



**CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY**

Name(s) Philip Q. Shao	Project Number S1220
Project Title Practical Use of Nyquist Sampling Theorem in Image Reduction	
Abstract Objectives/Goals The objective of this experiment is to find out the minimum number of pixels of a digital picture necessary to maintain the basic features of an image. As an extension of my last years experiment in time domain, this is a study of practical application of Nyquist Sampling Theorem in 2-D space domain. Methods/Materials The first part of experiment analyzes the pixel reduction (or resolution reduction) of a periodically patterned checkerboard using Microsoft Excel's cell merge and average functions. The model simulation results show that, with the correct starting point, the characteristics of the pattern can be maintained as long as a minimum of two samples per period is used. This means the Nyquist Criterion is applicable in 2-D space domain. It is also observed that when there is an offset in the starting point, the minimum sampling rate is considerably higher. The second part of the experiment is to reduce the resolution on pictures of three former presidents using the same Excel cell merge method. Three pictures of well-known faces were downloaded. They were cut into similar pixel sizes and saved in the same format as starting pictures. Some basic research in facial recognition suggested nodal points on the face are used as periods. As the resolution or the pixels, the independent variable, is reduced, the appearance, the dependent variable, of one president becomes more and more like the appearance of the others. Eventually, when the resolution drops below eight samples per nodal distance, the face becomes unrecognizable. This was explainable, because the nodal distances did not have a common pattern period and therefore were catastrophically off the correct starting point. Results See Methods/Materials. Conclusions/Discussion In conclusion, this study clearly demonstrates the Sampling Theorem is applicable in 2-D space domain. It provides a numerical tool for digital picture resolution reduction. However, from the model simulation of periodic pattern reduction, it is observed that the selection of starting point affects the minimum sampling rate and real-life image reduction confirms this phenomenon. This has wide applications from more efficient missile targeting systems, to easier facial recognition and, buddy icons.	
Summary Statement The focus of this project is to use the Nyquist Criterion to determine the minimum resolution an image requires for facial recognition.	
Help Received Mother helped type report. Helped organize board and ideas.	