Reusable Object Oriented Design for Stereographic Projections of Tetragonal Point Groups

Puvvada Nagesh , M. Radha Madhavi , M. Surendra Prasad Babu

Abstract*: *Design patterns is one of the latest technique in software development, emerged from object-oriented community. Pattern is a recurrent resolution to any normal problem. When associated patterns are merged together they forms a language that will provide a procedure for the logical purpose of software development related problems. An attempt has been made to connect these 'hot topics' with the renewed crystallography especially in the era of crystal symmetry and physical properties. The "Abstract factory method" of the patterns is applied to determine the physical properties, exhibited by the crystal belonging to the tetragonal ferroic point groups.

Index Terms: **Tetragonal** *Point Groups, Physical properties, stereographic projections, Abstract Factory method.*

I. INTRODUCTION

The occurrence of physical properties in crystals such as density, Ferro-magnetism, pyro-electricity, dielectric polarization and elasticity etc. may be determined using symmetry-operations, relating to that crystal. The combination of symmetric transformation forms a group known as the symmetric group or the point-group. The symmetric transformation reserve the space between pairs of point(s) for the body & brings it in to superposition within itself. Physical properties of crystals can be found by enumerating all the symmetry operations characterized by the molecular structure or any geometrical body. By taking into consideration the rotation, the inversion and the reflection as the symmetry elements there will be 32 crystallographic point groups. If the symmetry element translation is also taken into consideration there will be 230 space groups. A ferroic crystal contains two or more stable domains of the same structure but different spatial orientation. Aizu [7] determined all possible species of full or partial Ferro-elasticity and Ferro-electrics for the 212 non-magnetic ferroic species. In the present paper an attempt has been made to apply the abstract factory method of the "Design pattern" to determine whether a crystal exhibits a physical property or not, taking into consideration the generating elements of a group and applying on them the tensorial property.

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II. DESIGN PATTERNS

Design pattern(s) names, extracts and recognized the important aspects of a shared design arrangement that style the valuables for making a re-usable object-oriented design. Pattern is a called nugget of informative info that capture(s) the vital structure & insight in a effective family of established solutions to a recurrent problem that will arise with-in a assured context & system of force(s). Every pattern is always a three-point rule & expresses all relations between

- certain content
- certain scheme of force(s) which happens repeatedly in the context &
- certain s/w configuration, always allows this force(s) to decide themselves

Design patterns exist since very typical level explicit solutions to broadly widespread system issue(s). Hundreds of pattern(s) are available in literature.

The process of looking for a pattern (i.e. discovering a suitable pattern for the current problem) is called pattern mining. This involves the issues such as

- Looking for how design pattern solves the design problems
- Scanning the intent section of each pattern to find out one or more that sound relevant to the current problem.
- Study of how patterns interrelate each other
- Study of patterns of like purposes
- Consideration of what should be the variable in the current design

The applications of design patterns involves the issues such as

- Reading the patterns thoroughly and ensuring that the pattern selected is a right one for the current problem
- Choosing the name(s) for the pattern participant(s) that is meaningful in all the application(s) context.
- Looking at the sample code section of a concrete example and learning the implementation technique for the current problem.
- Studying the structures participants section and identifying the classes and objects in the pattern.
- Define the classes
- Define application detailed names for operation(s) in the pattern(s)

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- Implement the operation(s) to carry the tasks and collaboration(s) in all the pattern(s).

Depending upon the purposes of the design pattern can be classified into three categories.

- Creational patterns: The objects created instead of initiating them directly. Here programs gain additional flexibility in determining which object(s) need to be produced for any given scenario.
- Structured patterns: These pattern(s) helps in composing group(s) of objects into bigger structure(s) such as complex interface & accounting info.
- Behavioural pattern: These patterns helps to describe communications between objects in the system & the movement of control in a complicated program.

There are 23 design pattern(s) that were implemented in java in literature for different varieties of problems. The following diagram illustrates a hierarchy of java design patterns.

