Advancements in healthcare: ‘Harnessing GAN for the Prediction of Asthma through Radiographic Image Analysis’

Course : CN7041 - The Fundamental of Artificial Intelligence

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1. Abstract

According to an NHS research, asthma affects around one in eleven children and young adults in the UK, making it the most common long-term medical condition. Furthermore, its incidence among Chinese children is rising rapidly with a relatively poor control rate (1-3). This is in part attributable to the failure of primary paediatricians to distinguish asthma from common respiratory tract virus infections in children, with asthma often being misdiagnosed as bronchitis or pneumonia. The aim of this paper is to introduce new groundbreaking methodology on the use of generative AI (GAN'S) within the GP settings in the UK, as this is where most preliminary symptoms are first presented and mistreated or misdiagnosed. GANs can be utilised to augment medical image datasets, including asthma radiology images. The images produced by these GAN's can be further encoded for the detection of anomalies in lungs of multiple root causes. The model was primarily founded on the research done on the use of Artificial intelligence (AI) to treat gait issues by Dr. Atiqur, as well as present day research on the use of AI in medical imaging such as X-rays. Our research revealed a general distrust towards the safety of AI, and this poses a big obstacle for the use of AI in medical interventions. To circumvent the obstacles presented in this paper, we have created a procedure that is compliant with Humble AI and international bodies codes of conduct.

2. Introduction

Asthma is a common disease affecting an estimated 300 million individuals worldwide. It is a major global health problem that imposes a substantial burden on patients, their families and the community. The UK has one of the highest prevalences, emergency admissions and death rates for childhood asthma in Europe. Asthma is a long-term condition but can be perceived as a mild disease and research shows that it is often not taken seriously enough[1]. A study showed that one in six people in the UK do not know or are unsure if the condition can be fatal. Asthma is a dynamic condition with varying causes. As such, catching asthma at the early stages can be quite difficult.

Chest radiology is the primary tool for diagnosing asthma and can give important information about the structure of the lungs and bronchial surrounding tissues. GANs can be

utilised to augment medical image datasets, including asthma radiology images[2]. By generating synthetic images that resemble real cases, GANs can help enhance the diversity of the dataset, which can be beneficial for training robust machine learning models. The detection of anomalies and image reconstruction are two possible clinical applications for effective GANs.

3. Selection of GAN: Methodology

A generator and a discriminator compose a GAN. Using random noise as input, the generator creates synthetic medical x-ray images. Making images that closely resemble actual x-rays is the primary objective. The discriminator evaluates the synthetic and real x-ray images, determining the likelihood of each image's generation or authenticity by assigning probability scores. The generator becomes more adept at producing realistic x-rays as a result of the training process being guided by the discriminator's analysis.

Data augmentation is one common application[3]. By creating synthetic x-ray images, the generator can enhance the original dataset. GANs can perform image-to-image translation, transforming x-ray images from one modality to another. For example, converting low-resolution x-rays to high-resolution or enhancing specific features in the images. GANs can execute image-to-image translation, converting x-ray images from one modality to another[4]. For example, converting low-resolution x-rays to high-resolution or enhancing specific features in the images.

Anomaly detection in x-rays by training on real x-rays, the generator comprehends to construct typical images[5]. During generalisation, if the discriminator determines a deviation from normal patterns in the generated x-rays, it may reveal the existence of abnormalities or diseases.

