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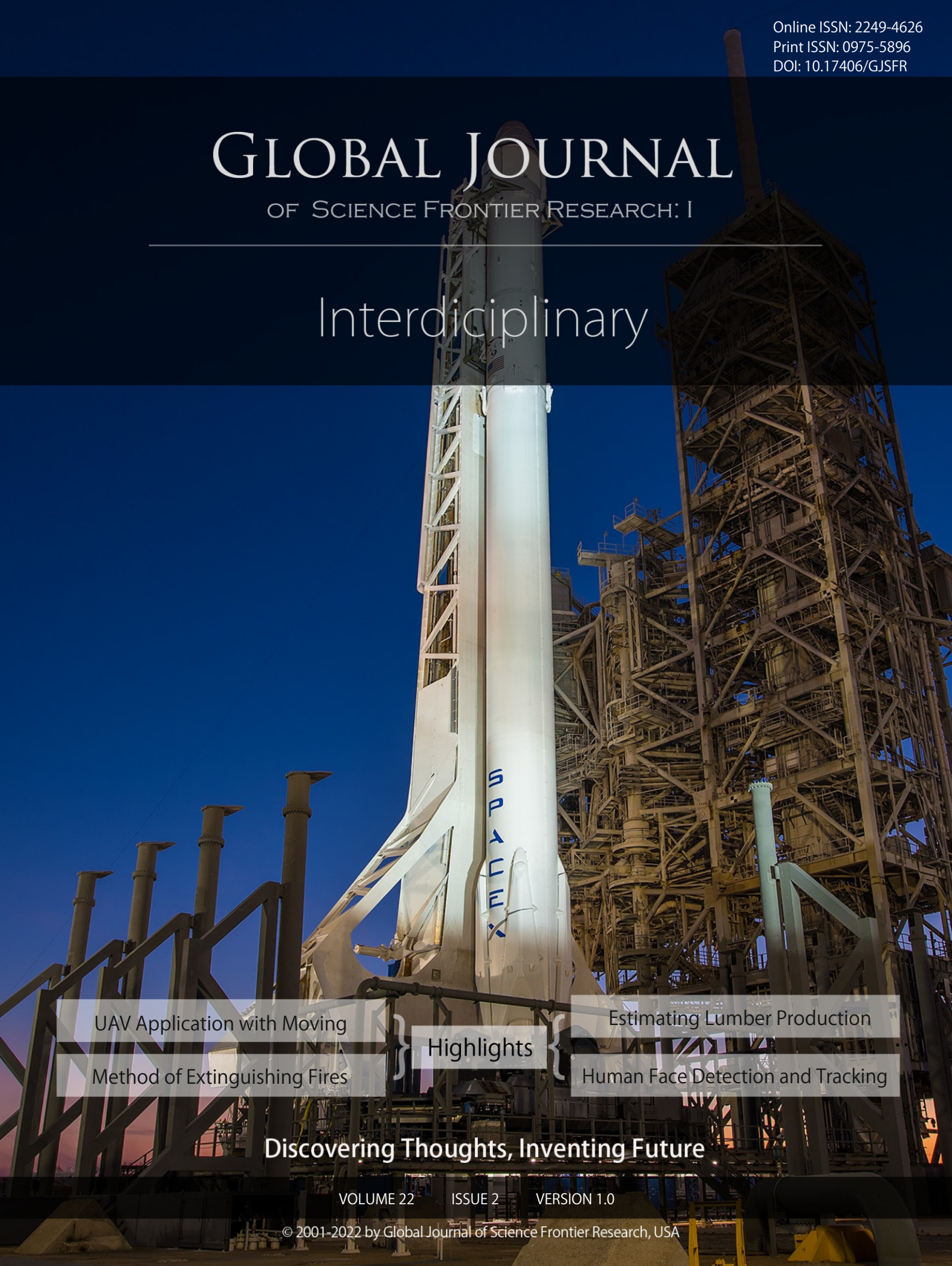

Highlights

- UAV Application with Moving Method of Extinguishing Fires
- Estimating Lumber Production
- Human Face Detection and Tracking

Discovering Thoughts, Inventing Future

VOLUME 22 ISSUE 2 VERSION 1.0

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The Method of Extinguishing Fires using an Antifire Rockets