III. ABSTRACT FACTORY PATTERN

A modest factory pattern always returns an occurrence of several probable classes dependent on this data to provide for it. However an abstract-factory pattern technique is one range of generalisation than this factory pattern technique. This pattern(s) can be recycled to reuse one of the multiple different related objects or classes each of which can return multiple different object(s) on request call. This pattern can be understood by the following garden maker factory application.

IV. ABSTRACT FACTORY PATTERN TO CRYSTALLOGRAPHY-FERROIC POINT GROUPS:

Each geometrical-body or molecular arrangement is categorized by a group of symmetric operation(s) which when totally enumerated constitutes a point-group. There are seven well known crystal systems and all the lattices should fall under one or other of these categories. In turn these seven systems generate 32 point groups. The occurrence of physical properties can be determined by the symmetry operations of the group relating to a crystal. The abstract factory pattern method has been used to determine whether a crystal exhibits a physical property or not. Here the generating elements of a group are considered and the tensorial property is applied on them to determine the physical properties exhibited by the crystal. The basic structure and features of the main program consist the following

- In the place of the class plant of the garden application my object class is introduced.
- In the place of the garden class Abstract Factory class has been introduced.
- In the place of Gardener class Abstract Factory Application class is introduced to control the whole program.
- By passing the parameter to the make element ( ) of the Abstract Factory class 7 possible classes may be generated. But in the present context a single class which preserves all the properties is constructed.
- The present application consists of four server classes and one client class.

V. RESULTS AND DISCUSSIONS

The drop down box of the java frames has been used to show the physical properties as well as the structure of all the 7 tetragonal point groups. The structure and the physical properties exhibited by the crystal for the point groups $\bar{4}$, $4, 4/m$ $\bar{4}$2m, 4mm,422, 4/mmm is obtained by selecting the each point group in the drop down box of the application frame.

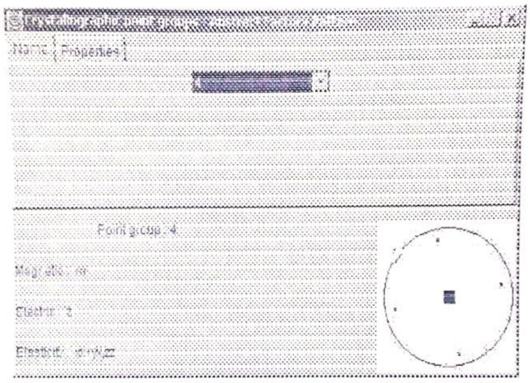

Fig 1: Stereographic projection and physical properties of tetragonal point group 4

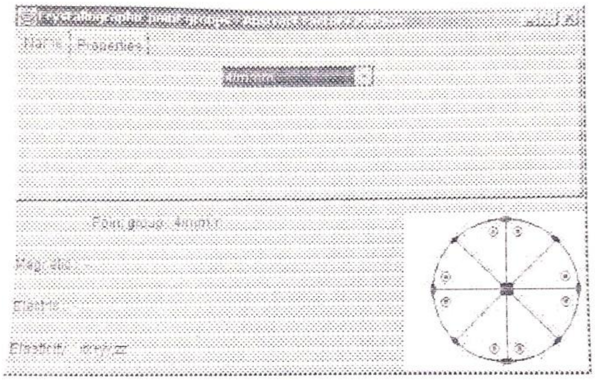

Fig 2: Stereographic projection and physical properties of tetragonal point group $\bar{4}$

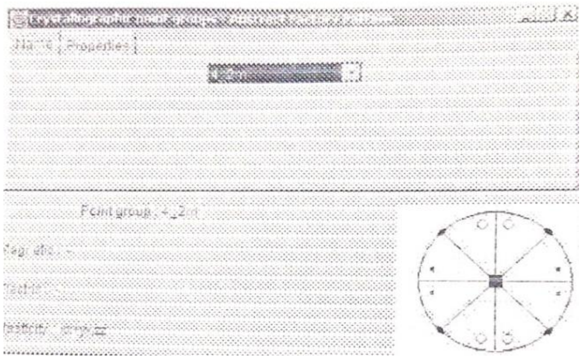

Fig 3: Stereographic projection and physical properties of tetragonal point group $\bar{4}2m$

