An AI based Smart Conference Calling System using Bluetooth Technology

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***Abstract*— Conference call using mobile refers to the telephonic call in which several people talks to each other simultaneously. This is one of the most eminent feature now-a-days. This concept is already existing using LTE technology for mobile phones supporting SIM cards. Hence, currently conference call is possible only with support of SIM card, i.e. Mobile operator. Bluetooth is a short-range wireless technology which is used for exchanging data between devices placed over short distances (up to 240 meters). This is a booming technology which is easily and freely available and have no dependency on network operators. Our study work proposes a smart system to enable conference call with more than two mobile users without SIM support communicating with each other simultaneously. AI based proposed solution will be self –governed, self-learned and will be intelligent enough to smartly switch between all callers connected via Bluetooth in conference call. This proposed solution system will greatly increase the potential of using Bluetooth technology from a wider applicability perspective of conference calls, which is currently only possible over LTE mobiles.**

Keywords – Conference Call, Bluetooth, AI, Frequency hopping, Piconet, Scatter net

I. INTRODUCTION

Bluetooth [1] is short range (0 to 240 mtrs) technology which is now immensely evolving in ever-expanding area of wireless connectivity. Key attributes includes low cost and low power requirement for wireless communication and is designed to connect mobile phones, laptops and PDAs. With time, this tremendously flexible technology has been global standard for wireless connections. Due to ease of using it, there exists potential usage of this technology.

One of the main objective of Bluetooth technology is to erase cables, wires, connectors for connection between devices within short range. Hence, this reduces expenses to a large value and gives huge economic gain [2].

While in a public place say mall, train / bus station, or any such place having crowded and noise in vicinity, this feature of Conference call via Bluetooth will act as a safe communication channel between groups of upto n people.
Having no dependency on SIM card, even dummy phone having working Bluetooth can be used. The conference call feature over Bluetooth channel will be same as we make conference call via LTE phone using SIM card.

Conference Calling is a required features in offices, at home and at any place where gathering of people is there.

Conference calls are used by businesses on daily basis internally to company. Common applications are team meetings / presentations, training classes and information radiators within Bluetooth range. This feature is expected to allow workers to have a communication channel without any support of LTE technology with range of 240 meters.

One potential use case is when group of people have to communicate in public place say crowed railway stations, airports, etc. There is no dependency on network or any other applications that needs internet / wifi to work. Hence, proposed system holds high value from regard of safety when group of people are in any location such as trekking, jungle safari or any such location where signal connectivity issues are there and user is unable to access internet dependent applications.

Conference call proposed system is smartly designed in such a way that all connected devices are communicating at the same time and if any caller drops from connected call-ecosystem, then ongoing call is not disrupted. AI logic designed smartly adjust the ongoing audio communication over Bluetooth channel.

II. LITERATURE REVIEW

[3] Represents designing of a Bluetooth digital communication system (DCS). It has made used of Frequency Hopping technique (date rata used is 1 Mbps with 1600 hops per second) to prevent interference with other devices that are operating in same band. This paper emphasis on providing high level of security and low interference in Bluetooth paired channel. [4] Discusses the key agreement mechanism, dual channel security (DCS) that aims at overcoming the vulnerabilities and attacks that are arising from well-known protocols.

[5] Represents a cost effective and low-energy solution for tags to communicate with wireless devices using Bluetooth 4.x and Bluetooth 5 standards. It has used Bluetooth Low Energy technology to a present a multi-channel backscatter tag design and have built a prototype using a FPGA (Field Programmable Gate Array) and then experimentally evaluate it using Bluetooth Low energy(BLE)-devices. [6] Introduces the modulation and encoding of the BLE standard in the physical layer (PHY), including the maximum reachable range, transmission latency, and power consumption of BLE

[7] Represents establishment of a within Bluetooth enabled devices. With this, the range of accessible device is expanded through enabled intermediate devices. Distance vector algorithm is used for expansion and route is discovered as per requirement. When a devices tries to connect to other device, it establishes a path to the destination device taking route of intermediate devices and then forward the message.

[8] Proposes an unsupervised approach for channel-annotation of RSSI (Received Signal Strength Indicator) data received by a stationary receiver object and

determine period and time spent by a receiver in an individual channel. It proposes an algorithm which is based on sliding-window. It utilizes two well-known Likelihood-Ratio algorithms - KLIEP (Kullback-Leibler Importance Estimation Procedure) and uLSIF (unconstrained Least-Squares Importance Fitting) - for extracting Channel State Information of retrospective RSSI observation data.

