speaker of earphones from the ear, music will automatically paused and then if user plug the speaker of earphone in ear, music will start playing. Many tasks like changing music tracks, increment or decrement in volume, fast forward or fast rewind of any track and many more tasks can be performed without opening the host device or pressing any button in earphone (Vatanparast *et al.*, 2007).

2. Construction

Figure 1. ATMEGA 8 Microcontroller

In this earphone there are capacitive touch sensors. Two or four capacitive touch sensors are there according to how many task has to be completed by the host device via earphone without opening host device or touching button on earphone. Using two capacitive sensors less task can be performed and by using four capacitive touch sensors more tasks can be performed by the host device.

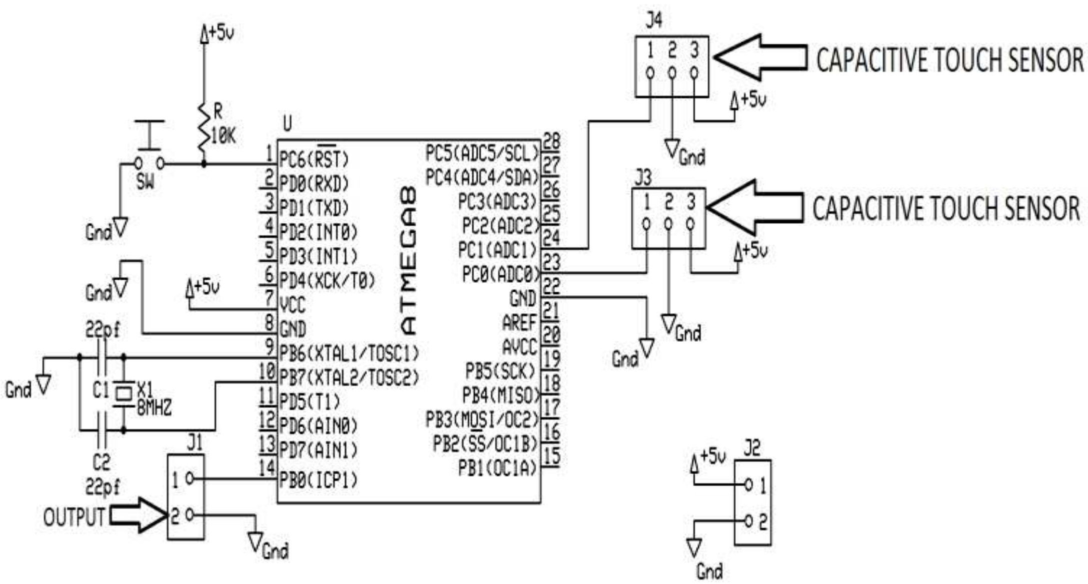

Figure 2. Hardware connection with ATMEGA 8

Figure 3. Output from the Microcontroller attached with Smartphone

2.1 Hardware Construction: The position of capacitive touch sensor if two capacitive touch sensors are used then on both the speakers of the earphone a sensor is placed as shown in Figure 5 or in Figure 6 (in figure shown only one speaker same configuration for the other speaker of the earphone) Figure 5 type is easy to manufacture but Figure 6 type will be more efficient. The position of capacitive touch sensor if four capacitive sensors are used then two sensors are attached to the speaker as in Figure 5 or Figure 6 and two additional sensor as shown in Figure 4 (in figure shown only one speaker same configuration for the other speaker of the earphone). Now the output coming out of the capacitive touch sensors will go to input port of the microcontroller. In simple words output coming from the capacitive touch sensor will become the input of the microcontroller. Now the output of the microcontroller goes to the host device. Any microcontroller can be used. Author have used ATMEGA8 microcontroller. It is 28pin low cost microcontroller with 5V dc supply 512bytes EEPROM.

