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# AI Device to Identify Black Fungus disease - Post Covid-19 Pandemic Infections

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***Abstract*— Amid a major 2nd wave of COVID-19 infections, a fast increase in cases of mucormycosis, often known as black fungus, adds to the problems of India's health care system. This disease is not contagious, meaning it cannot be spread through human contact. However, it is transmitted by fungal spores that are prevalent in the air or the environment, and it is practically hard to prevent exposure to them. According to the US Centers for Disease Control and Prevention, mucormycosis has a 54 percent mortality rate, which varies depending on the patient's state and the body area affected [1]. More than 7,000 incidences of the usually uncommon disease have been recorded in recent weeks throughout India, with the majority of the occurrences being individuals who have been diagnosed with COVID-19 or are recuperating from the disease [1]. Although COVID-19 has been linked to a variety of secondary bacterial and fungal diseases, researchers believe that India's second wave of COVID-19 has provided an ideal environment for mucormycosis. According to experts, an increase in the usage of particular immune-suppressing medications during the COVID-19 pandemic might be the root cause of the surge in black fungus cases. This research paper will look at finding solutions on how this condition can be detected in real-time paving the way for medical experts to analyze it utilizing AI techniques [1].***

***Keywords:*** *Black Fungus, Mucormycosis, Artificial intelligence, Covid-19, FTIR* microscopy

## I. INTRODUCTION

Candida, Aspergillus, and mucormycosis are among the main fungal diseases that are usually seen in individuals with a weakened immune system. Even though there are few occurrences of mucormycosis, it is impossible to get a precise figure since no national monitoring system exists in the US. It was estimated that there were 1.7 cases of mucormycosis per 1 million inhabitants per year especially in the San Francisco Bay Area [2]. Prospective monitoring of 16,808 transplant patients at 23 institutions undertaken in 2001-2006 indicated that mucormycosis had become the third most prevalent kind of invasive fungal infection amongst stem cell transplant recipients, accounting for 8% of all fungal infections. 2percent of the total invasive fungal infections were caused by mucormycosis, whereas in 1,208 solid organ transplant patients, micromycetes infections were the primary cause. These cases were among the first to show signs of a wave of infection currently overwhelming India, a crisis within another pandemic: infections with a rare group of fungus known as mucormycosis. Black fungus infection (mucormycosis) is referred to colloquially as "black fungus." When the disease remains untreated, up to half of the people who get it may die from mucormycosis [2].

In recent months, about 12,000 instances of the virus have been reported in India, with the majority of them happening in the western states of Maharashtra and Gujarat [3]. There was no black fungus in the initial wave of COVID according to the medical experts in India. The black fungus has turned the country red when the second wave started.

Mucormycosis is a fungal illness that may be fatal if there are no interventions to manage it. An analysis of documented mucormycosis cases revealed an overall death rate of 54% from all causes. The death rate varies according to underlying disease, type of fungus, and afflicted bodily location (for instance, the mortality rate among the people with sinus infections was 46 percent, 76 percent for people with pulmonary infections, while it is 96 percent for people with disseminated mucormycosis) [3]. An unwanted discovery brought by the COVID outbreak is the increasing incidence of mucormycosis. Several kinds of fungal illnesses have affected COVID patients, notably lethal yeast known as Candida Auris and a series of diseases involving Aspergillus fungus which gained the name CAPA (for COVID-associated pulmonary aspergillosis).

Such fungal infections appear to be associated with a COVID diagnosis, which seems to be a sign. High doses of corticosteroid, antiinflammatory medicines that dampen the immune system's reactivity to infection are one regular component of treatments for severe instances of COVID [4]. People use steroids to save lives, but steroids concurrently make a patient more susceptible to assault by existing germs or fungus. We do an excellent job of removing the fungal spores from our lungs. However, COVID harms the lungs. The capability to naturally remove the spores is also diminished due to the steroids. At this moment, it is impossible to foresee the end of the black fungus shadow pandemic, while increased knowledge of patients' susceptibility may enable doctors in India to identify infections earlier. This why this paper aims at developing an AI device that can detect black fungus disease to assess its spread in patients and alert medical practitioners of its symptoms [4]. The device that will be developed will utilize AI algorithms

