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|  | **Universidade de Aveiro**  **Ano 2024** |  | |
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|  | Projeto final apresentado à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Licenciatura em física, realizado sob a orientação científica do Doutor Gil Fernandes, Professor (categoria do orientador) do Departamento de (designação do departamento) da Universidade de Aveiro | |

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| presidente | Prof. Doutor João Antunes da Silva  professor associado da Universidade de Aveiro |
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**Intorduction**

Communication plays a crucial role in the current and future scenario, driving globalization, innovation and collaboration in various sectors, while also facilitating the dissemination of knowledge and education around the world. In the business world, effective communication is the backbone of successful operations, allowing coordination between globally distributed teams and enabling rapid adaptation to market changes. Furthermore, in the educational sphere, communication plays a vital role in delivering educational content to a wide audience, allowing students and teachers to interact efficiently, regardless of physical distance.

In this context, advanced technologies such as fiber optics play a crucial role, offering high bandwidth and low latency to support the growing demand for fast and reliable communication. However, optical fibers face significant challenges, such as chromatic dispersion, which can distort the transmitted signals, and attenuation, which limits the transmission distance. In addition, the non-linearity of optical fibers can introduce distortions in signals at high transmission powers.

To overcome the inherent limitations of optical fibers and advance the capacity and efficiency of communication networks, innovative solutions are being developed that address specific challenges. The use of structured light is one such solution, where the spatial pattern of light is manipulated to optimize data transmission, and this can involve various techniques such as the following :

Bessel beams, which are being explored because of their ability to maintain their shape during propagation, which minimizes dispersion and preserves signal integrity, thus enabling more reliable communication over long distances. This unique property of Bessel beams makes them particularly valuable in applications that require high-quality transmission in challenging conditions.

In addition, Hermite-Gauss and Laguerre-Gauss beams are being developed to mitigate chromatic dispersion, a phenomenon that causes distortion in transmitted signals at different wavelengths. These beams have been designed with specific intensity distributions that minimize chromatic dispersion, thus improving the efficiency of optical fibre communication and allowing the use of a wider range of wavelengths.

On the other hand, there is Orbital Angular Momentum Multiplexing (OAM) technology, which allows multiple channels of information to be transmitted simultaneously on a single optical fiber, significantly increasing data transmission capacity. Light is encoded with different values of orbital angular momentum, which is an intrinsic property of light that can take on an infinite number of values. Each value of orbital angular momentum can be used to encode a separate channel of information, thus allowing the simultaneous transmission of multiple channels of information on a single optical fiber.

And this results in a significant increase in available bandwidth, enabling faster and more efficient communication.

However, despite its many advantages, OAM technology still faces several technical challenges that need to be overcome. For example, generating and detecting light beams with orbital angular momentum requires complex and precise optical devices. In addition, light beams with orbital angular momentum can be affected by atmospheric turbulence, which can degrade transmission quality.

The aim of this work is to generate beams with OAM, analyze their purity and make any corrections to obtain a beam with OAM of greater purity.

Structure: ...

**Theoretical foundation:**