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Abstract- This article presents a Firefighting Method Using Automated System On The Basis Of Multiple Launch Rocket Systems (Patent for a utility model of Ukraine No. 123017 dated 12.02.2018 Bull. No. 12 dated 25.06. 2018. Electronic document identifier 3305200618). It is used to extinguish fires in hard-to-reach areas and difficult conditions. These are: powerful wind, thermal radiation, complex terrain (mountains, hilly terrain), buildings in cities (high-rise buildings and skyscrapers). And also it uses in the aftermath of disasters (chemical and radioactive contamination of the area), in industrial areas, among the destruction resulting from the consequences of attacks. The method uses an automated fire safety system based on multiple launch rocket systems. Here, fire extinguishing is carried out with the help of an automated volley of fire-fighting missiles from the transport and launch containers of the network.

Keywords: method extinguishing fires, rocket systems, multiple launch, automated safety system.

GJSFR-I Classification: DDC Code: 614.845 LCC Code: QC100

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The Method of Extinguishing Fires using an Antifire Rockets

Galyna Sokol [α] & Andrey Sokol [σ]

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I. Introduction

Fires continue to tear apart our planet. Such types of fires as forest fires are becoming an increasingly acute problem around the world affecting life on our entire planet. In just the past few years, large fires have besieged a number of countries, including the United States, Canada, Ukraine, Australia, Spain, Portugal, Russia, Turkey, and Brazil, and even such regions as Greenland and Northern Europe [1-6].

According to the National Fire Protection Association (NFPA), over the past 3 years, 40,000 buildings have been destroyed in the United States alone, 100 people have died and almost $ 40 billion in insured losses have been paid due to wildfires.

According to preliminary estimates, the United States spends no less than $ 2 billion a year on fighting wildfires.

As it gets hotter and drier in the world, most experts believe wildfires will become even more intense in such regions as Australia, California, the Mediterranean, and Central Eurasia.

Global fire protection associations are working on new standards and practices that address wildfires. One of the ways to increase efficiency of fighting against forest fires and fires in general is the use of automated systems for detecting and extinguishing fires.

The aim of this article is working and studying the method for extinguishing fire with the use of automated fire safety system based on reactive fire systems.

The following tasks are solved herein:

- Drawing up an analytical review of the use of liquid rockets to extinguish fires.
- Development of a new method of extinguishing a fire.
- Creation of an automated system for use in the method of reactive fire systems.

II. Analytical Review of the use of Liquid Rockets to Extinguish Fires

It is known that in cases of firefighting in hard-to-reach places (such as forest fires) in our country and abroad use helicopters, light and medium aircraft that discharge water or special liquid for fire, such as AN-32P (Ukraine), SN-415 Canada) and even heavy transport aircraft S-130, DM-6 (USA), IL-76 (Russia) [1-6] The disadvantage of this method is the low efficiency due to the high values of the resistance of the aerodynamic and output streams of combustion products from fire at a small plane of extinction.

It is known the air delivery of the water in special suspended tanks and targeted discharge of water into the centre of the forest fire when the helicopter hovers over the centre [7].

The disadvantage of this method is the weak and uneven spraying of water, which leads to a small area of effective extinguishing, significant non-target water losses due to constant rocking of the water tank. The presence of powerful ascending and descending air currents affects the accuracy of the aircraft relative to the fire zone, as the helicopter can rarely fly at an altitude of less than 100 m above the forest fire due to this.

There is a method of extinguishing fires using a number of devices from launchers with fire extinguishers. They are launched with a single or volley launch. The fire extinguishers have equipped with an explosive fire extinguishing agent. A satellite tracking system to extinguish the fire is used.

Necessary aeration and scattering of explosives are provided by the rupture of the charge remotely at a

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height of 20-25 m from the ground level to extinguish from above the tops of the forest. They are can use contact breakers. They are triggered by contact with trees or the ground, providing extinguishing ground fire [8].

The disadvantage of this method is the high dependence of the speed of fire extinguishing on the time of arrival of fire extinguishers from storage to starting devices and staff readiness. Personnel carry out work to prepare and launch fire extinguishers.

There is a method of using traditional high-explosive and high-explosive munitions to extinguish forest fires.

The disadvantage of this method is the danger of its use due to the possibility of re-ignition [9].

III. Problem Definition the Antifire Rockets Automated Multiple Launch Rocket System

A method of extinguishing fires using an automated safety system based on multiple launch rocket systems is working [10].