## II. PROBLEM STATEMENT

The main problem that this paper will solve is identifying and tracking Black Fungus disease, by developing an AI device that can identify disease in real-time to alert and report its spread post-covid-19 treatment. The AI techniques that will be employed in this device will involve the capabilities of identifying any black fungus symptoms then analyzed to determine the condition among the patients. Mucormycosis, often known as black fungus, is a dangerous and sometimes deadly sickness brought on by mucor mold exposure. Several species of molds of the genus Mucor are often found in soil, plants, rotting fruits and vegetables, and manure. Consequently, those who have exposure to fungal spores from the air usually suffer from fungal infections in their sinuses [5,6]. Even if a cut, burn, or skin irritation occurs, the fungus may infiltrate the skin. About half of all people who have this virus will die from it. People with diabetes, cancer and HIV/AIDS have compromised immune systems, which makes them vulnerable to this product (AIDS). Indians have seen a rise in instances of mucormycosis, due in part to the higher rate of infection caused by SARS-CoV-2. A COVID-19 pandemic provided the pathogen with suitable conditions in which to proliferate and spread. With weak immune systems, people are vulnerable to black fungus [7].

## III. LITERATURE REVIEW

### *A. Fungal infections*

The diagnosis of fungal diseases is often difficult because of their visual similarities. As a result, extra biochemical tests are often required. This creates extra expenditures and delays the identification procedure by up to ten days [8,9]. When immunosuppressed patients do not get specialized therapy as soon as possible, their mortality rate will increase. Researchers employ artificial intelligence to categorize microscopic scans of distinct fungal species using a computational intelligence technique and a bag-of-words system. It has been estimated that this methodology shortens the biochemical identification procedure by 2-3 days and reduces the overall cost of the diagnostic procedure. Previous research comparing AI to dermatologists has consistently shown that AI is basically on par with human skills [9]. Notably, deep neural networks outperformed dermatological professionals in very complex situations over simpler occasions. Dr. Han is often called upon to treat various skin disorders. Though he has learned other computer programming languages over the years, including C++ and Python, he is not an expert in either. And after learning about AlphaGo, a self-taught Go-playing AI, called DeepMind, beating the world's greatest human players such as Lee Sedol of South Korea, he became interested in deep learning [9,10]. But to teach an AI to identify connected patterns, the algorithm requires a large amount of data. Obtaining useable images of nail fungal infections is a significant barrier since there is often no common format for the scans. Many photos exhibit images of both healthy nails and fingernails afflicted with onychomycosis. Since these deep learning algorithms only can scale photos to 224 × 224 pixels, photos that are much larger or smaller will end up distorted.

### *B. Innovative technologies thwart the deadly fungal threat*

Forward-thinking firms are now using artificial intelligence (AI) to combat antimicrobial resistance (AMR). According to research released by the Wellcome Trust and the UK government, AMR kills more than 700,000 people worldwide each year and is expected to kill more than 10 million people by 2050[10].

The increasing use of artificial intelligence to combat antibiotic resistance is a current trend. For instance, Google recently gave the Doctors Without Borders/MSF Foundation a $1.3 million grant to develop a mobile smartphone app that would employ AI to assess antibiotic resistance testing and provide suggestions in low-resource settings. A deep learning solution (DeepARG) created by Virginia Tech researchers has been shown capable of accurately identifying antibiotic resistance genes (antibiotic resistance genes) [11]. Tuberculosis, which is the common name for TB, is a disease caused by bacteria that infects the lungs and can spread to other parts of the body. UC San Diego researchers developed an AI machine learning platform that enables doctors to identify and predict which genes cause these bacteria to become antibiotic-resistant. C. Auris infections are said to have over 90% resistance to at least one antifungal, and it is believed that around a third of C. Auris infections have resistance to two or more different drugs [11].

