

Design and visualization of virtual sunshine greenhouse

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Abstract. For the aim that designing greenhouse structure on computer and simulation virtual environment condition in accordance as reality, in the basis of reality greenhouse basic structure, constructing virtual model of sunshine greenhouse, its main part is decided by several important parameters. The experimental result on computer proved than the model is suitable and successful, it also provided a platform for greenhouse production in reality.

Introduction

Greenhouse is an important agriculture facilities, especially in temperate area and cold area, it is necessary to grain and vegetable production[1]. So, controlling greenhouse environment well will create an good environment for plant growing, it is also an important research subject[2]. Recently, with the development of virtual agriculture and intelligence agriculture, the research of virtual greenhouse got more and more attention, its aim is establishing greenhouse structure on computer through the analysis of greenhouse physical property and environment factors, simulation the same growing environment as reality[3], and its result will be an important suggestion for farmer to adjust their true greenhouse.

The basic structure of sunshine greenhouse

The main components of sunshine are structure frame, which contain containment wall, transparent cover material, fan, drencher system and other inside facilities[4]. The material of structure frame is stainless steel in common, containment wall contains front wall, back wall, left and right containment wall, transparent cover material will cover the top and front part of sunshine greenhouse, and most greenhouses have back slope, they are also have frame and covered with transparent materials[5].

Parameterization model of sunshine greenhouse

According to the structure of sunshine greenhouse, choosing parameters to construct the model. The main parameters are: length L , span S , the angle between front roof and ground α , The length of the projection of back roof in the horizontal direction P , the elevation angle of back slope β , the length of front wall h_1 , the length of back wall h_2 , ridge height H , fig.1 is a lengthwise section diagram of an sunshine greenhouse which has an arc front shed.

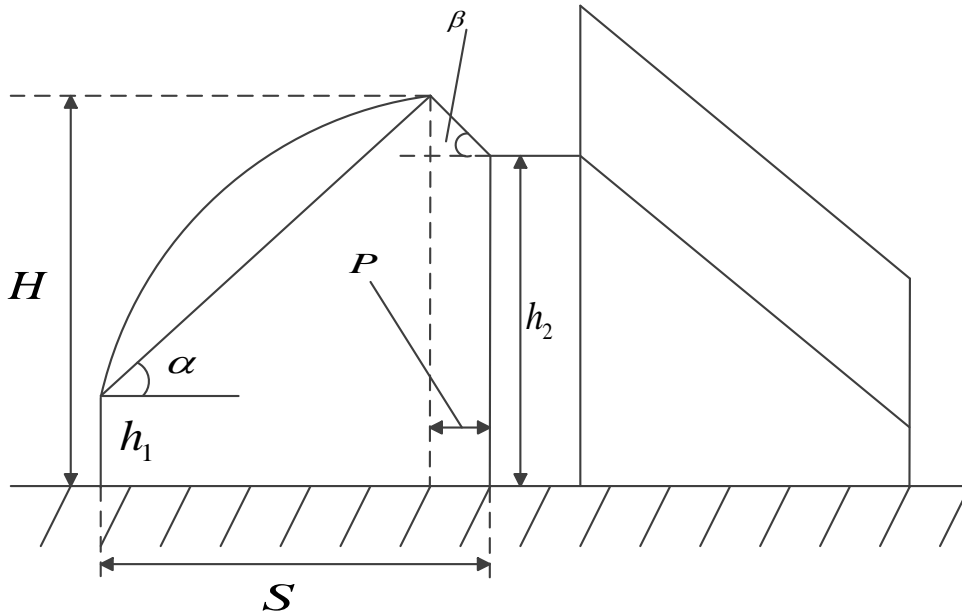


Fig.1 the Longitudinal section of sunshine greenhouse

In fig.1, the elevation angle of back slope β should be $5^\circ \sim 8^\circ$ bigger than the highest angle of the sun in the local state on the winter solstice, that means the best value range of β is $[h_{\min} + 5, h_{\min} + 8]$, here, h_{\min} is the highest angle of the sun in the local state on the winter solstice. the length of back wall h_2 is equal to the product of the length of the projection of back roof in the horizontal direction P and the tangent function of elevation angle of back slope β , that is:

$$h_{\min} = H - P \tan \beta \quad \text{Eq.1}$$

In addition, the angle between front roof and ground should conform to eq.2.

$$\alpha + h_{\min} \geq 55^\circ \quad \text{Eq.2}$$

And h_{\min} can be calculated by Eq.3.

$$h_{\min} = 66^\circ 34' - \phi \quad \text{Eq.3}$$

In Eq.3, ϕ is geographic latitude of local state.

Experimental results

According to sunshine greenhouse constraint rules, divide grid structure of greenhouse into three part: left view, right view and top view, and then construct the skeleton grid structure on the basis of the parameters and other conditions, as shown in fig.2. At last choose an material of walls and shed, adjust the light transmittance, the three dimensional model of sunshine has been constructed completely. The simulation results is shown in fig.3 and fig.4

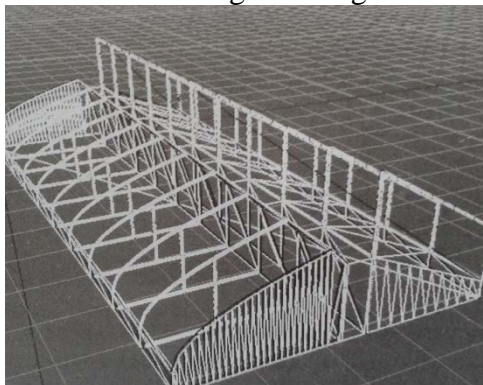


Fig.2 The skeleton grid structure of sunshine greenhouse

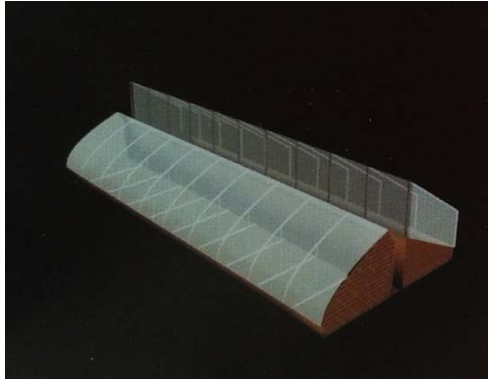


Fig.3 The simulation result of arc-top greenhouse

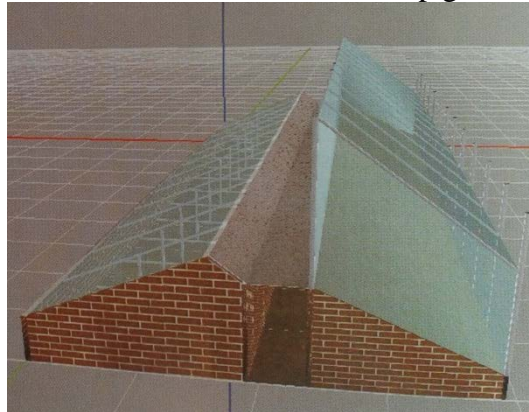


Fig.4. The simulation result of straight line-front shed greenhouse

Conclusion

Sunshine greenhouse is an important agricultural production facilities, the virtual model constructing of its structure is significant, it will conducive to the reality production of sunshine greenhouse. This paper research the structure of greenhouse and then put forward its model and constraint rules on the basis of several important parameters. Through modifying the parameters, this model can simulate different kinds of greenhouse. The simulation results on computer proved that the model is suitable to describe the structure of greenhouse and its three dimensional models are accurately and effectively.

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