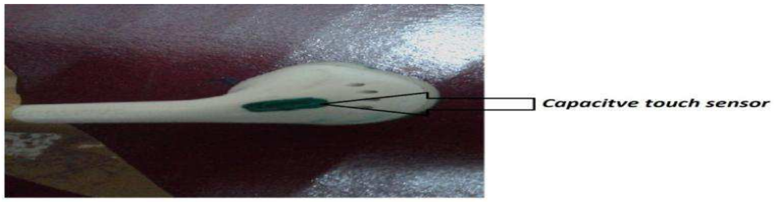

Figure 4. Capacitive Touch Sensor on speaker

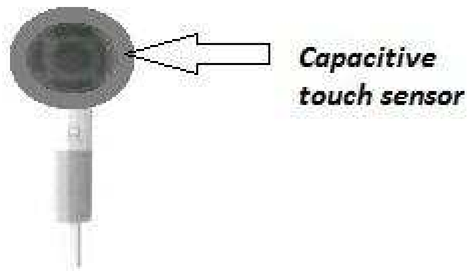

Figure 5. Capacitive Touch Sensor front position

2.2 Software Implementation: Software or an App has to be installed in the host device which can detect the output of the microcontroller and according to the output of the microcontroller it can control the host device like playing music, pause music, next track, previous track, increase volume, decrease volume, fast forwarded the track, fast rewind the track and many tasks. An android app can be made for android smart phone. Many apps are also there in Google play store which can control the signal like headset droid, headset button controller which controls the button given in the earphone by double clicking the button and additional feature.

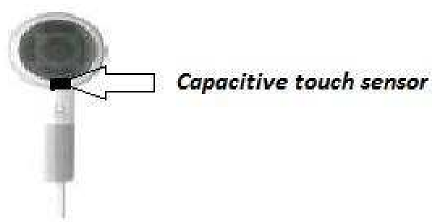

Figure 6. Capacitive Touch Sensor back position

3. Design

The design of the smart earphone is just like a normal earphone. The only change is it has now capacitive sensors in it. In four capacitive sensors earphone two capacitive touch sensors are there in a single speaker of the earphone. One of the sensors is placed in a position so that it become high or in simple language sensor is touched when a user plug the speaker of the ear phone in the ear, as shown in Figures 5 and 6. Now the second sensor is placed in the position so that it do not get high or in simple language touched by the user skin when the speaker of the earphone is placed in the ear as shown in Figure 4. In two capacitive sensor earphone each speaker has one capacitive touch sensor, which is placed such that when the user plug the speaker of the earphone in the ear it gets high or in simple words the skin of the ear get touched to the sensor, as shown in Figures 5 and 6. Position of both the capacitive sensor in a single speaker is shown in Figure 9. This technology comes under wearable technology. As wearable technology becomes increasingly common on the commercial market, social wear ability is becoming an ever-more-important variable contributing to the success or failure of new products (Dunne *et al.,* 2014). The "wear ability" of wearable technology addresses the factors that affect the degree of comfort the wearer experiences while wearing a device, including physical, psychological, and social aspects (Dunne *et al.*, 2014). So on making design of this device wear ability is a big issue.