### *C. AI used for antifungal resistance*

According to the Stratistics MRC, the global antifungal pharmaceutical market is estimated to reach 18.2 billion dollars by 2022 and rapid expansion is expected to be the largest in the Candida-treating sector. It should be noted that there is a fundamentally distinct market dynamic for antibiotic development [11]. The antibiotics market is being abolished by large pharmaceuticals such as Sanofi and Novartis. However, the discovery of anti-fungal drugs is an increasing possibility. For example, in partnership with Monash University, fungalAi, directed by Dr. Michelle Ananda-Rajah at Alfred Health in Melbourne, Australia, established the world's first platform (fungalAi) technology, which can real-time identify and aid to identify fungal disorders in hospitals. FungalAi's platform technology combines natural language, a deep learning artificial neural network algorithm to identify chest-CT fungal illnesses, and an advanced algorithm for medical data incorporation for fungal prediction [11].

AI may be utilized for the development of antimicrobials, not just to diagnose and identify fungal illnesses. Deep learning in a variety of fields may be used to shorten the process of medication innovation. For instance, deep learning patterns may be used to forecast biological response results, medication performance in tests, and toxicity in clinical studies. AI can help automate the design of molecules and expedite both computer-assisted and molecular similitude-based synthesis. Using new technology such as artificial intelligence to fight the developing fungal danger is a growing potential, which is now a widespread sector for start-ups, risk investment, biotech firms, and big pharmaceutical firms [11].

## IV. METHODOLOGY

Ethics committee approval is required to carry out tests on human serum samples, which have been obtained. There will be a comparison of sera from patients and healthy controls. Samples from the serum will be tested using a Fourier transform infrared scanner. Black Fungus has a distinctive and identifiable absorbance pattern that is suitable for using FTIR microscopy. For the FTIR studies, a microplate adapter in conjunction with a Tensor 27 FTIR spectrometer is used (Bruker Optics GmbH). Acquiring the spectra in data transmission would be carried out in the spectral range of 4000 to 500 cm1 and will still be carried out according to the variables that will be used in the detection of black fungus, which includes spectral resolution, Blackman-Harris 3-term apodization, zero-filling factor, as well as interferograms approximated with background subtraction on every spectral region [13]. Following the collection of background spectra against an individual cell on the disk, the specimen spectra are obtained against the test sample. A minimum of 20 series of measurements obtained should be acquired from each serum sample and subject to data analysis before the results are published.

The preceding data analyses were carried out to assess the spectral quality of the data of FTIR observations. To assess the effectiveness of the collected spectra, the quality test tool of the software was used to check the absorption spectra, signal-to-noise ratio, and amplitude of the water vapor patterns in each spectrum [13]. After this, Hotelling's T2 vs Q residuals charts are constructed, with the mean-centered data being used to identify the outliers. The majority of the spectra (more than 95 percent) should satisfy the quality test examination [14,15]. The outermost spectra, which are located far away from the origin of the T2 vs Q residuals charts developed by Hotelling, are eliminated from further data processing.

Principal component analysis (PCA) is a data reduction technique that is commonly used to handle high-dimensional collinear data sets, like the FTIR spectrum data, to identify the primary change pattern. Because the study included mice samples from two distinct trials, Piecewise Direct Standardization (PDS) is performed to ensure that the data is consistent [16]. The Unscrambler X (version 10.5) software, as well as the Python programming language involving a Scikit-learn module, will be used to do the pre-processing, visualization, and unsupervised classification (PCA) of the FTIR spectra [17].

The MATLAB tool was used to create a convolutional neural network learning model, which was then tested. When it comes to obtaining spectral fingerprints of complex substances based on their distinctive absorbance pattern, Fourier transforms infrared spectroscopy (FTIR) is a highly selective approach. In conjunction with artificial intelligence, Fourier transforms infrared spectroscopy (FTIR) allows for the stratification of human blood samples obtained from individuals suffering from Black Fungus infection. Human serum spectra recorded by FTIR spectroscopy will exhibit more variability, which may be produced in part by a variety of confounding variables such as diet habits, which are mirrored in the metabolic patterns in serum, independently of the individual's immunological condition [17,18].