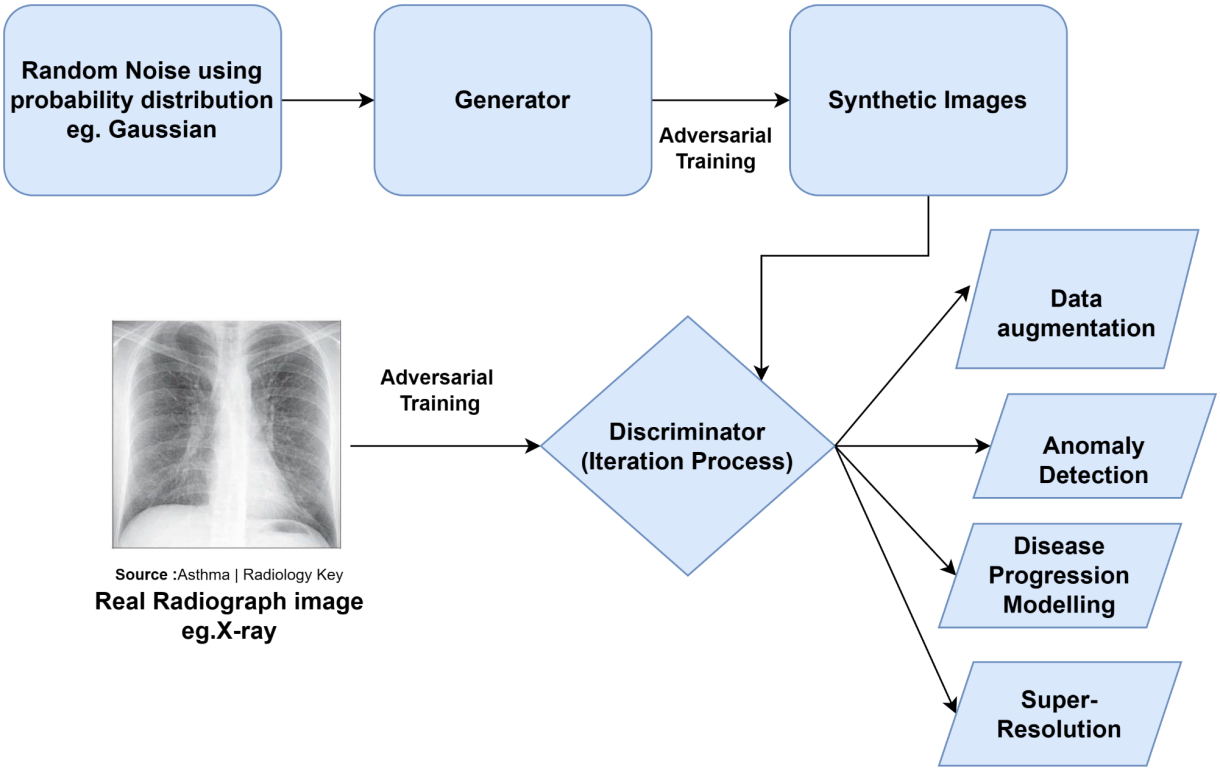

Fig. GAN process with X-ray

There is immense potential in creating synthesis asthma's images data to be used as data training for predicting asthma in children, largely due to the inability to collect and share patient's personal data.

This model can have a significant risk of producing inaccurate and unrealistic output that could mislead or harm users' health, and therefore the untrust of this model can increase the challenges of using generative images approach in predicting the asthma in children.

On the other hand using generative AI images using Generative adversarial network As Langer cited. Generative Adversarial Networks, GANs, are an incredible AI technology capable of creating images, that are indistinguishable from the "real thing".[6] can accelerate time to diagnosis and predict the asthma at early stage and avoid the patient prolong for waiting to be assessment ,therefore it can also save money and improve the social-economies impact.

4. Justification of GAN technology: A bulk image generator

To date there are not many studies on the prediction and prevention of Asthma. Conversely Asthma is one of the biggest health concerns of the children in the UK [7] and is a precursor of developing more severe pulmonary and cardiac diseases later in life[8] [9]. Asthma will also be a greater concern in the future due to the covid pandemic of 2019 [10].

Asthma has several root causes however depending on a GPs specialisation, it will dictate how they search for early symptoms. For instance, a GP who specialised in microbiology during their training as a General practitioner [11], may have developed the lens to look at all diseases being pathological viruses or bacteria whilst ignoring other symptoms such as the constriction of arteries. As our topic involves predicting Asthma at the preliminary stage, before it has the chance to evolve, there is a chance that the patient has not yet developed, or will never develop a virus, whilst still developing asthma. It is impossible to expect GPs to be able to identify all types of asthma especially with the development of new types of Asthma thanks to Covid-19. With the use of an AI bulk image generator, GPs will now have access to more radiographic imagery of lungs affected by asthma originating from a plethora of different causes. A greater pool of knowledge to pull from means GPs will have more scans to compare their patient's lungs to and will be able to predict when a patient has a higher likelihood of developing Asthma. Then they will be able to provide the necessary treatment to prevent the symptoms from developing further.