III. WORK FLOW METHODOLOGY

Two way Audio communication is not possible in Bluetooth 5.2 [9] and there exists only one Master devices and rest connected devices are slave devices[10]. Our proposed system has been designed in such a way that it will overcome one way communication channel limitation and will use existing implementation of one master and many slaves. Proposed system is designed to such a degree that that all connected devices will act as both Master and Slave at the same time.

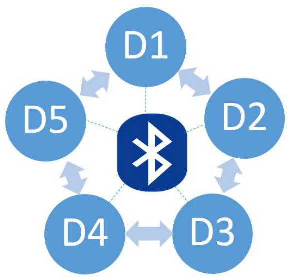

Fig.1 Master-Slave Interaction Simultaneously

Thus, functionally overcoming single Bluetooth channel limitation and giving veracity of two way communication channel. The actual work flow strategy followed in proposed work is divided in four Stages as depicted in Fig 2:

Stage 1: Recurring Weight Assignment Engine

Stage 2: Dynamic Priority Decision Engine

Stage 3: Determination of duration of each connected device

Stage 4: Determination of disconnected devices

We have considered cycling frequency factor f (1 min = 60 sec and 1 sec = 30 cycles)

Factor i = connected device number (say i =1 for Device D1, i = n for Device Dn)

In explanation of System design Solution, details of few factors is explained below -

Ceiling frame [0, 1] x 10 = [0, 10] – This refers to numeric value capping to allow easy integer calculations based on factor of 10.

UII (Unique Identification Indicator) – This refers to unique identification number being assigned to each connected device. It will help to distinguish connected devices such that we can track connected / non-connected devices

CT (Call Time) - This refers to the total speaking time of user being selected in priority. It holds numeric value 1 when user is speaking and holds number value 0 when user is not speaking. Total Call time will be summation of all 0 and 1 during entire course of call duration of that user Fig 3.

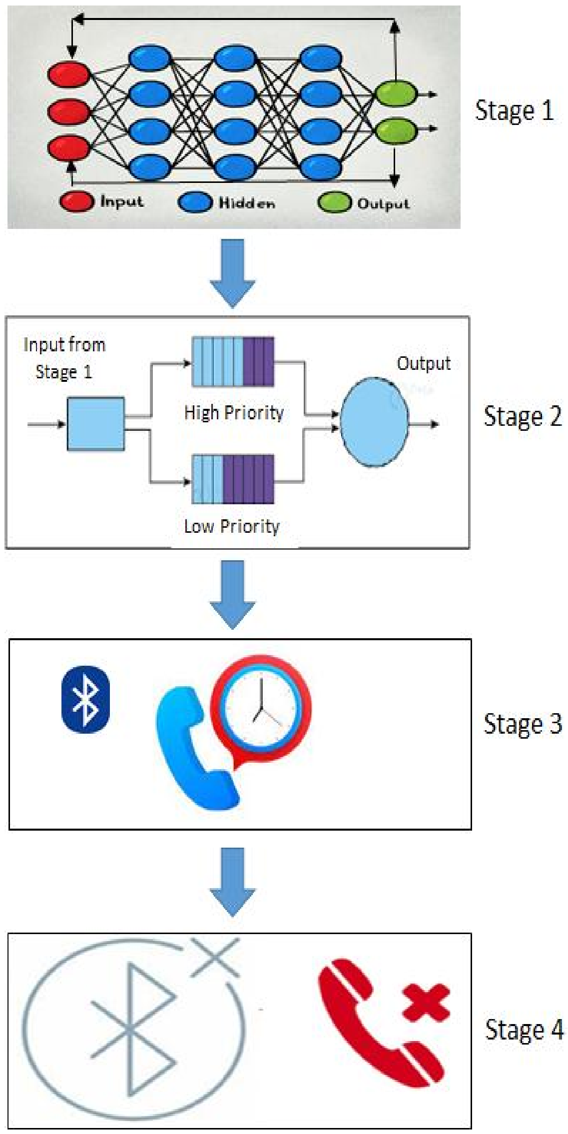

Fig. 2 System Design Flow

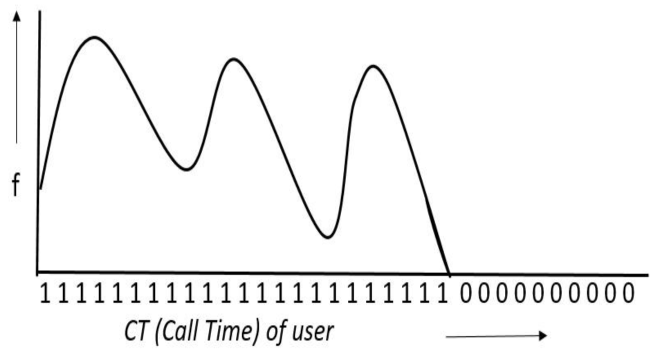

Fig. 3 Call Time

III. SOLUTION

Stage 1: Recurring Weight Assignment Engine

The input to this Periodically Repeated Network will be all the Bluetooth connected devices in Conference call. This stage will assign weights to all the connected devices (i =1 to n, here n is 8 as per latest Bluetooth ver. 5.2) [1].