## V. PROPOSED AI DEVICE

My proposed system will utilize infrared sensors and AI algorithms in collecting biological data and analyze it to make a confirmation of the black fungus disease.

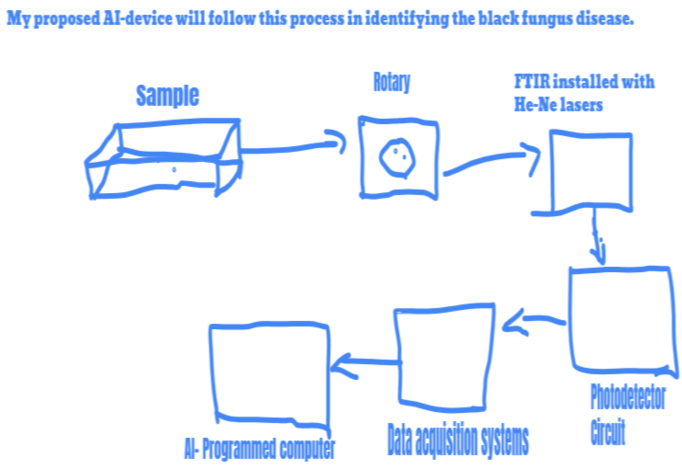
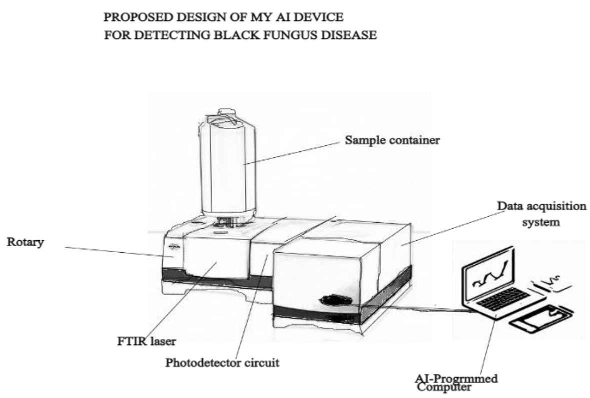



*Fig i:* A sketch of the process in the proposed AI-device

***Design:***




**How it works:**

The sample collected from the patients will be placed in a sample tube of the rotary machine. These samples will be rotated to separate the serum of the sample which will then be subjected to an FTIR system installed with He–Ne laser beam. The laser beam will measure the spectrum of the serum molecules which will be detected by a photodetector circuit. The photodetector circuit will send a signal to the data acquisition system which consists of sensors, DAQ measurement hardware, and a computer with programmable software. The AI-programmed computer is already trained to identify signals of black fungus molecules which will it compare each sample from the patients with the already known spectrum. If the parameters especially the spectrum for the patients matches that of the AI-programmed computer, then a confirmation of the disease will be detected.

## VI. DISCUSSION

Black Fungus disease detection using my proposed device using the Fourier Transform Infrared sensors will be employed in addressing the problem a hand in a simple, quick, and dependable way. When FTIR is used for machine learning-assisted Fourier Transform Infrared (FTIR) microscopy, it is an efficient, quick, and repeatable methodology that provides spectral fingerprints of biomolecules from samples. Having this information in an accessible manner might be necessary for effective intervention [12,13]. Black Fungus Pathogens isolated from saliva, epithelial cells, or blood cells have been proved to have observable spectral features, and hence might serve as a good resource for spectral analyses. In the spectra of the material employed, the peaks of a clear black fungal sample mounted stand out clearly. The samples of swabs obtained from an infected patient's mouth will be utilized in detecting the black fungus. This approach may be utilized for quick bacterial/fungal differentiation.