The Global fire protection associations are working on new standards and practices that address wildfires. One of the ways to increase efficiency of fighting against forest fires and fires in general is the use of automated systems for detecting and extinguishing fires.

The «Antifire Rockets» automated multiple launch rocket system is a network of transport-launch containers. This network of transport-launch containers is managed by the Center for Remote Monitoring and Control, and if necessary, information from Earth remote sensing satellites can be used.

At the same time, the autonomy of the transport-launch container while identifying and launching missiles in the automatic mode for extinguishing fires is preserved. System composition are depicted in Fig. 1.

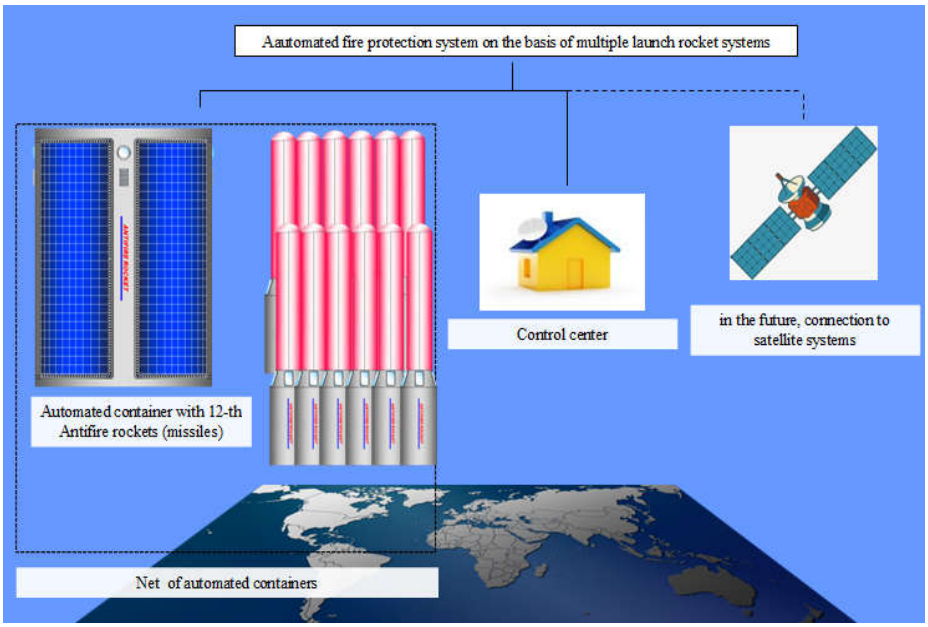

Fig. 1: The system composition

The "smart" firefighting missile it self consists of two units: a unit with a fire extinguishing agent and a reusable jet drone.

System composition the Transport and Launch Container are depicted in Fig. 2.

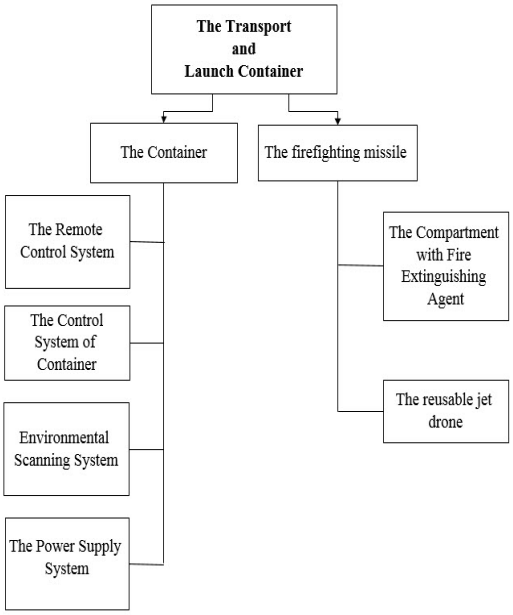

Fig. 2: System composition the Transport and Launch Container

The jet drone is equipped with the necessary sensors, smart avionics, and controlled jet engines, which allows the firefighting missile to bypass obstacles while flying to the target.

Launch of Antifire Rockets are depicted in Fig. 3.

The "charge" of one robotic firefighting missile is capable of spraying a fire extinguishing agent over an area of ~100 м2 (~1000 square feet). One container contains twelve robotic firefighting missiles, which makes it possible to extinguish twelve ignitions or a forest fire with an area of ~1200 $м^2$ (~12000 square feet).