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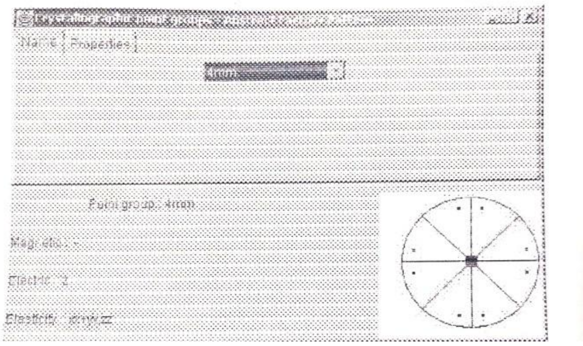

Fig 4: Stereographic projection and physical properties of tetragonal point group 4mm

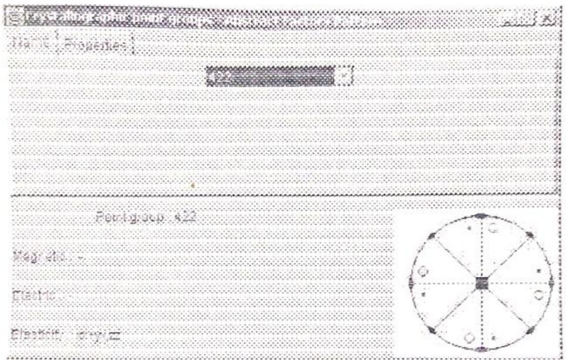

Fig 5: Stereographic projection and physical properties of tetragonal point group 422

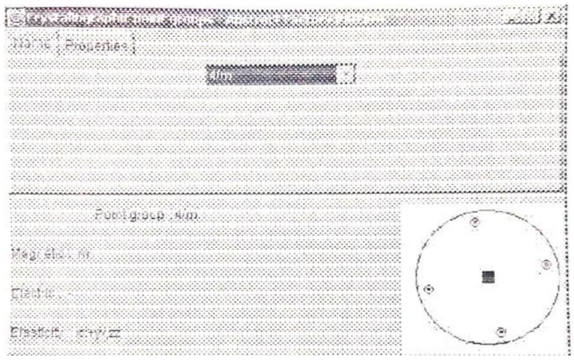

Fig 6: Stereographic projection and physical properties of tetragonal point group 4/m

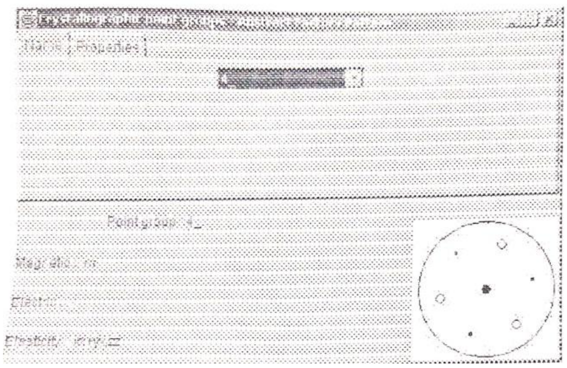

Fig 7: Stereographic projection and physical properties of tetragonal point group 4/mm

VI. CONCLUSIONS

In the method make element ( ) of Abstract Factory class, based on the parameters passed, a new element is constructed which may take 7 possible forms, which returns the required outputs. This process eliminates a high degree of redundant code and execution time. Thus the basic object oriented features of the java design patterns i.e. the data abstraction and encapsulation etc. helps in better design for complex broadly generalized system. This signifies that the present work can also be extended to the other classes of 32 point groups and 212 non-magnetic ferroic species for their full or partial physical properties as well as their stereographic projections of the geometrical bodies.

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