Application for conversion of types of cut XpYm and angles in a fishing net

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Abstract—The trawling fishing system is nowadays the most important and more used among all the caught systems in the fishing industry. Its most significant feature relies on the capability of capturing very different fish species. The modern technology seems to be the way to reach major improvements in such an environment, where there's not enough data available for research. When looking for new solutions, simulation and optimization of new models will surely reduce manufacturing costs.

Keywords—Fishing, Optimization, Trawl geometry, Trawl net, Type of cut.

I. INTRODUCTION

IN this paper a novel stadium design of fishing nets oriented application is presented, related to the types of cut of the net to allow its subsequent manufacturing.

With this innovative application it will be possible to manage a large number of types of cut. Among these types of cut, the usual cuts in the construction of nets are included, as well as combinations of them [1].

The type of cut for fishing nets is a determining factor in how the net will work in the sea, since this factor is directly related to the width and length of the fishing net as well as to the type of fish to capture and even with the type of trawling system [2], [3].

The characteristics of the target to be captured, the distribution type and the form of fish concentrations, and the nature of their migration determine fundamentally the type of trawling system and the type of construction of the fishing net [4].

For example, in the case of pelagic species, which inhabit most of the time in layers of half water, we must use the half-water trawling system. While if the species is located on the seabed or near it, the bottom trawling or semi-pelagic system is chosen.

Regarding the type of construction of the net, it is especially determined on the basis of concentrations of species to capture. That is, each species moves along the sea in a particular way, forming different shapes for shoals [5], [6], [7], [8].

The result of this analysis lets the designer chooses a net more or less elongated in the vertical or horizontal plane.

II. STATE OF THE ART

So far the basis geometry has been dealt with, as a simplification way for application in formulas, as dependent of the coefficients of vertical and horizontal opening of the grid [9].

Another approach to the problem might involve taking into account each netting individually, as shown in the next figure.
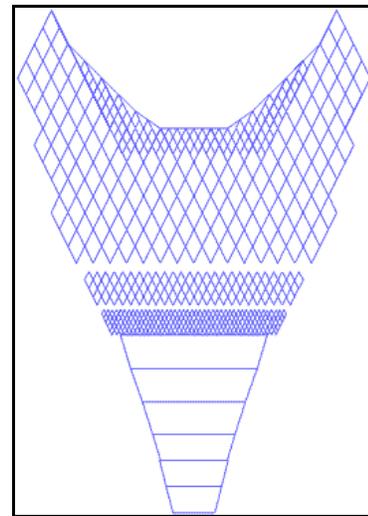

Fig. 1. Computer aided software for fishing nets design.

The panel, when we understand it as a constituent of the nettings, which make up the structure of the fishing net, has been modelled on other occasions in a very simplified way, as shown in the following figures.
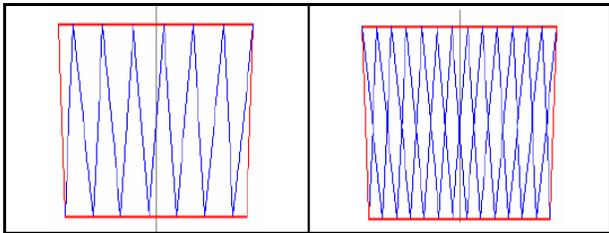
Fig. 2. Modelling of panels in a simulation application.

The extension of the model based on individual elements, saving neighbourly relations among the nodes once they are grouped, covers the definition of all types of panels with or without lateral different cuts [10], [11], [12].

III. GEOMETRY

For all the calculations that are going to develop below, some basic relationships have been taken into account to be fulfilled in the structure of basic mesh (structure that will be repeated in the geometric shape determined by the cuts in different parts of all the nettings).

That structure, as you can be see in Figure 4, consists of 4 sides and 4 vertexes (concurring in turn each of these vertices with the coordinates of the 4 nodes located at the intersections of these sides).