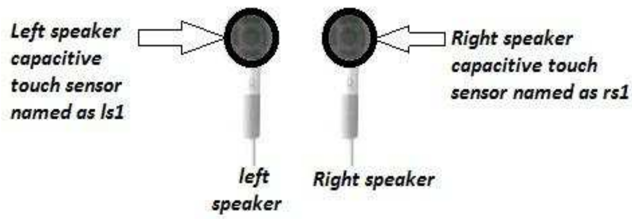

Figure 7. Front view of Speaker

4. Capabilities of smart earphone

Now the most important part capabilities of this earphone, in two capacitive sensor earphone, there is a sensor which gets high when the user plug the speaker of the earphone in speaker. If we use the two capacitive sensor earphone then user wants to pause the music, user has to just plug out any of the two speaker of the earphone from the ear then music will pause after a short time interval, then if again user plug in the speaker of the earphone in ear, device starts playing the track. If user wants to change the track of the music to next or previous, there are two speakers one is at right and other at left, if the user plug out the right speaker from the ear and plug it in the ear in a very short time interval then music track changes to the next track, and if the user plug out the left speaker and plug it back in the ear in a short time interval music track changes to previous track and if user plug out the speaker from the ear and do not plug it back in ear in a short time interval music track will be paused. And if the speaker is plug in the ear of the earphone after the short time interval, music track do not changes to next or previous track, it will start playing the same track which has been paused. For call receiving, plug out the right speaker and plug in the ear in short time interval and to decline a call, plug out the left speaker and plug in the ear in a short time interval. Now the users have not to take the phone from the pocket or to press any button to do any simple task. It can be control by the earphone. In four capacitive sensor earphone, two additional sensors are attached in a position so that it does not get high or does not touched by the ear of the user when user plug the speaker of the earphone in the ear, as shown in Figure 1. Now due to the additional sensor user not has to plug out the speaker then plug it in back in short time interval and also more tasks can be performed as compare to the two capacitive touch sensor earphone. In this four capacitive touch sensor earphone if user wants to pause the music user has to plug out the speaker from the ears music pause immediately, in two capacitive touch sensor music pause after a short interval. Now user plug in the speaker of the earphone in ear again music starts playing again. If user wants to change the track to next or previous track user just have to tap the speaker. If user taps the right speaker when both of the speakers of the earphone are plugged in the ears the music track will be changed to the next track. On tapping the right speaker the sensor which is not touched by the ear is get touched or get high. On tapping the left speaker of the earphone when both the speakers are plugged in music track changed to previous track. Now there are some extra features in four capacitive sensors earphone in this user can also control the music volume if user not tapped the speaker of the earphone instead of it user touch the speaker of the earphone for a time interval then the volume will change in proportion to the time that user touches the speaker of the earphone, for example if user touches the right speaker of the earphone when both of the speakers are plugged in the ears then volume of the music track starts increasing in proportion to the time user touch the speaker. Similarly if user touches the left speaker of the earphone when both of the speakers are plug in the ear volume of the music track starts decreasing in proportion to the time user touches the left speaker.

5. Working of the Smart Earphone

This technical part describes that how smart earphone works. We start with design of working of hardware part followed by the working of the software.

5.1 Working of Hardware part: In hardware there are sensors and a microcontroller, the hardware part is very simple sensors output coming from the ears and touching by the hand the user will become input for the microcontroller. Now on different inputs microcontroller give output according to the codes and output coming from the microcontroller goes to the smart phone.

Figure 8. Back view of the Smart Earphone

5.1.1 In Four Capacitive Touch Sensor Earphone: In these earphones there are four sensors, two sensors are in position as shown in Figure 5 or as in Figure 6 and rest of two are attached as shown in Figure 4. We name all sensors, the sensor at left speaker as shown in Figure 7 named as ls1, the sensor at left speaker as shown in Figure 8 named as ls2, the sensor at the right speaker as shown in Figure 7 is named as rs1 and the sensor at the right speaker as shown in Figure 8 is named as rs2. Output coming out from the sensors will become input for the microcontroller and on every different input condition we design an appropriate output from the microcontroller which will go to the host device like mobile phone. There are different conditions, user plug the speaker of the earphone in ear in this condition ls1 and rs1 gets high and ls2 and rs2 is low in this condition microcontroller generates a output, this can be any output for example take as a single pulse, this output will go to the host device like mobile phone. If user plugs out the speaker of the earphone from ear any one of ls1 or rs1 get low and immediately an output is generated by the microcontroller which will go to the host device like mobile phone. If user plug the speaker of the earphone in ears and tap the right speaker of the earphone (tap means touch the right speaker of the earphone for a very short interval), in this case ls1 and rs1 is high and rs2 gets high and then low after a short time interval and ls2 remains low so program the microcontroller in this case that output will be different for example two pulses.

If user plug the speaker of the earphone in ears and tap the left speaker of the earphone (tap means touch the speaker of the earphone for a very short interval), in this case ls1 and rs1 is high and ls2 gets high and then low after a short time interval and rs2 remains low so program the microcontroller in this case that output will be different from other condition for example three pulses. If user plug the speaker of the earphone in the ears and touches the right speaker, in this case ls1 and rs1 is high and also rs2 gets high and ls2 is low in this condition microcontroller gives the output which will be different from other case for example four pulses then a break then again four pulses and this will be continue till rs2 does not gets low, in this case according to proportion of time user touches the speaker, host device has to work, for increasing the volume if user touches the right speaker so until rs2 does not gets low host device has to increase the volume so microcontroller has to give the output till rs2 gets low so it will give output like four pulses then a break then again 4 pulses and continue till rs2 gets low, if four pulses increase the volume by 1 unit then it will increase the volume till rs2 gets low.

