EXECUTIVE SUMMARY-UGC MINOR RESEARCH PROJECT

1. Title of the Project :**STUDY ON THE EFFECTIVENESS OF OPENLOOP CONCATENETED DYNAMICAL DECOUPLING SCHEMES TO COMBAT POLARIZATION DECOHERENCE IN OPTICAL QUBITS**

2. NAME AND ADDRESS OF THE PRINCIPAL INVESTIGATOR **: Dr. D Sajeev, Assistant Professor, Department of Physics, KNM Govt. Arts and Science College Kanjiramkulam**

3. NAME AND ADDRESS OF THE INSTITUTION :**KNM Govt. Arts and Science College Kanjiramkulam, Kanjiramkulam P. O, Thiruvanathapuram (Dt), Kerala**

4. UGC APPROVAL LETTER NO. AND DATE :**: MRP(S)/13-14/KLKA014/UGC-SWRO ,15Feb2014 and MRP(S)-0667/13-14/KLKA014/UGC-SWRO dated 06March2015**.

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6. **OBJECTIVES OF THE PROJECT**: Device an open loop concatenated control strategy and numerical evaluation of its effectiveness to preserve the purity of polarization qubits from a birefringent optical channel.

7. **ACHIEVEMENTS FROM THE PROJECT**: Usually for high speed long distance communication single mode optical fibers are used. One major drawback of such fibers is that polarization mode dispersion (PMD). Due to PMD it is not possible to increase the speed of communication. The findings from the project here can be implemented to combat PMD related problems effectively than other control techniques such as Periodic Dynamical Decoupling(PDD).

8. **SUMMARY OF THE FINDINGS**

First as a proof of the numerical experiment, tested CDD and PDD scheme for a dephasing acting along the known Z- axis for all channel sections and the channels are arranged in parallel. Since the decoherence acts along Z-axis, a pure diagonally polarized qubit with purity one, after a few passage through the channel undergoes decoherence, and becomes in a completely mixed state. The PDD and CDD scheme can completely recover the purity of the qubit even after 126th passage through the channel (Fig 1(a)). Here PDD and CDD scheme is both effective in recovering the qubit purity. Fig 1(b) represents numerical result with decoherence in alternate channel sections along Z-axis, but the coupling angle between channel sections set at 14^{o} . The performance of the PDD scheme degrades after 30th passage, but the CDD scheme preserves purity. For the refractive index difference between fast and slow axis of the channel section Δn, typical value used is 0.0012.

In order to test the effectiveness of the scheme for a general decoherence scenario, different decoherence directions are assigned for channel sections. Fig. 1 (c) shows simulation

result with such a condition. The alternate channel sections encounter decoherence along Z and X directions and the coupling angle between channels is 14^{o}, Δn around 0.002. An anti-diagonal input state undergoes decoherence and the purity value decayed around 0.6, the PDD scheme preserves purity for up to 6th passage, afterwards due to accumulated error the purity decays. The CDD scheme preserves the purity even after a very long passage.

