**Introduction:**

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In the field of diagnostics and healthcare, detecting brain tumors early and accurately has become a challenge. In diagnostics and healthcare, the early and precise detection of brain tumors has emerged as a formidable task. Brain tumors, regardless of their nature—benign or malignant, can have severe repercussions if not diagnosed and treated promptly [35]. The demand for efficient detection methods has never been more urgent, considering how quickly the disease can progress and affect patient's lives.

Historically, the identification of brain tumors heavily rested on the expertise of radiologists who methodically analyzed medical pictures, such as those produced from magnetic resonance imaging (MRI) and computed tomography (CT) scans [36]. While these professionals possess knowledge and experience, the sheer volume of medical imaging data and the need for accuracy calls for an efficient and reliable approach. Deep learning techniques, which are a subset of artificial intelligence (AI), come into play in this context.

Deep learning, which falls under the category of machine learning, has made advancements in recent times [33]. Its ability to autonomously learn patterns from datasets has paved the way for groundbreaking developments across various fields, including medical image analysis [34]. In brain tumour detection, deep learning is promising in improving accuracy, speed and consistency.

**Medical Images:**

Medical imaging holds significant importance in assessing and managing diverse health conditions[9]. Specifically, when examining the complex structure of the human brain, several imaging techniques offer unique perspectives. Magnetic Resonance Imaging (MRI) stands out as a cornerstone in neuroimaging, delivering exceptional comprehensive images of the brain's interior architecture through the application of magnetic fields and radio waves. These high-resolution images permit clinicians to spot small abnormalities, such as brain tumors, with amazing precision [10]. Computed Tomography (CT) scans, utilizing X-rays to generate cross-sectional pictures, supplement MRI by providing crucial information regarding tissue density. Despite its slightly reduced resolution, CT serves a significant role in the overall evaluation of brain health.

Positron Emission Tomography (PET) imaging offers a metabolic component to the diagnosis of brain malignancies. By tracing the spread of a radiotracer, PET scans highlight areas of heightened metabolic activity, aiding in detecting and characterising malignancies. While not as common in brain imaging, Ultrasound remains a flexible modality. Though it is commonly linked with prenatal imaging, ultrasonography can be applied in specific neuroimaging circumstances, particularly in measuring blood flow and detecting anomalies [11]. The development of Functional MRI (fMRI) significantly advances our understanding of the brain's dynamic activities, allowing doctors to correlate structural abnormalities, such as tumors, with changes in neural activity. As technology progresses, so does our capacity to utilize imaging modalities like Diffusion Tensor Imaging (DTI), which studies water diffusion in tissues to determine white matter pathways. In the field of brain tumor detection, these different imaging tools collectively contribute to a comprehensive diagnostic strategy, establishing the framework for integrating cutting-edge technology, including deep learning approaches, to automate and refine this delicate process.

**Motivation:**

Primary brain or spinal cord tumors arise in these tissues. Primary malignant brain and spinal cord tumors will affect 24,810 Americans (10,530 women and 14,280 men) in 2023. This kind of tumor is rare, less than 1%. Brain tumors account for 85%–90% of first CNS malignancies. Worldwide, 308,102 instances of primary brain or spinal cord tumors were expected in 2020. [1]

US CNS tumor diagnoses in children under 20 are expected to reach 5,230 in 2023. The rest of this manual covers’ adult primary brain tumors. Brain and nerve system malignancies are incurable and the ninth leading cause of death for men and women. Primary malignant brain and central nervous system tumors will kill 18,990 Americans in 2023 (seven,970 women and 11,020 men). Primary malignant brain and central nervous system cancers killed 251,329 people worldwide in 2020.[1]

Under-15s had a 75% 5-year relative survival rate. The 5-year relative survival rate for 15-39-year-olds is 72%. The 5-year relative survival rate was 21% for those over 40. Doctors calculate brain tumor survival rates every five years. [1]

About 120 types of brain tumors affect different brain tissues. Benign or noncancerous brain tumors might be dangerous owing to their size or location. Brain and nerve cancers affect 30 per 100,000 Americans. Brain tumors damage healthy brain tissue by pressing on or spreading into it. Certain brain tumors may become cancerous. If they obstruct cerebral fluid flow, skull pressure may increase. Certain cancers may spread via spinal fluid to distant spine or brain regions.[2]

Global cancer observatory (2020) ranks 1,284 new cases 22nd with a cumulative risk of 0.82% and a rank of 0.09. The sickness caused 1,144 deaths, ranking 19th, with a cumulative risk of 1.0% and 0.08. These numbers show the prevalence of brain and CNS cancer. In all age categories, 2,898 cases occurred over five years, resulting in a 1.76 per 100,000 rates. [3]

In Bangladesh, according to research by Sarkar et al. (2021), Treatment of brain tumors is in requirement of joint efforts by several professionals from neurosurgery, neuroradiology, neuropathology, oncology, and radiation. The result is poorer in underdeveloped nations compared to developed countries because of shortcomings in adequate registration, lake of awareness of patients, failure of prompt diagnosis, lack of availability and co-ordination of numerous professionals for complete care and high abandonment rates. [4]

Brain tumors have decreased, although they remain a medical concern. Brain tumors may profoundly impact an individual's quality of life and well-being. Brain tumors must be detected early to optimize therapy and patient survival.

Early detection and therapy are crucial for the cure of brain tumors. Risky, untreated brain tumors raise healthcare expenses and suffering. However, early discovery and proper therapy may improve brain cancer. Early brain tumor detection improves treatment outcomes and lowers disease severity. So, the goal is to use image processing and machine learning techniques to identify brain cancers early, benefiting the medical business.

**Objective**:

The final sub-goal is to provide a rationale for our method selection from a broad range of options, detailing their functionality and our development process.

**Sub-Objective 1:** To collect a suitable dataset of brain tumor images, then enhancing the image clarity and characteristics through various augmentation and filtering techniques.

**Sub-Objective 2:** To process the gathered data, training it with chosen Convolutional Neural Network models, and categorizing them using specific classifiers. This approach is crafted to be both efficient and effective.

**Sub-Objective 3:** To develop a model capable of detecting brain tumors from imaging data, focusing on enhancing the model's precision.

**Orientation:**