In the event of lacking firefighting missiles when extinguishing a fire from one transport-launch container, neighboring transport-launch containers from the network will be connected to extinguish the fire.

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The compact dimensions of the transport-launch container allow it to be transported in the back of a conventional pickup truck.

Initially, the system was considered as a means of extinguishing fires in high-rise buildings. But it can also be safely put in defense of densely populated areas and megacities, in industrial areas.

There are dangers of contamination with hazardous substances during a fire, as well as objects on the water surface.

Unlike existing vehicles for extinguishing fires, «Antifire Rockets»:

- Do not depend on the state of the road surface, traffic jams, and landscape drops, like the fire fighting vehicles;
- Do not depend on weather conditions, like firefighting aircrafts;
- Do not require preparatory measures and deployment of fire brigades.

Fig. 3: Launch of Antifire Rockets

Types of fires are depicted in Fig. 4.

Fig. 4: Types of fires

Along the way, this system can not only monitor the surrounding area in order to detect ignitions, but also provide relevant information in real time for law enforcement agencies, hydrometeorological services, as well as provide sparsely populated areas with wireless communication, etc.

Achievements of Ukrainian scientists will help to solve the issue of prompt fire extinguishing at the stage of ignition and thus save the population and business from more global damage and, as a result, colossal insurance payments.

IV. Conclusion

The research papers dedicated the method for extinguishing fire with the use of automated fire safety system based on reactive fire systems.

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Calcmadeira: Software for Estimating Lumber Production

By Thomaz Costa, Luiz França, Tiago Santos, Lucas Barbosa Ramos & Monica Campanha

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Abstract- One information that is generally not used but is still essential to the economic evaluation and wood yield of the sawmill production chain is the quantification of lumber a priori. The few applications that provide a solution to this problem work with one log at a time and generally use optimization techniques instead of cut pattern models. The software developed for this work uses trigonometric rules, applying the circumscribed square (block), longitudinal (or tangential), log rotation, and radial cut patterns to help a producer sell a tree not in cubic meters but as a function of the pieces obtained from trees. Six tests were performed using trees and individual logs. The comparison between the calculated and milled or drawing pieces was presented for each model. The total errors obtained were approximately 2% for priority pieces. The best accuracy for the number and volume of the lumber pieces was 2.2% and -5.4%, respectively, obtained with a 30° angle of the slab (waste wood) and 0.60 to the proportion of the radius parameters in the model that rotates the log. The total calculated and observed piece width distributions were statistically equal in the radial model. This application requires observation of the milling operation while monitoring parameters in a heterogeneous sample of wooden logs to obtain the best results.

Keywords: timber, log, cut pattern, saw, wood.

GJSFR-I Classification: DDC Code: 662.88 LCC Code: TP339

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I. Introduction

The supply of planted forests with homogeneous dimensions favors creating business rules to support wood management and processing. As a result, information reported of the pieces milled per tree or log (number, volume and potential revenue), allows suppliers the opportunity to trade their wood in more profitable markets (Costa et al. 2016).

Business rules can also assist in the native forest wood trade with some limitations, due to different ages and heterogeneous dimensions. An example is the Brazil concessions for management plans in national conservation forests, which has been making since 2014.By means of monitoring and inspection systems, the product from tree to sale is tracked, guaranteeing the legalization of logging products. An essential variable in this process is the yield of lumber, which depends on the diameter of the logs, the combination of the cutting pattern with the dimensions of the pieces, and the occurrence of defects, such as knots, tortuosity, and cracks, as well as the general health/quality of the lumber (Bonato et al. 2017; Cunha et al. 2015; Juízo et al. 2014; Mahica et al. 2013; Rocha and Tomaselli 2002).

Currently, monitoring and inspection systems use a volumetric yield coefficient of 35%, which is the ratio between the volume of milled wood and the total log volume (Brazil 2016). When applying this coefficient, if the sawmill obtains a yield lower than this percentage, it can receive authorization to extract wood from the forest above what was established by the management plan. If the yield is higher than 35%, the supplier must retain the surplus wood in the yard without a sales receipt.I.e. the technical criteria is not suitable, which consequently increases the environmental impact on the forest or give costs for sawmills.