A new technique that is capable of directly measuring the wide range of biological properties of a fungal specimen without the need for a label involves the use of FTIR imaging. To visualize the spatial distribution of the related active compound in samples, regions or band heights of specified spectral ranges may be computed and color-coded within each imaging pixel. The spatial resolution of FTIR microscopes is much beyond the wavelength-dependent resolution limit, however, the precision of a single hypha is not [13]. Multivariate statistics can also be used to determine if a given spectrum in the sample or several samples have distinctive patterns. Without background understanding of their chemical base, the primary spectrum distinctions may be detected and their exact composition discovered via the wavelength/wavenumber of absorption. Also, it is feasible to get an idea of how the fungal mycelium is distributed across growth substrates. Fourier transforms infrared (FTIR) analysis, by observing the differences in spectral patterns, may distinguish between a wide range of fungal species [14]. It is fairly straightforward to recognize a small number of fungi with unique spectral properties, while it is harder to differentiate numerous fungi with identical spectral traits. It is also feasible to identify changes in chemical composition owing to biological interactions.

## VII.DEVICE FUTURE IN THE U.S

2020 was a difficult year for healthcare. A year later, the difficulties have persisted. Caregivers continue to combat the COVID-19 epidemic – a difficult endeavor in and of itself, let alone when compounded by a staffing shortage, a nationwide mental health problem, and treatment of prolonged chronic ailments. Relying on automation, my proposed artificial intelligence device will be poised to improve healthcare delivery services by assisting caregivers in overcoming various obstacles in detecting Black Fungus symptoms. The COVID-19 dilemma has compelled the healthcare industry, which has historically been cautious of technological advancements, to embrace contemporary technology aggressively. Accenture forecasts that the healthcare AI industry will reach $6.6 billion by 2021, growing at a 40 percent compound annual growth rate. The same report emphasizes the economic benefits of AI in healthcare. Artificial intelligence deployment will result in yearly savings of $150 billion for the US healthcare industry in only five years. Consider some of the instances of AI in healthcare that has such tremendous benefit. 89 percent of people in the United States Google their symptoms before seeing a physician, and the outcomes of self-diagnosis are rather frightening. My proposed device will eliminate the need for such questionable undertakings. It will help the U.S patients in monitoring health issues related to Black Fungus, tracking the spread of the disease, management, and routines to avoid chronic illnesses from deteriorating, and to arrange medical visits as required.

## VIII. ECONOMIC BENEFITS TO THE HEALTHCARE SYSTEMS

This device is economically viable as its components are inexpensive. The Healthcare system will have a better chance of benefitting in detecting the black fungus disease without spending a lot on acquiring the devices that would be costly considering the current situation of the COVID-19 pandemic. By analyzing enormous volumes of data, it may significantly improve the efficiency with which tasks are completed and the decision-making process. Additionally, it may stimulate the development of technological innovations, sectors of the economy like the manufacture of medical equipment, hence increasing customer demand and providing new income streams. Due to AI's ability to handle large amounts of data concurrently, it has the potential to greatly improve humans in identifying illnesses such as Black Fungus. This AI

Device will contribute significantly to this progress in three ways. To begin, it will result in a significant improvement in labor productivity (up to 40%) as a result of novel technologies that enable more effective staff time management. Second, this AI device will generate a new virtual workforce – referred to in the research as 'intelligent automation' – capable of decision making and self-learning. Thirdly, the economy will profit from innovation diffusion, which will impact many industries and provide new income sources.

## IX. CONCLUSION

This work was meant to demonstrate the feasibility of developing an artificial intelligence-based FTIR spectroscopy prediction model for biological samples of patients with Black Fungus. Moreover, since FTIR spectroscopy is capable of measuring several biochemical changes at the same time, it may also be ideal for monitoring patients' sera over a longer time, allowing health professionals to monitor and tailor the disease's treatment approach. Because of the increased need for patient-centered care, such an approach may prove to be a significant step forward in the development of personalized therapies. As a result, a follow-up age-matched research should include a large group of patients who have had Covid-19 vaccines to determine if FTIR spectroscopy is appropriate for monitoring the course and outcome of Black Fungus in the hospital environment.

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