The length of the sides (longitudA) can be obtained in several ways:

Height of the mesh 2H:

$$H = A * \cos(\beta) = A * \sin(\alpha) \qquad (1)$$

Width of the mesh 2W:

$$W = A * \cos(\alpha) = A * \sin(\beta) \qquad (2)$$

By default the values of 60º and 30º for angles alpha and beta respectively are considered as initial conditions, at least for the static case in 2 dimensions (this could change within the configuration of the application).
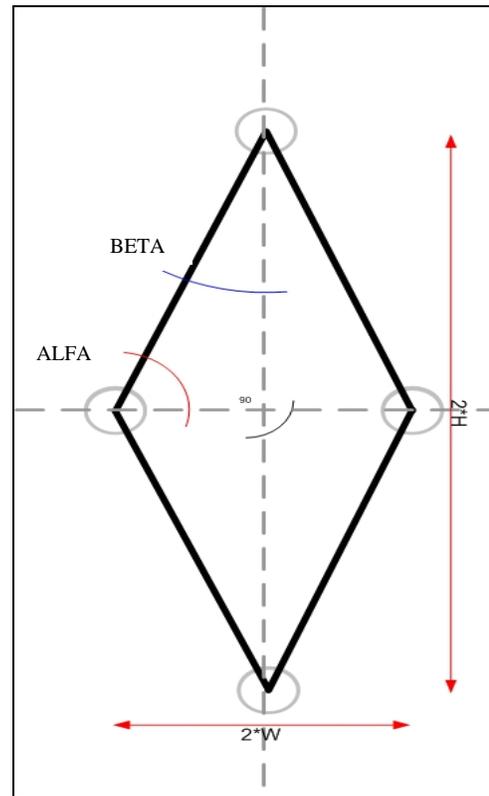

Fig. 3. Geometry of the basic mesh.

IV. MATHEMATICAL DEVELOPMENT FOR THE TYPE OF CUT XP YM

The figure below shows the outlines of the basic forms related to the types of cuts:

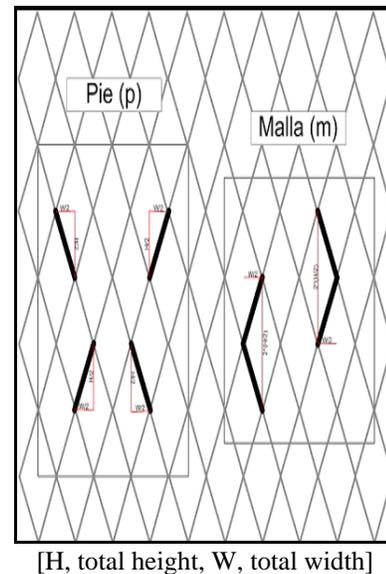
[H, total height, W, total width]

Fig. 4. Basic forms for the construction of the various cuts.

The mathematical expressions related to the cuts of the type XpYm, depending on the angle α, as in (3) and (4):

Calculation angle θ - (2p2m):

$$\cos(\vartheta) = \frac{(2) \cdot a \cdot \cos(\alpha)}{\sqrt{(2)^2 \cdot (a)^2 \cdot \cos^2(\alpha) + (2+4)^2 \cdot (a)^2 \cdot sen^2(\alpha)}} \qquad (3)$$

Calculation angle γ - (2p2m):

$$\cos(\gamma) = \frac{(2+4) \cdot a \cdot sen(\alpha)}{\sqrt{(2)^2 \cdot (a)^2 \cdot \cos^2(\alpha) + (2+4)^2 \cdot (a)^2 \cdot sen^2(\alpha)}} \qquad (4)$$

Expressions depending on β:

Calculation angle θ - (2p2m):

$$\cos(\vartheta) = \frac{(2) \cdot a \cdot sen(\beta)}{\sqrt{(2)^2 \cdot (a)^2 \cdot sen^2(\beta) + (2+4)^2 \cdot (a)^2 \cdot \cos^2(\beta)}} \qquad (5)$$