Given that the volumetric performance studies used to inform the environmental agency of the actual yield of milled wood are expensive and may vary according to the demand for milled products and the quality of the wood in stock, it would be advisable to use software to perform this estimate instead of adopting a fixed, arbitrary value for several sawmills. Another function of this software would be to support production planning so that sawmills could estimate the stock and revenue of milled pieces.

Computational tools used for estimations in multiple tree products are not a novelty. Most of these tools are used to optimize wood volume for firewood, cellulose pulp and lumber (Binoti 2012; Oliveira et al. 2011; Oliveira 2011; Soares et al. 2003; Chichorro et al. 2003; Leite 1994) or estimate growth in forest production and milled wood; examples include Dyna Tree, Saw Model and Sigma E softwares (Nunes 2013; Leite 1994), Sis Eucalipto (Oliveira 2011), and RPF (Binoti 2012). There are also scanning methods (Halabe et al. 2011) that evaluate or simulate sawmill processes (Vergara et al. 2015; Murara et al. 2013; Voronin et al. 2012; Heinrich 2010; Maturana et al. 2010; Baesler et al. 2004; Lin et al. 1995; Steele 1984).

Computational solutions for lumber, which calculate the conversion into milled pieces, are intended for commercial use or were developed solely for technical and scientific purposes. Among the commercial applications are MaxiTora (Serpe et al.

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2018; OpTimber 2020), CutLog (TEKL STUDIO 2018), TimberLOG (Timber Vision 2020), and Pitago Optimizers (2020). Most of these solutions are based on linear programming, a technique applied to optimize the dimensions of selected pieces in a section of the trunk.

CalcMadeira provides a new solution when simulating cut patterns applied to trees or individual logs. Its algorithms use trigonometric rules (i.e., arrow concepts, string, sine, and cosine) rather than optimization techniques (Costa et al. 2019a; 2019b; 2020).

Most sawmills do not adopt a cut pattern model. Instead, they entrust the cutting performance to the experience of the saw operator. Therefore, a pattern that parallels the empirical procedure performed by the operator is proposed. In the approximated pattern, the log is turned 180° and 90°.The parameters used in this model are cited in the method described later in this article.

The goal of this work is show and validate these cut models (circumscribed square, longitudinal (tangential), turn 180°/90° and the radial), comparing the accuracy between the number of pieces of wood calculated by the software and that obtained by the sawmill or by drawing in the face of the log.

II. Materials and Methods

In this section, the models for trees and milled wood are described, followed by the structure of the tests. Then, data is collected and calculated, and the statistical analysis is presented.

a) Taper model

The software adjusts taper functions using the Kozak et al. (1969) model and volume with the Schumacher and Hall (1933) model from taper data to estimate milled product from trees. The Smalian formula is used to estimate the milled product from log.

b) Models for milled wood

As shown in Figure 1, four slab cuts are made to the circumference for the circumscribed square cut pattern. The saw stays in the remaining square and begins to saw the lumber. In the longitudinal cut pattern, the saw first cuts the lateral slab and then begins parallel cuts on another side with the last amount of the slab cut. The model that rotates the log at 180 and 90 degrees combines the two models previously described. To begin this cut, the angle *a* is defined for the slab (Figure 2). The chord is the width (*L*) available for lumber and is calculated by Equations 1, 2, and 3, where *D* is the diameter of the log, the arrow (*f*) is a parameter that increases as the pieces are selected, and (*b*) is the angle calculated from the thickness of the lumber.

In the model that rotates the log, when *f* reaches the limit established by the radius ratio, which is the parameter that defines the maximum *f* for the longitudinal cut, the cut is interrupted. The same procedure is repeated on the opposite side (i.e., a 180° turn of the log). With the second interruption, the remainder (i.e., a rectangle plus two slabs) is rotated 90° to perform the procedure using the circumscribed square model, where $L = \frac{D}{\sqrt{2}}$.