5. Discussion of the Analysis:

As this methodology is currently in the ideation phase, there are no actual results to test our hypothesis. However, we have pulled data from Large language models (LLMs), as well as additional research to infer what the possible outcomes could arise from deploying such a model within the healthcare industry.

5.1 Doctors' general lack of trust in AI

As Doctors deal with matters of life and death, it is of utmost importance that any new strategy they implement is considered critically. However, whilst most doctors claim objectivity, we cannot deny just how much the media influences our beliefs. [12] Unfortunately through social media's misuse of deepface [13], as well as movies depicting robots as machines of destruction, a fear of technological advancement has permeated, and informed the social constructs around our beliefs on technology's inherent 'goodness'. This can be reflected in a recent study, where a third of the population surveyed stated that they believe technology is more harmful to our well being than it is co-operative and beneficial [14].

5.2 Ethical aspects

Includes potential issues with data privacy and the lack of transparency on the source of data for the multiplication of images. However, these concerns can be mitigated by following the United Nations' world ethical data foundation. Additionally, we should adhere to the UK national cyber security guidelines for data privacy and security of AI system development.

5.3.Legal aspects

The legal dimensions include ensuring all regulatory frameworks are in place for any misdiagnosis resulting from AI applications. We must also ensure compliance with the Care Quality Commission standards related to the safety and quality of care. Finally, we must ensure obtaining formal consent from the patient for the use of AI in their treatment.

5.3.Societal aspects

Address transparency by clearly defining GAN functionality in identifying early-stage asthma from X-ray images. Collaborate closely with healthcare professionals, particularly GPs, to validate and refine the GAN model. Conduct educational programs to improve awareness among healthcare providers and the public. Continuously assess and mitigate biases, while encouraging open communication and feedback for continuous advancement.

5.4.Algorithmic Aspects

Potential biases in training data, interpretability problems, and the requirement for accurate validation are problems of utilising GAN algorithms for X-ray analysis in asthma diagnosis. Biases can arise from imbalances in patient demographics, concerning model generalisation. The interpretability of GANs can be difficult, hence methods for elucidating model decisions must be developed in order to improve workflow integration in clinical environments. Extensive clinical validation using a wide range of datasets, incorporating explainability methods into the GAN architecture, and applying strong data preprocessing techniques to eliminate biases are necessary to overcome these obstacles. Collaboration with healthcare professionals ensures the algorithm aligns with clinical insights and enhances its utility in identifying early stages of asthma for GPs.

6.Reflection of LLM [15-17]:

Table.1.Ethical issue in using GAN technology

ChatGPT	Implication ensuring patient privacy, obtaining informed consent, and addressing potential biases.
Bard	The ethical implications involve balancing the potential benefits of improving diagnostic accuracy and patient care with the potential risks of privacy violations, algorithmic bias, and misuse of generated images.
Bing	Ethical concerns is the privacy of the patient's' medical data and the creation of fake medical records that could be used for fraudulent purposes
2596741	Attention must be focused on the ethical aspect of using GAN in the healthcare application because it defines and justifies the beneficial and safety.
2555470	Patient’s medical data must be used after receiving informed consent from them. Fake medical images can be created for fraudulent purposes.
2616424	When this model is put into practice in clinical settings, we must ensure that the patient has given their full consent after being briefed on the matter.

Table.2.Legal issue in using GAN technology

ChatGPT	Legal aspects include compliance with medical data protection laws, obtaining consent, and adhering to regulations governing the responsible use of GAN technology.
Bard	The legal aspects of using generative adversarial networks (GANs) to generate radiograph images of asthma children involve compliance with data protection regulations, such as the General Data Protection Regulation (GDPR), and ensuring that the generated images do not violate intellectual property rights.
Bing	The use of GAN technology in radiograph images of asthma children patients raises legal concerns regarding the privacy of the patient's medical data and the creation of fake medical records that could be used for fraudulent purposes.
2596741	I support the world's agreement to enact a unified law to control the use of AI specifically because it will be harmful to human health if it has been used unsupervised.
2555470	Data protection is important so that all the data used in AI models must meet with regulatory compliance.
2616424	Law enforcement bodies should be involved in the software development process of this model before it is sent out to market in local clinics.
2590401	The legal aspect of using GAN in generating radiography images is important for both regulatory compliance and gaining trust from healthcare professionals and patients.