Calculation angle γ - (2p2m):

$$\cos(\gamma) = \frac{(2+4) \cdot a \cdot \cos(\beta)}{\sqrt{(2)^2 \cdot (a)^2 \cdot sen^2(\beta) + (2+4)^2 \cdot (a)^2 \cdot \cos^2(\beta)}} \qquad (6)$$
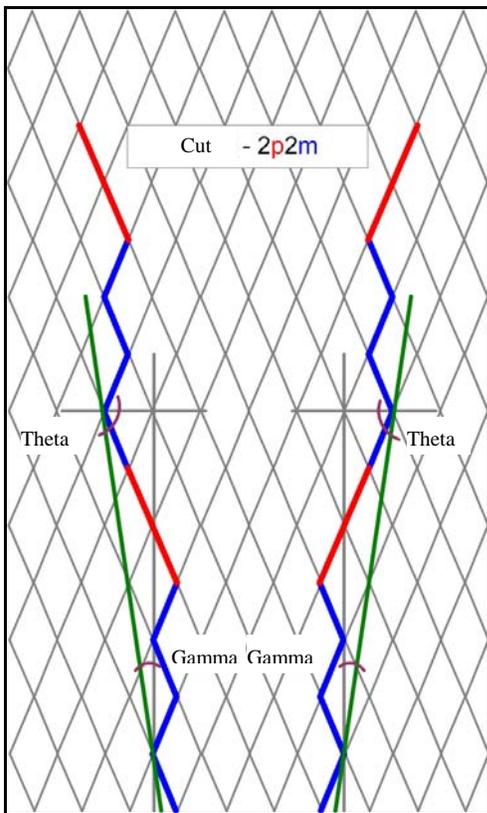

Fig. 5. Expressions and geometry of the type of cut 2p2m.

V. APPLICATIONS FOR CONVERSIONS

It has built a simple application that allows you to calculate the angle of attack of a netting, directly from the type of cut. The application allows the user to interact with the input data through a simple user interface, getting some numerical results of associate parameters as well as a schematic preview of the selected type of cut (application has been developed using Matlab software).

Application consists of different elements that are shown in the Figure 6.

The tool is based on the development of the different types of cuts that there may be in a netting, and always taking as a starting point the relations that have been highlighted within the geometry of the basic mesh.

Additionally, we present a novel application oriented to the design stadium of fishing nets, related to the types of cuts that allow its subsequent construction. The application is supported by a series of geometrical developments, to manage a large number of types of cuts. Among these types of cuts, the usual cuts in the construction of nets are included, as well as combinations of them.

Following, in the Figure 7, a screenshot of the dialogue that the application shows can be observed. In one part of the dialogue may be requested the conversion of type of cut to angle and in other part of the dialogue the reverse conversion can be requested.

The application, developed in C++, uses two similar objects to represent the entities, strCorte and strMultiCorte, which respectively represent a type of cut and a combination of types of cuts.

By default, in the initialization of the application, it fills a one-dimensional array of objects of type of cut with the full range of initialization strings of type of cut (a total of 4096 or 8192 items, powers of number two to optimize the management).

The conversion of the string of characters of type of cut to a value of angle in radians is direct. We only have to parse the content of the type of cut and calculate the digits and its parameters (m, p, mf), and then apply the corresponding formula depending on the circumstances in which the application is. Also, the application takes into account the case of combinations of cuts, making the conversion to the corresponding cut in each case.

The reverse conversion, from angle to type of cut, however, is not so simple. If we obviate part of the spectrum of possible types of cuts, then it is possible to obtain direct numerical relationships with parameters growing with the types of cut (1pYm, 1pKmf, ..., etc.).

