Faster Than Light Quantum Teleportation between Alice and Bob of Bits 0 and 1 Akshay Patil , Founder and CEO of Heisenberg Quantum AI

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1 Abstract

Teleportation of Quantum State is instanteneously i.e. as soon as Alice measures her qubits , Bob's Qubits receive the state , due to Bob having the entangled particles (qubits) that he shares with Alice . But this is limited by requirement of transfer of measured quatum state at Alice side via a Classical Communication Channel which is limited by speed of light . But here we propose a solution to remove the need for classical communications and instantaneous transfer of '0' and '1' states to Bob, as soon as Alice measures her state. Note -> Here we assume that irrespective of what planet , gravity , environment conditions Bob is in the state transfer is instantaeous , irrespective of it.

2 Introduction

Before going into details of our Algorithm , let us discuss , Quantum Teleporation Protocol (Standard).

2.1 Quantum Teleporation Protocol (Standard)

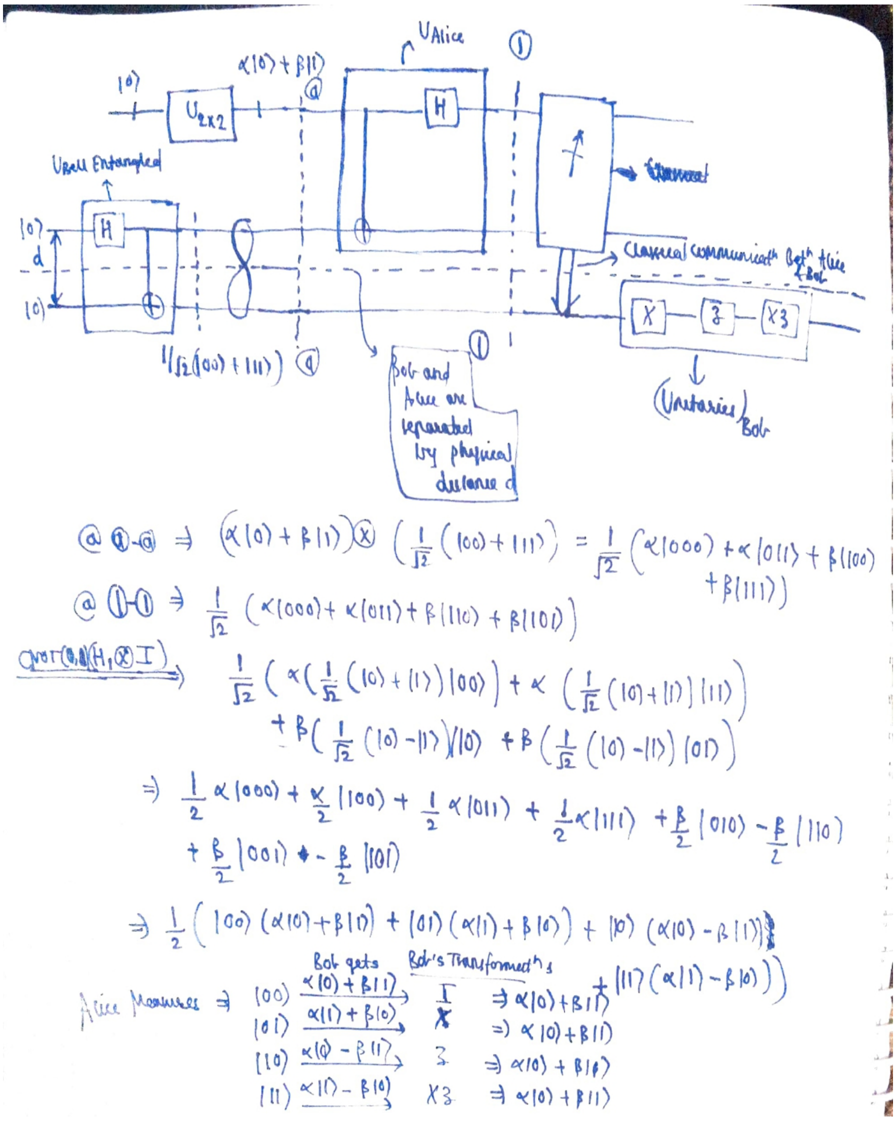

Figure 1: Quantum standard Teleportation Protocol Standard

As shown in fig above the Protocol Bob receives the state from Alice Instantaneously as soon as Alice Measures her state ,but since Alice's Measurement is random based on her probability amplitudes , her measurement can produce at random either one of $|00\rangle$,$|01\rangle$,$|10\rangle$,$|11\rangle$ states on her qubits , depending on that Bob receives either one of the 4 quantum states , $\alpha|0\rangle+\beta|1\rangle$, $\alpha|1\rangle+\beta|0\rangle$, $\alpha|0\rangle-\beta|1\rangle$ and $\alpha|1\rangle-\beta|0\rangle$ (Bit and Phase Flip Errors) , but for Bob to know which state has Alice measured and what state he has gotten instantaneously , Alice should communicate her measured qubits through classical communication channel to Bob and only then Bob can apply relevant unitary circuits from his end to get the state that Alice wanted to send . Here all the unitaries used in the protocol are independent of the probability amplitudes of $\alpha and \beta$, which can be complex and satisfy the norm condition as unity from Copenhagen Interpretation of the Quantum Mechanics.