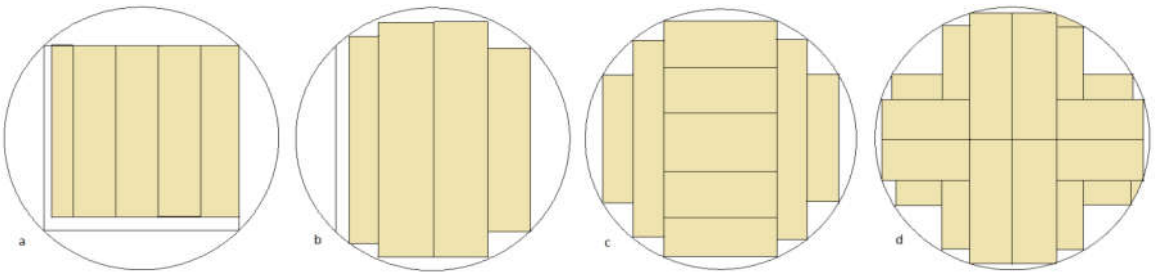


Fig. 1: Cut patterns for milled wood: a) circumscribed square; b) longitudinal; c) 180° 90° turn log; and d) radial

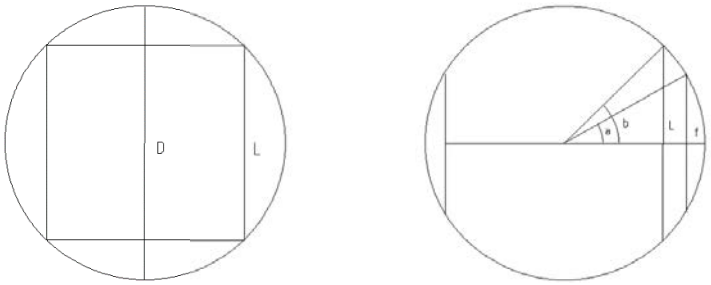


Fig. 2: Models for cut patterns from Fig 1

$$\cos(180 - b) = (f - D/2)/(\frac{D}{2}) \quad (1)$$

$$b = 180 - \text{acos}\,[(f - D/2)/(\frac{D}{2})] \quad (2)$$

$$L = D * sen(\alpha),\ \alpha = a, b\ \ldots. \quad (3)$$

The slab is defined to find the smallest piece width. The angle generated in the cut of the slab is proportional to the diameter of the log in the milling operation. Smaller logs will have larger slab angles, while larger logs will have smaller slab angles (Figure 3). In the first version of the proposed software, the parameter "average angle of the slab" was considered. From this angle, logs with smaller diameters have an undersized initial width, which will not result in errors because the algorithm will increase the width of the slab until it reaches the width of the piece. In contrast, logs with larger diameters may experience aloss in the number of pieces, especially those of smaller widths, due to the estimation of slab areas with larger widths than those executed in the saw mill.

The distance between the radius ratio values increases with the diameter of the log; then, logs with large sections need smaller intervals between radius ratios in the simulated case (Figure 3).

One way to define the slab angle is to observe the cut of the first slab on logs with different diameters and select the grade closest to those used in the milling operation. The same procedure can be performed for the radius ratio.

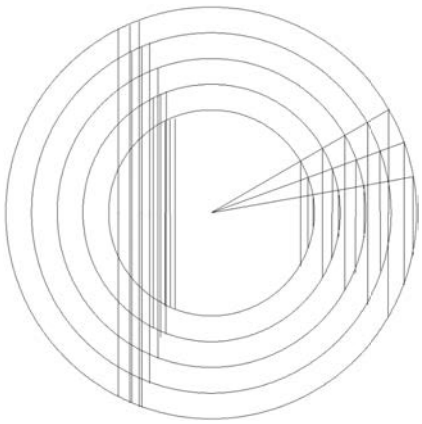


Fig. 3: Slab angles of 10, 20, and 30°, which show variable slab widths (right side of the circle) and chords defined by radius ratios of 0.55, 0.60, and 0.65 (left side of the circle) concerning to logs with diameters of 20, 25, 30, 35 and 40 cm

The radial cutting model (Figure 1) consists of dividing the log to quadrants and calculating sawn pieces to the radius direction. The cutting of parts is run by alternating the edges within the quadrant, limited to two slices by an angle of 45°. Calculations are performed for one quadrant and multiplied by 4 for the log.

All models were validated with draws in digital graphics using the CAD software Libre CAD (2020).

c) Data

Six tests were performed with trees and logs by applying the circumscribed square, longitudinal (tangential), 180° and 90° turnlog, and radial cut patterns (Table 1). These tests range from more controlled to more sampled.