As soon call will start, O/P weights will be randomly assigned with random values.

Random weight assignment will be done via a hidden layer of neural network. I/P to the recurring engine will be from the O/P weight. I/P of this stage will be aggregation of both weighted O/P and other factors such as SF (Speaking-frequency) of that particular device.

SF is explained in binary 0 for not speaking and 1 for speaking. The SF I/P will be aligned with current ongoing call and it will keep randomly changing based on speaker's speaking status.

Assigned O/P weight of a device will be send back to corresponding I/P device along with user's speaking status SF at that instant of time (0 or 1). At the same time, this O/P weight will also be given as input to Stage 2 (Priority Decision Engine).

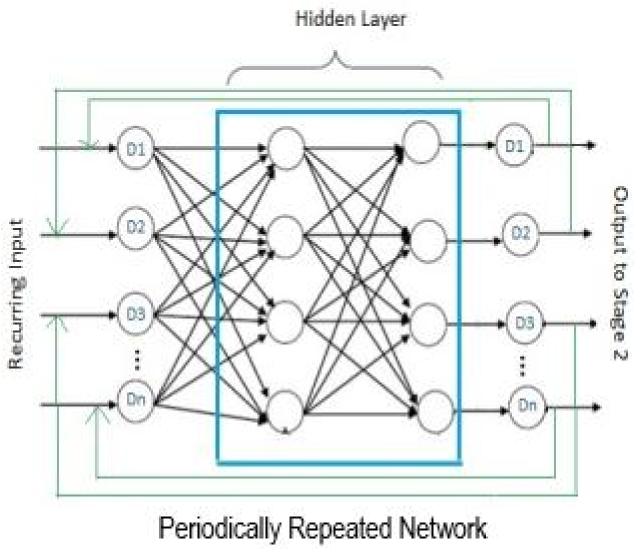

Fig. 4 Stage 1: Periodically Repeated Weight Assignment Engine

Recurring Input(i)= SF (0 or 1)(i) + O/P weight(i) (1)

Here, SF (0 or 1) refers to the Speaking Frequency status. If user is speaking (1) or not speaking (0) at a particular instance of time.

Stage 2: Dynamic Priority Decision Engine

The Priority decision engine will determine priority based on weighted O/P from *Recurring Weight Assignment Engine* of Stage 1. In this stage, Sorting of connected devices will be done based on high to low weights. Priority decision criteria will be based on below factors -

i. Speaking duration of caller (CT) [Fig.2]

ii. Weighted O/P from Recurring Engine (Eq. 1)

iii. Speaking interruption by other participants while current user (i) was already speaking –

Interruptions can be in two ways:

a. If another person murmured in between while current user (i) is speaking

b. If another person continues to talk making current user (i) to stop speaking

Sorting will be done by a Decision Making Engine which will be a continuous learning engine and will prioritize devices based on above mentioned criterions.

Output of Stage 2 will be factor Ni.

Where, Ni = [O/P Weight (i)] x 10 (Ceiling frame) (2)

At the end of Stage 2, we will get output as Ni which will be the weighted prioritized devices list and will be in a factor of 10 for easy calculation.

Stage 3: Determination of duration of each connected device

This stage will monitor connected devices and will determine duration for which each user is connected in the call for particular cycle with frequency f.

Say D1, D2, D3 to Dn devices are connected in Call

$D1 = N1/ D_F$

$D2 = N2/ D_F$

$D3 = N3/ D_F$

:

$Dn = Nn/ D_F$

Where f = N1 + N2 + N3 + ... + Nn + Ack

i.e. $f = \sum Ni + Ack$; (i= 1 to n)

Where, Ni represents each device weight factor respectively and DF represents the denomination factor.

$D_F = \sum Ni - [Num] + Ack$

Where, $Ack = \sum AckB_i$ where i [1 to n]

Num = ∑ Summation of disconnected devices.