If user plug the speaker of the earphone in the ears and touches the left speaker, in this case ls1 and rs1 is high and also ls2 gets high and rs2 is low in this condition microcontroller gives a different output like five pulses then a break then again five pulses and this will be continue till ls2 does not gets low, in this case according to proportion of time user touches the speaker, host device has to work, for decreasing the volume if user touches the left speaker so until ls2 does not gets low host device has to decrease the volume so microcontroller has to give the output till ls2 gets low so it will give output like five pulses then a break then again five pulses and continue till ls2 gets low. If five pulses decrease the volume by 1 unit then it will decrease the volume till ls2 gets low. If ls1 and rs1 are high and ls2 is low and rs2 is first tap (tap means touch the speaker of the earphone for a very short interval) then touched means rs2 is high then a different output is generated by the microcontroller for example six pulses are generated then a break then again six pulses are generated from microcontroller till rs2 is high. If ls1 and rs1 are high and rs2 is low and ls2 is first tap (tap means touch the speaker of the earphone for a very short interval) then touched means ls2 is high then a different output is generated for example seven pulses are generated then a break then again seven pulses are generated from microcontroller till ls2 is high.

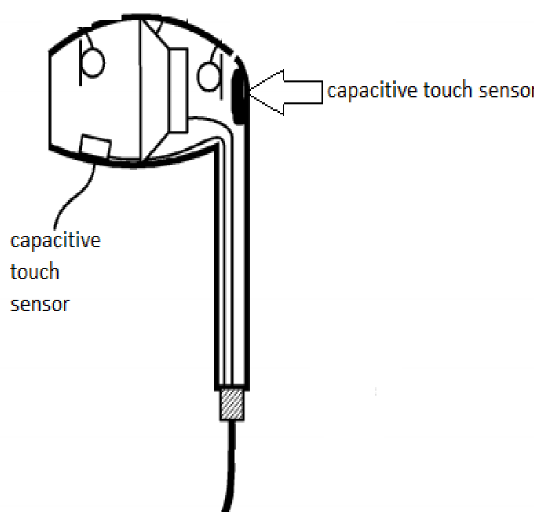

Figure 9. Showing both the sensors in one earphone lower one will touch the skin of the user when plugged in and the other one will not touched by the skin when plugged in, it will be touched by the user finger.

5.1.2 In Two Capacitive Touch Sensor Earphone: In these earphones there are two sensors. They are in position like in Figure 4. Both sensors got high when user plugs the speaker of the earphone in the ear. So there are only two sensors ls1 and rs1. There are different conditions, user plug the speaker of the earphone in ear in this condition ls1 and rs1 gets high in this condition microcontroller generates a output like a single pulse this output will go to the host device like mobile phone. If user plug out any of the speaker from the ear so one of the ls1 or rs1 get low and if it is low for more than a specific short time in this condition microcontroller generates a output which will go to the host device like mobile phone. If user plug out the left speaker of the earphone and plug in the speaker in ear in a short time interval in this condition microcontroller generates an output like two pulses. If user plug out the right speaker of the earphone and plug in the speaker in ear in a short time interval in this condition microcontroller generates an output like three pulses.

5.2 Working of the Software part: In software it does not depend on the four or two sensor earphone it depend on the signal coming out from the microcontroller basically having more sensors will generates more input possibilities, but the software depends on the signal coming out from the microcontroller, in android app we can make an app which can control these signal for example every signal coming from microcontroller detected by the software and a task will be completed. For example if a single pulse is coming it will play or pause the music, if two pulses are detected then it will change the track to previous and can also reject the call, if three pulses are detected then it will change the track to the next track and can also receive the call. If four pulses are detected then an increase of one or two unit in the volume of the music if five pulses are detected then a decrease of one or two unit in the volume of the music. If six pulses are detected then it can fast forward the track by 1 unit (in fast forwarding by 1 unit is like forwarding the song by 2 or 3 seconds). If seven pulses are detected then it can fast rewind the track by 1 unit (in fast rewinding by 1 unit is like rewinding the song by 2 or 3 seconds).

5.3 Output from Microcontroller and Detection by Smartphone android app: Firstly output coming from the microcontroller can be any signal but in different condition from the sensors different output must be generated. Now the output generated by the microcontroller goes to the smart phone the app in smart phone will detect the signal and according to signal task will be performed by the smart phone.

