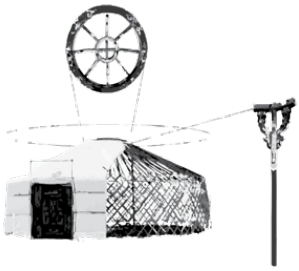
Biomimetic Yurt-Lung Ventilation System for Sustainable Mongolian Housing

Introduction:
This project introduces a new ventilation system for Mongolian yurts (gers) inspired by the human lung's structure. The goal is to improve air quality, insulation, and preserve the yurt's cultural design. Traditional yurts struggle to balance insulation and airflow, especially in cold winters, leading to poor air quality and high CO_2 levels. Most yurt modifications focus on insulation, which often reduces airflow. This new system uses ventilation channels built into the insulation, mimicking the branching structure of the lungs to control airflow and temperature.



[4] Figure 1.

[4] Figure 2.

The design keeps the traditional circular shape and conical roof of the yurt, which is important for cultural reasons and portability. The ventilation system will use branching ducts, ranging approximately 2 cm to 10 cm in diameter, embedded within the insulation. These ducts help create natural airflow by using temperature differences inside and outside the yurt, improving air quality while still keeping the yurt warm. The system also includes adjustable layers of felt or wool to allow for customization based on the climate. Unlike other designs, this system doesn't rely on mechanical ventilation, making it suitable for modern residents in Mongolia or elsewhere.

The ventilation system will work by utilizing the temperature difference between the warm indoor air and the cold outdoor air to create airflow. The ducts will split into branches at certain angles, a design that is anticipated to reduce airflow resistance. As of now, the project assumes that the ducts will be constructed from lightweight, frost-resistant PVC pipes, while the insulation will consist of felt and wool, which has approximately low thermal conductivity of 0.04 W/m·K.

Methodology:
The project will be carried out in three phases to ensure its success. The first phase will use computer modeling (ANSYS Fluent) to compare the airflow and heat transfer in a traditional yurt with the new design. The aim is to optimize the duct shape and size to better remove CO_2 and reduce heat loss. Studies on the energy efficiency of yurts demonstrate that traditional structures can offer crucial insights for optimizing modern design solutions [1].

In the second phase, a 1:10 scale prototype of the yurt will be built with 3D-printed ventilation channels and traditional felt insulation. This prototype will be tested in a controlled environment to check its thermal performance (how well it keeps heat inside) and airflow efficiency.

The third phase will focus on applying the findings from this project to propose design strategies for integrating traditional architectural elements with biomimicry and modern technology. Instead of pushing for full modernization, the aim is to inspire further exploration into how traditional structures can be enhanced with biomimicry and modern technology, ensuring they remain viable and comfortable for modern-day use.

Outcome & Impact:
Ultimately, this project aims to contribute to a more sustainable future by demonstrating how biomimetic design principles can address real-world challenges. If the design proves successful, it could offer solutions for people worldwide facing similar housing issues and contribute to the global dialogue on sustainable, portable, and temporary housing. This approach would support communities and build environmental resilience, particularly in regions with extreme climates or where traditional construction methods are prevalent.

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