Ack = acknowledgement received from all connected devices

AckBits – $AckB_1$, $AckB_2$, $AckB_3$, $AckB_4$ …….$AckB_n$

$Num=\sum Ni^*(\sim AckB_n)$

$AckB_n$ - Acknowledgement Bits which is non zero value that we will get if device gets disconnected

Stage 4: Determination of disconnected devices via Acknowledgment Bits

Further, stage IV depicts a way for the determination of the disconnected device within the queue throughout the communication channel in optimal time with the help of Ack bits received. Transfer bit (used for classify weather if any new device connected or the ongoing connection is lost) will be assigned and adjusted with respect to the connection status of the devices. The connection channel status changed whenever the devices get disconnected and also if make the reconnection within the communication transmission channel. And the same procedure comes into picture whenever some other new device joins the communication channel connection.

CABR – Current Ack Byte received

LABR – Last Ack byte received

XNOR – ambiguity in connection

For example,

- In Fig. 5, Tb_1, Tb_2, Tb_3, Tb_4 and Tb_5 represents the transfer bits which are connected with D_1, D_2, D_3, D_4, D_5 devices respectively, while transferring frequency data on the channel.

1	1	0	1	0
Tb_1	Tb_2	Tb_3	Tb_4	Tb_5

Fig. 5 Transfer bits

- Suppose in our example,

Case 1: Devices D_1, D_2 and D_4 are connected through the channel so Transfer Bits should be as shown in Fig. 6.
Last Acknowledgment Byte Received (LABR) is shown in Fig. 6

1	1	0	1	0
Tb_1	Tb_2	Tb_3	Tb_4	Tb_5

Fig. 6 Transfer bit diagram (LABR)

Case 2: Suppose connection with D_2 is lost. The Current Acknowledgment Byte Received (CABR) is shown in Fig. 7.

1	0	0	1	0
Tb_1	Tb_2	Tb_3	Tb_4	Tb_5

Fig. 7 Transfer bit diagram (CBR)

Difference between Last Acknowledgment Byte Received (LABR) and Current Acknowledgment Byte Received (CABR) is not equal to zero, by taking XNOR as shown in Fig 8.

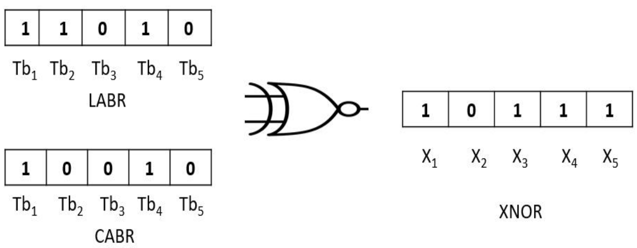

Fig.8 (XNOR of LABR and CABR Configurations)

Fig.1 depicts the Smart channel Formation where devices acts as Master-Slave simultaneously at the same time in Smart Channel Formation over bluetooth. Fig.2 represents the System Design Flow which is processed into four stages and are explained with some view factors as Ceiling frame, UII and Call time. Fig.3 depicts the call time-frequency variation. Fig. 4 represents the stage I of the System Design Flow as the Recurring Weight Assignment Engine with the help of hidden layer. Fig. 5 represents a normal transfer bits arrangements within the smart channel formation. Fig.6 and Fig.7 represents the arrangements of Last Acknowledgment Byte Received(LABR) and Current Acknowledgment Byte Received (CABR) as the transfer bit diagrams when the devices D_1, D_3 and D_5 are connected into a channel and also the case when Device D_2 got disconnected from the channel respectively. Fig. 8 represents the dissimilarity between LABR and CABR with the help of XNOR design logic circuit.

IV. CONCLUSION

We have proposed a smart, self learned solution which is unique, AI based mathematical solution for smart communication system channel to establish conference calls between mobiles using Bluetooth. This proposed system is designed in such a way that it is adaptable to connect simultaneously as many count of connections possible to be supported by Bluetooth technology[1] in future, though currently latest Bluetooth version have limitation to support 8 parallel connections.

V. FUTURE SCOPE

Implementation and simulation of proposed research work is left for future work. This work can be extended in the calculation of Acknowledgment values as current Bluetooth supports only 8 active connections. In this way modification of the formulated factors can be improved with respected to the further coming Bluetooth algorithm. The inclusion of additional environmental factors and constraints are also left for future work.

While this solution aims to create effective communication system without network operators dependency but it has not included various factors such as if system itself is faulty or biased, this is left for Future work. Improvements related to more optimization and scalability also remain areas for further extension and research.

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