Table.3.Societal Concern in using GAN technology

ChatGPT	Image generation in healthcare enhances diagnostic accuracy, enables remote consultations through telemedicine, and contributes to personalised medicine, leading to improved patient outcomes and increased accessibility to healthcare services, thereby positively impacting society. However, ethical considerations, data privacy, and regulatory frameworks are crucial in ensuring responsible integration and maximising the benefits of these technologies.
Bard	Generative image models hold the potential to revolutionise asthma care by enabling early detection, improving diagnosis, guiding treatment, and reducing healthcare costs.
Bing	Societal concerns regarding the privacy of the patient's medical data and the creation of fake medical records that could be used for fraudulent purposes.
2596741	The rapid development in diagnosis of diseases and the early predictions make society benefit from this technology, but on the other hand it will increase the gap in the developing countries in terms of healthcare.
2555470	Transparency of output from the model without bias can break a mistrust by society in AI.
2616424	Personal beliefs around technology in society will be one of the biggest hurdles to tackle in making this model a reality.
2590401	Societal concern to prevent asthma using GAN requires comprehensive public awareness campaigns and educational initiatives to ensure parents, caregivers and communities understand the technology.

Table.4.Algorithmic Concern in using GAN technology

ChatGPT	Image generative algorithms like GANs, VAEs, and transformers, with architectures involving competitive training, probabilistic frameworks, and self-attention mechanisms, offer diverse applications from realistic image synthesis to uncertain data generation. Ongoing trends focus on improving stability, addressing weaknesses, and exploring hybrid models, reflecting a dynamic landscape of advancements in image generation.
Bard	Image generative algorithms, such as Generative Adversarial Networks (GANs), have revolutionised the field of computer vision by enabling computers to create realistic and diverse images from scratch. These algorithms learn from large datasets of existing images to identify patterns and relationships within them, allowing them to generate new images that are both visually plausible and consistent with the underlying patterns
Bing	The use of GAN technology in radiograph images of asthma patients can have significant algorithmic implications. GANs can be used to generate synthetic medical images, which can be used to train deep learning models and improve the accuracy of medical diagnoses.
2596741	The invention and creation of many Algorithms for use in health research is still a subject of interest to everyone.
2555470	The algorithm must be medically sound, meaning no hallucinations or misleading images can be made as a result of it.
2616424	As this model is created to eliminate biases cropping up in the diagnosis of early asthma, the algorithm must be built to spot all possible root causes of asthma.
2590401	The algorithm must effectively spot any white noise in the data, as the outcomes of the algorithm will be used to help diagnose patients.

7. Conclusion

In conclusion the present study aimed to identify an effective and efficient artificial intelligence (AI) model which can be used to assist paediatricians in diagnosing asthma in real clinical settings. To overcome the socio-ethical and legal obstacles, the use of Humble AI values such as transparency, and explainability must be incorporated into this model. Finally, the GP must remain as the focal point of all health advice, whilst the AI tool simply serves as an additional resource.

With further research, this model can eventually be deployed as a personalised diagnostic tool to lower the misdiagnosis rate of asthma among children and to reduce the misuse of antibiotics and systemic glucocorticoids. Image generation for predicted children asthma can contribute to better resource allocation, ensuring that medical resources are directed to areas where they are most needed.

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Appendix:Future Work

- Developing personalised risk prediction models that take into account individual family history of disease, environmental background, and genetic predispositions. Generative AI can assist in creating models that adapt to the unique characteristics of each child, improving the accuracy of predictions.
- Using generative AI to develop personalised interventions that consider behavioural and lifestyle factors. This could involve recommending specific changes in diet, level and

frequency of physical activity, and their personal stress levels quantified by surveys/ or interviews by a GP/doctor.

- Further collaborative research across nations to further develop the innovation and push the boundaries of AI and its implications within healthcare.