5.4 Synchronization of Software and Hardware part: After implementation of the necessary interfacing of hardware and software it will do the required task. The pulses are just example single pulse, two pulses etc. basically for completing a unique task a unique signal has to be transmitted from the microcontroller which will be detected by the software in the mobile phone and then the task is completed for example. If user plug out the earphone ls1 or rs1 will get low. Now when ls1 or rs1 gets low a signal is transmitted from the microcontroller and it go to the mobile app, now when making the app it is predefined on that particular signal music has to be paused, so when ls1 or rs1 gets low music will be paused. So when a user plug out its earphone music will be paused automatically. Now when user has to change the track to next or previous song user has to just tap the speaker if user touches the right speaker it will touches the right capacitive sensor and microcontroller gives a signal on that signal it is pre decided that the next track task should be executed similarly for left speaker in four capacitive touch sensor earphone.

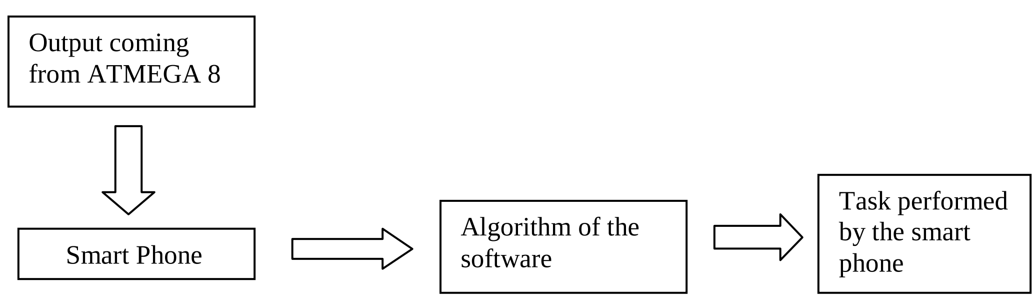

Figure 10. Showing the working of the app

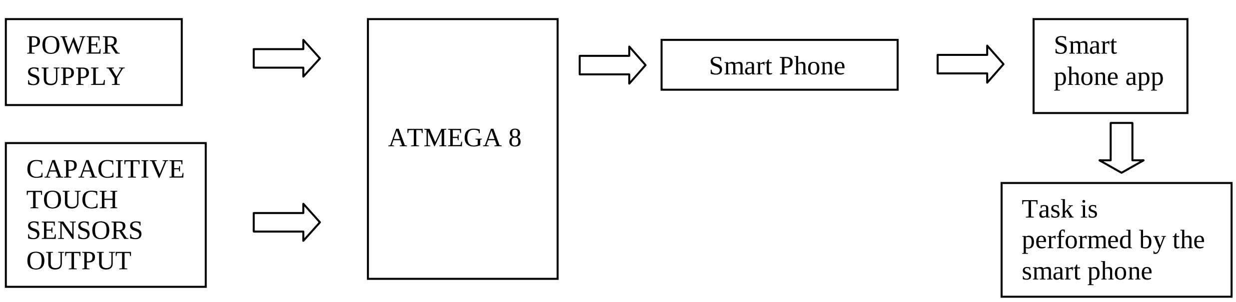

Figure 11. Showing Overall working of the Smart earphone

In two capacitive touch sensor user has to plug out the earphone then plug it back in a short time firstly sensor gets low then in a specific time high this will generate a signal and task will be executed like changing track. If user wants to increase or decrease the volume of the track if user touches the right speaker volume starts increasing automatically because microcontroller send a continuous signal and volume start increasing as user remove the finger from speaker it will stop further increment because it will come in normal conditions similarly if left speaker is touched volume start decreasing. If user has to fast forward just tap the right speaker then touch it in this condition microcontroller have different input generate different output and on this output app will perform this task similarly if left speaker and then touch it continuously.

6. Conclusions

Migration of the user interface platform from a bulky personal computer to a smart phone has significantly facilitated its usage by turning it into a true wearable assistive technology (Kim *et at*, 2012). So basically there are sensors in the speaker of the earphone on different combination of output coming through sensors (ls1 on, rs1 on, ls2 on and rs1 off and many more combination) go to the microcontroller, microcontroller generate a specific signal for different input condition, the output of microcontroller go to the mobile phone and a app is there for detect the signal and on that signal task will be performed by the mobile phone. So far authors has done changing the track, changing the volume and pause and play of music there are many more combination that can be created by the sensor and on those input a task can be performed by the host device and also a speech recognition feature can be added to the device.

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Biographical notes

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