But in the case of our application, we automatically calculate the angle corresponding to each element of the initial list of types of cut that we have generated (using the
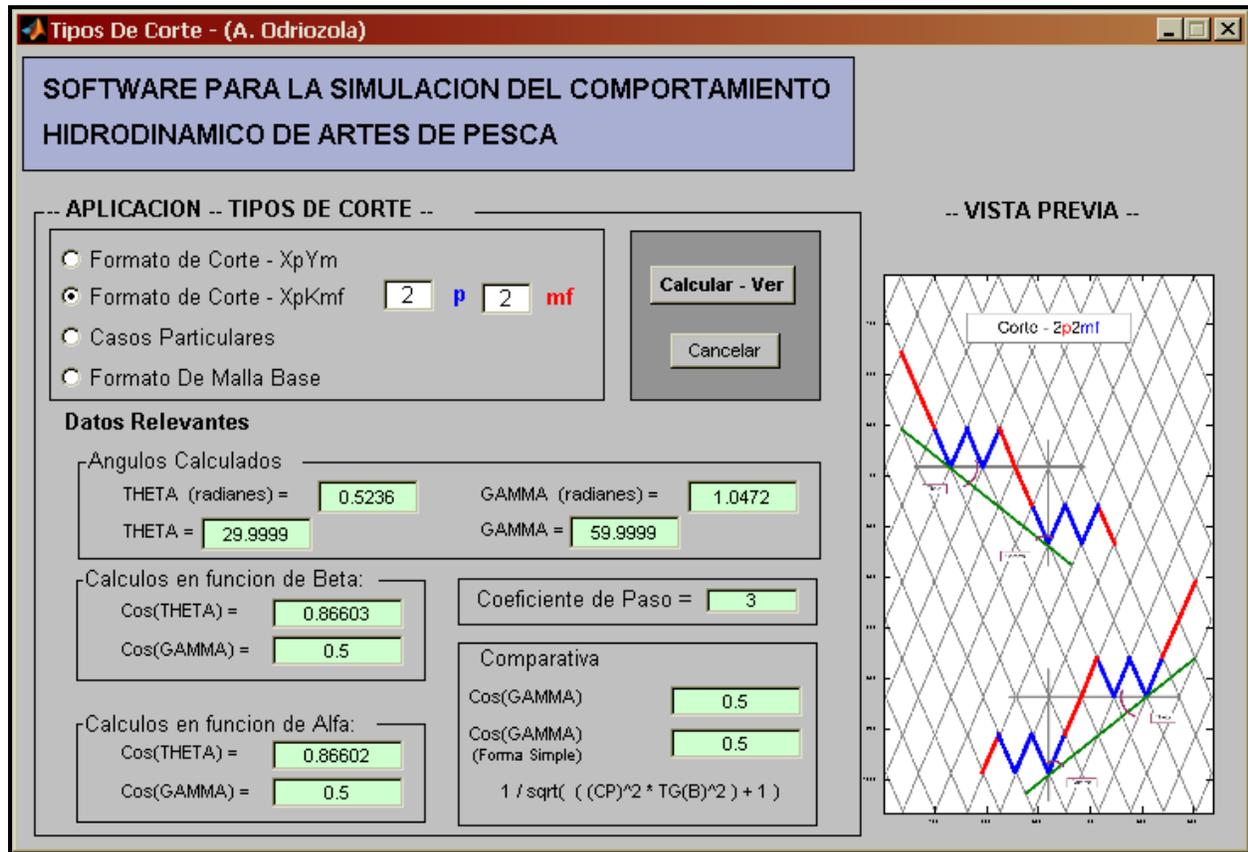
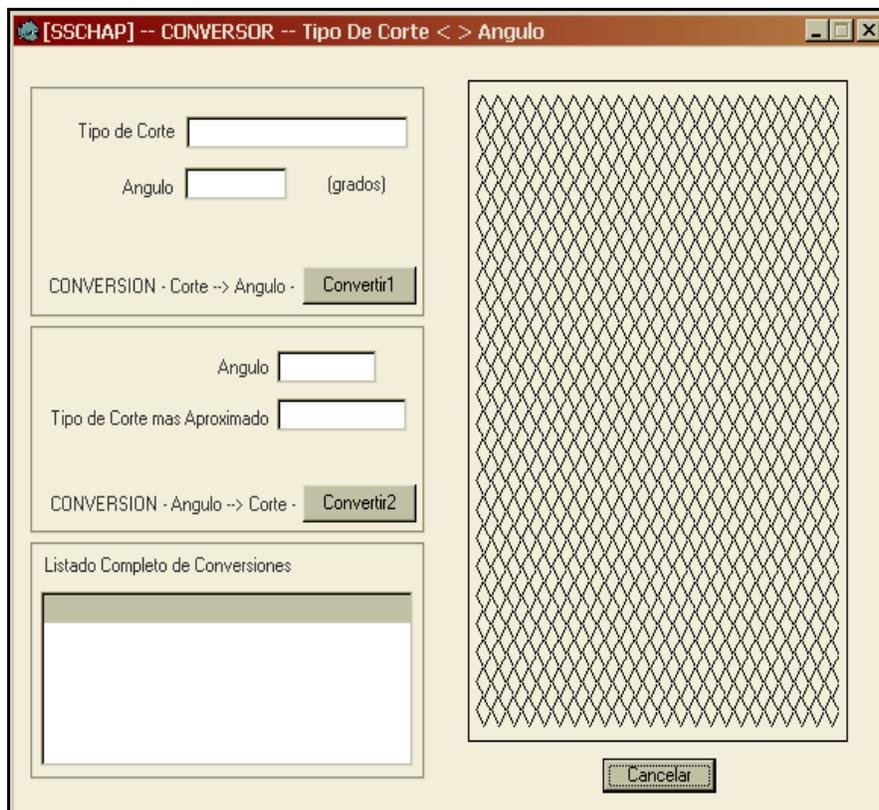Fig. 6. Application for conversion of types of cuts [Matlab].