The question answered in this paper is how can we remove the classical communication channel by introducing leniencies in the strictness of entanglement measures of the entangled state that Alice and Bob shares. How can we remove the classical communication channel ? Here if we remove it , Bob will have 1/4th chance to recieve correct state , but then the communication will be based on chance and one can think of unitaries to apply on the Bob's gotten state to produce the input state that Alice sends conditioned on the weak measurements at Bob's side to infer what unitary to apply , but we will not go into details of that here , since it is another project at Heisenberg Quantum AI.

3 Scaling Up the Quantum Teleportation Protocol By Induction

The Figure given below is breadth qubits extension of the standard quantum teleportation protocol.

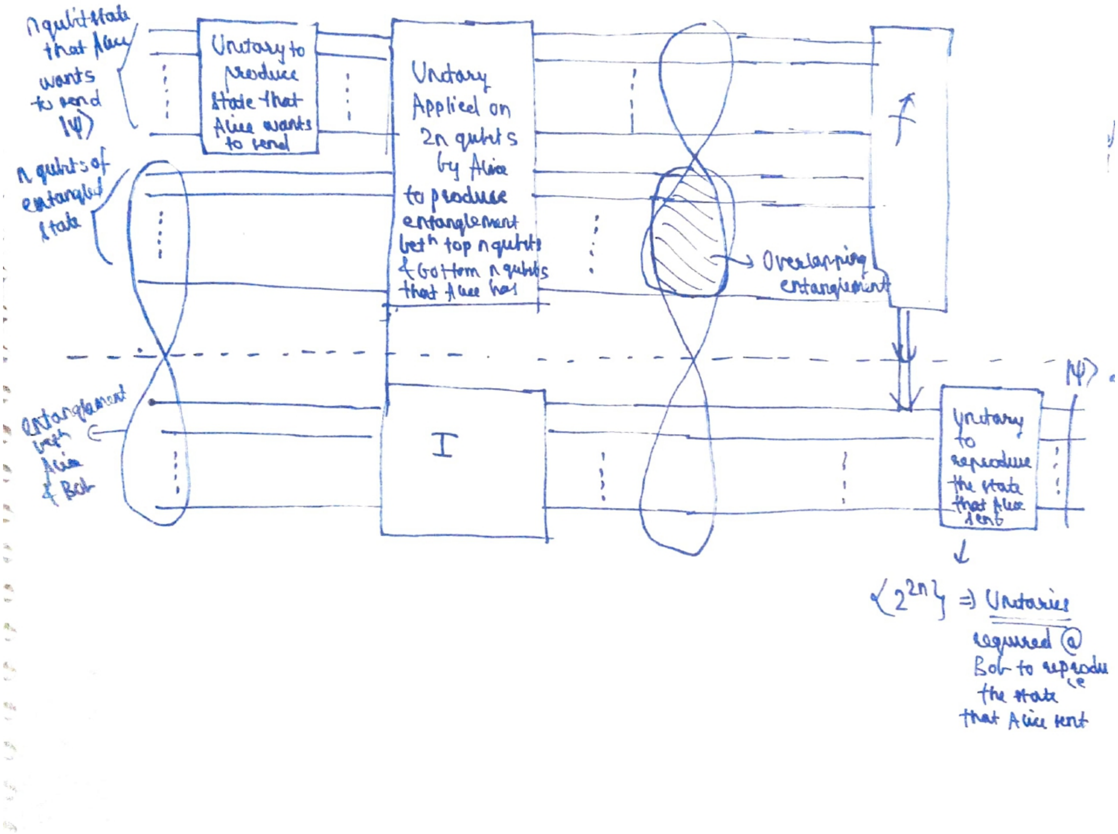

Figure 2: Scaling up by Induction of the Standard Quantum Teleportation Protocol

4 Faster than Light Quantum Communication via Quantum Teleportation - Our Method

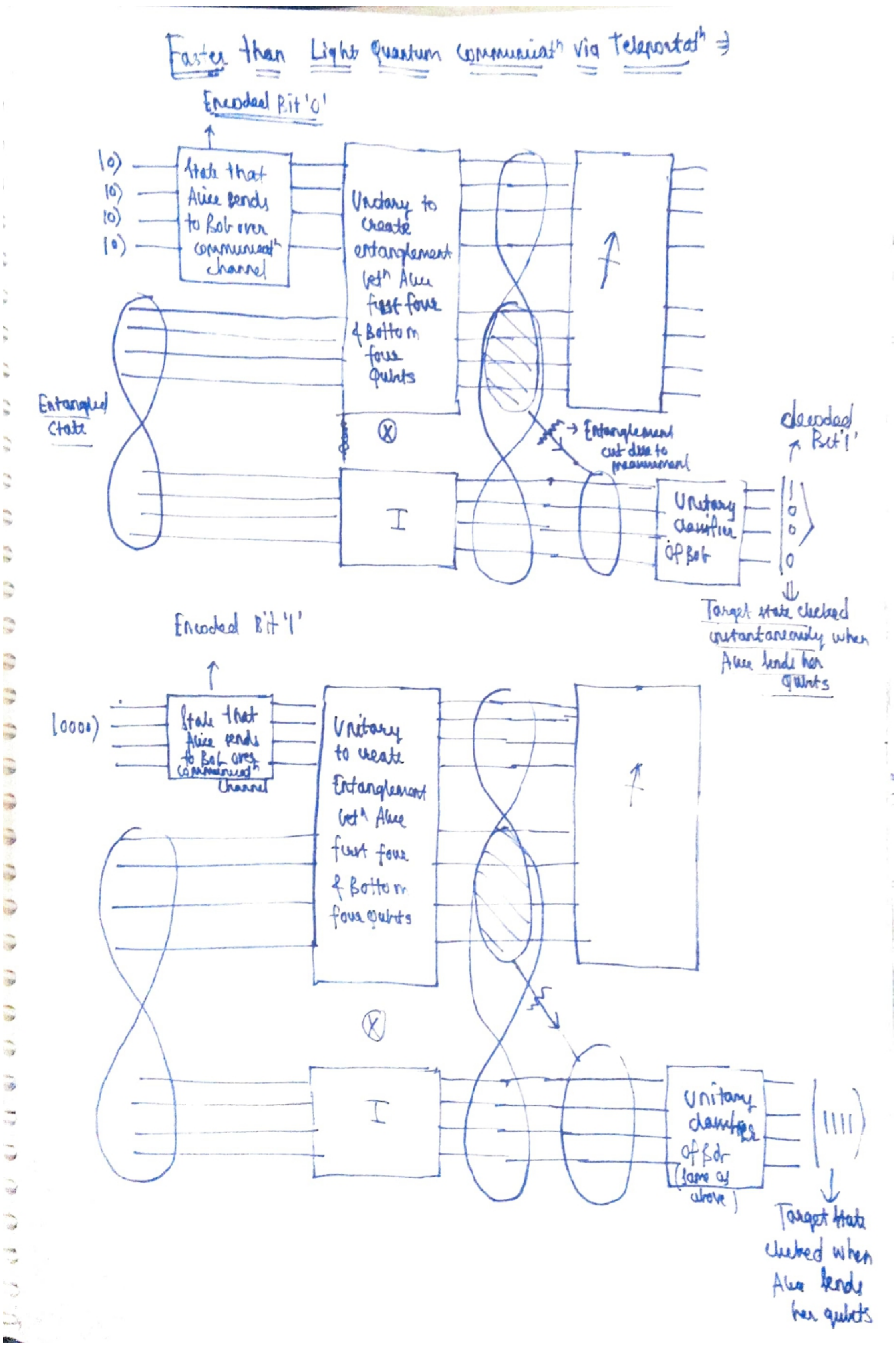

Figure 3: Faster than Light Quantum Communication via Quantum Teleportation

Before discussing the implementation details let us discuss , the theoretical aspects of our algorithm , a schematic of which is shown in the figure above.