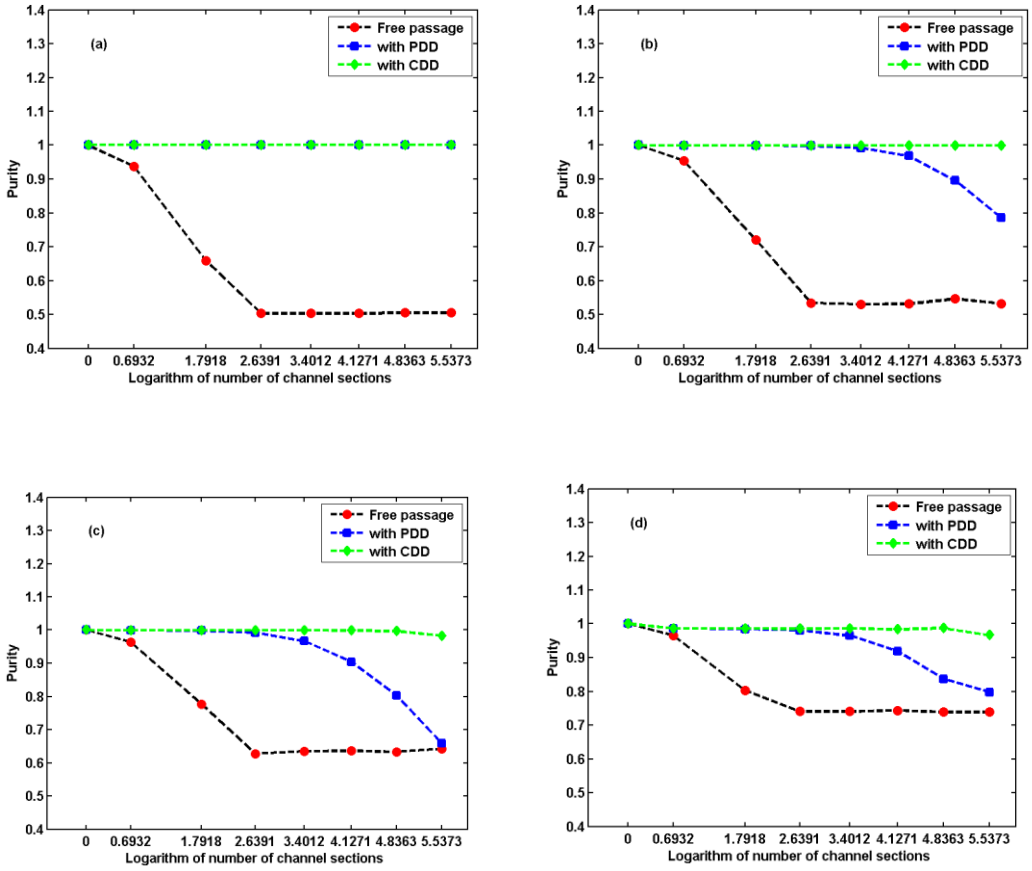

Fig.1(a). The PDD and CDD scheme tested for a simple model of decoherence. Since decoherence is acting along the Z-axis for alternate channel sections, a diagonally polarized qubit (circle) undergoes a fast decoherence, while the PDD scheme (square) and CDD scheme (diamond) recovers the purity of the qubit after long passage through the channel.Fig.1(b). Performance of the schemes with a 14^{0} twist between channel sections, Fig.1(c). result with alternate channel section encounter decoherence along Z and X directions on Bloch sphere . Fig.1(d). result for a general elliptical qubit and high birefringence around 0.0025.

A general elliptical state with initial high purity is tested for high value of Δn around 0.0025, compared to previous simulations. The decoherence directions on channel sections are along Z and X directions alternatively with parallel coupling between channels. The purity of elliptical qubit with initial purity one, decays after a few passage and clamped around 0.75, after 30th passage though the channel sections. In this case with PDD control operations can keep

the purity around 0.98 up to 14th passage, afterwards the purity decreases, while the CDD scheme preserve the purity value about 0.98 even after 256th passage.

In conclusion presented some preliminary numerical simulation results on the effectiveness of concatenated dynamical decoupling schemes over periodic dynamical decoupling schemes to combat birefringence induced polarization decoherence of optical qubits from a dispersive communication channel. One source of polarization decay from practical communication channels such as optical fiber is random coupling of polarization between fiber sections with constant birefringence .A similar scenario is numerically tested for error correction with CDD and PDD dynamical decoupling schemes. The CDD scheme is found superior over PDD scheme to combat polarization decoherence in such scenarios.

9. **CONTRIBUTION TO THE SOCIETY**: Research and Development in science and technology is one of the major contributing factors in the lifestyle advancement of modern society. Nowadays our society witnessing a paradigm shift in the communication and information technology due to the advent of INTERNET. One major drawback in the current internet technologies is the lack of speed. Since most of our communication links relies on single mode fibers, any attempt to increase the speed of communication through them will change the scenario of communication and information technology. The finding out of the project is applicable to improve the speed of communication through single mode fibers.