Fig. 7. Dialogue of the application for conversion.

corresponding formula), and later use an implementation of sorting algorithm QuickSort directed to the structures of type of cut that have been mentioned, and perform a growing order on the basis of this angle. The list at the bottom of the dialogue is filled on the basis of this list of data pairs (type of cut-angle) once it has ordered.

Fig. 8. Complete list of conversions.

With the array of pairs of data ordered, application will do any request to resolve the most approximate type of cut through the angle, conducting a search within the array, to find, within the available list, the angle that offers a lower difference with the angle inserted by the user.

Regardless of which of the two options for conversion is chosen (conversion angle to type of cut or type of cut to angle), the system represents at the right side of the dialogue the outcome of the application. The figure shows the representation of the type of cut 1p1m on the right side of the application.

For the representation, we use the geometry of the panel and the type of cut selected, we make a series of triangulations of position on the basis of known coordinates and of a basic grid with structure Lattice (resulting of normalizing the grid of generation of coordinates based on standard dimensions of the basic mesh of the used panel). And with all these data the system decides whether it represents or not the corresponding line between the source node and the destination node in question.

Finally, it is possible to run the application from the command console. The options are similar in regard to the possibility of conversion, except for the fact that it is possible to get a complete list of available conversions in the initialization array.

Anyway, the application supplies help. The result is obtained in the standard output, with the possibility of using pipes to redirect to a file.

The following table shows some of the types of cut most widely used in manufacturing, along with its conversion to associated equivalent attack angle and step coefficient. Data have been generated by applying Types of Cut (for Matlab environment).

Table 1. Types of cut used more frequently.

TYPE OF CUT	ANGLE [γ]	STEP COEFFICIENTS
tm	0°	0
2p11m	2.7545°	0.083333
2p7m	4.1278°	0.125
2p5m	5.4964°	0.16667
2p3m	8.2132°	0.25
1p1m	10.8934°	0.3333
2p1m	16.1021°	0.5
3p1m	19.10°	0.6
4p1m	21.0517°	0.66667
5p1m	22.4109°	0.71429
tp	30°	1
4p1mf	40.8934°	1.5
2p1mf	49.1066°	2
1p1mf	59.99°~(60°)	3
tmf	89.99°~(90°)	1000000~(∞)

VI. CONCLUSION

The mathematical developments of the types of cut used in the nettings used in the fishing industry allow generalize calculating profiles so that it is possible to know the contours of a panel according to the openness that the configuration of its basic mesh presents. This knowledge provides significant benefits for the modelling structures that allow deal with the simulation of the hydrodynamic behaviour of fishing nets.

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