Alice and Bob shares partially 8 Qubits Entangled States (same) (4 Qubits each) , let us say n pairs for n bit communication. So Alice applies a unitary that entangles the state of the top 4 qubits of Alice with the entangled four qubit state that Alice has from shared entanglement , to produce state of form $|00000000\rangle$ |Bob's State one of class zero$\rangle+$ $|00000001\rangle$ |Bob's State two of class zero$\rangle$ + $|00000001\rangle$ |Bob's State three of class zero$\rangle$ + $|00000010\rangle$ |Bob's State four of class zero$\rangle+|00000011\rangle$ |Bob's State five of class zero$\rangle$ ....+ $|11111111\rangle$ |Bob's State 256th of class zero$\rangle$. Now when Alice measures her eight qubits , Bob can recieve one of the 256 states that Alice has after she applies her unitary to produce the states of class zero , but whatever state Bob receives , Bob has a 'Unitary' circuit that maps these state to class zero with the target state as $|0000\rangle$ and this detection is instaneous , which Bob can safely assume that Alice has communicated bit '0' from her end. Now , Alice takes the second Entangled Pair and then decide on a new state of class one or class zero produced from the same unitary circuit used by here priorly, let us say she wants to communicate bit 1, then she will apply a Unitary to produce a class 1 state and then unitary to produce class 1 group states ,such that the top 4 and the bottom four qubits that Alice has are entangled to produce the superposed state ,

$|00000000\rangle$ |Bob's State one of class one$\rangle$ + $|00000001\rangle$ |Bob's State two of class one$\rangle$ + $|00000001\rangle$ |Bob's State three of class one$\rangle$ +

$|00000010\rangle$ |Bob's State four of class one$\rangle+|00000011\rangle$ |Bob's State five of class one$\rangle$ ....+ $|11111111\rangle$ |Bob's State 256th of class one$\rangle$.

Now , when Alice measures her eight qubits , Bob receives any of the 256 states of class one , now whatever state Bob receives , Bob applies the same unitary circuit what he applied earlier for class zero and now produces target states $|1111\rangle$ and this detection is instantaneous.

There we have it , Quantum Teleporation communicatio faster than speed of light !!!

Now how to find the entangled shared state , how to find the two unitaries that Alice applies , how to find the classification unitary that Bob applies to distinguish between the class zero and class one state that Alice sends , this becomes an optimization problem , which we can solve by 'Backpropogation Algorithm via various Optimization Techniques' of the target states we want at the output seperate for two unitaries of Alice , all the while enforcing the entanglement criteria between Alice and Bob and Alice's top and middle four Qubits , Unitary Constraints on the matrix , and normalization constraints on the quantum state. The code implemented from the Architecture given in the link below gives the 'nitty-gritty' of the implemented algorithm , once we have the unitaries required to produce entanglement state , which can be found again using Backpropogation Algorithm from ground qubits to entangled state between Alice and Bob , unitaries of Alice required to produce the class 0 and class 1 states , and unitary of seperation at the Bob's side to classify the incoming state sent by Alice into class 0 and class 1 , we can transpile the Unitaries into U3 and CNOT gates as per the connection availability of the quantum hardware , so that this algorithm / prortocol can be implemented on actual quantum hardware , as well as implement for long distance communication.

5 Entanglement Measures Implemented in the code to put in the Entanglement Constriant

Below we will dicsuss few of the Entanglement measures to identify whether the state is entangled from Quantum Information Theory.

1. Von-Neumann Entropy/Entanglement Entropy -> $S(\rho)$ = -Tr(ρln(ρ)) = -$\sum_i \lambda_i^2 * ln\lambda_i^2$
If $S(\rho)$ > 0 state entangled , $S(\rho)$ = 0 state is seperable.

2. Schmidt Decomposition -
ρ_B = $Tr_A\rho_{AB}$ => Find the eigen values of ρ_B, Number of eigen values positive > 1 => State is Entangled => Schmidt Rank ρ_A = $Tr_B\rho_{AB}$ (reduntant after above eigen values are known).

3. Negativity - $N(\rho_{AB})$ = $\frac{||\rho_A||-1}{2}$, where $||\rho_A||$ = $\sqrt{\rho_A^+\rho}$, $N(\rho_{AB})$ > 1 => Entangled State and = 0 => Seperable State (But can be entangled).

4. Reduced Partial Trace - $Tr(\rho_A) < 1$, $Tr(\rho_B) < 1$ => Entangled State , $Tr(\rho_A) = 0$, $Tr(\rho_B) = 0$ => Separable State.

Many other entanglement measures can be introduced as entanglement constraint to find the entanglement state.

6 Future Scope and Conclusion

1. To implement the protocol experimentally to demonstrate long distance communication faster than speed of light. 2. To implement the Algorithm on quantum Hardware 3. To write a more efficient code for optimum Entangled state and class zero and class 1 states production , and quantify the relation between the entangleability measures and the classification accuracy. 4. Based on the method of induction vary the number of qubits on Alice and Bob's Side.

Unless Refuted this paper and its conclusion of faster than light communication via our novel protocol/algorithm remains firm and soaring.

7 Github Link for the Code

Faster than Light Quantum Teleportation Algorithm/Protocol

8 References

1. You can find good resources on Quantum Teleporation Protocol online. Remaining all work is novel.