Table 1: Tests of cut models, sources (i.e., trees or logs), diameter at breast height (*dbh*), height total (*h*) and commercial (*hc*), percentage of bark, diameter range of logs, kind of lumber milled, length of logs and priority of milled pieces

Test	1	2	3	4	5	6
Cut pattern	Circumscribed square	Empiric	Longitudinal	Longitudinal	Turns of 180 and 90°	Radial
Cut model applied	Circumscribed square	Circumscribed square	Longitudinal	Longitudinal	Turns of 180 and 90°	Radial
Source	Tree	Tree	Log	Log	Log	Log
Quantity	3 trees/16 logs	3 trees/19 logs	9	19	51	6
dbh/h/hc/bark%						
Tree 1	24/25.2/10.7/8.7	24/25.2/10.7/8.7				
Tree 2	21/22/11.3/4.8	21/22/11.3/4.8				
Tree 3	19.5/24.4/11.4/8.5	19.5/24.4/11.4/8.5				
Range of logs diameters (cm)	9–22	9-24	13-22	19-46	19-38	28-61
Lumber type	NBR 14807*	Clapboard 50 x 30 mm Clapboard 40 x 30 mm Board 100 x 30 mm	Clapboard 40 x 20 mm	Board 50–400 x 27 mm Large board 50–400 x 40 mm Step width 50 mm	Board 50–400 x 27 mm Large board 50–400 x 40 mm Step width 50 mm	Board 50–600 x 27 mm Step width 50 mm
Length (m) of log	2	3.1	3.1	3.4	3.4	1.5-2.9
Priori of lumbers	By size	User choice	User choice	None	None	None

**Brazilian rule to width and thickness dimensions of the lumbers (ABNT, 2002).*

i. *Test 1*

In this test, we applied the rule of priority by size in width and thickness to calculate lumber pieces of small trees of the *Corymbiacitriodora* species planted from seeds, which had some tortuosity in the trunk. The trees were cut and processed in a sawmill of the Embrapa company in Sete Lagoas, Minas Gerais State, Brazil.

The Kozak taper model was applied to each tree. The lumber pieces calculated by the proposed software were drawn in the most minor section of each log before being sawed (Figures 4a and b). The diameters with bark (*di _log*) were measured, and the width of the lumber (*wi_log*) was framed in the log section.

The milled pieces were measured in width (*wi_sw*) and thickness (*th_sw*) at the ends and in the middle of the lumber (Figure 4c).

A b c

Fig. 4: a) Log in the sawmill machine, b) smaller face of a log with pieces calculated and selected to be cut, and c) stacked pieces to dry after measurement and identification

ii. *Tests 2 and 3*

In Test 2, It is compared results among the Calc Madeira and CutLog softwares. The trees were cut in Maravilhas city, Minas Gerais State, and transported to a sawmill in Matosinhos city, Minas Gerais.

It is used nine trees close to the evaluated trees (i.e., those that were milled) for generate taper model. The width and thickness of the pieces were not measured according to uniformity in production and the constant width and thickness of the lumber. Only the number of pieces per log was obtained(Figure 5), and imperfections, such as tortuosity and cracks, were noted.

In Test 3, It is cut a new set of 3 trees of the *Corymbia citriodora* species. However, evaluations were performed by individual logs without the need for taper models, already validated in Test 1. As in Test 2, only the number of pieces per log was obtained (Figure 6).

a b

Fig. 5: a) First product of the empirical procedure and b) large clapboards and clapboards after going through the second step in a circular blade

a b

Fig. 6: a) First product of the longitudinal cut pattern and b) clapboards after the second step in a circular blade

iii. *Tests 4 and 5*

In Test 4, it is measured nineteen logs, and in Test 5, fifty-one logs, both from eucalyptus with different ages and genetic materials (i.e., stock). The tests were performed in a sawmill in the municipality of Martinho Campos, Minas Gerais. The pieces milled were boards larger than or equal to 50 mm in width up to the maximum width allowed by the diameter of the log. The thickness was fixed at 27 mm. The 40 mm thickness was milled in the center of the log to prevent the large board from cracking in its core. The cut pattern was longitudinal for Test 4 and turns of 180°and 90° for Test 5. In these tests, only the width was measured.

iv. *Test 6*

This test was performed at the Embrapa farm in Sete Lagoas, Minas Gerais. Six logs from *Pinus sp* and *Araucaria angustifolia* trees with different displacements of the pith with reference to the center of the face of the log were measured in Test 6. The pieces were drawn in small sections of the logs. These pieces were boards larger than or equal to 50 mm in width up to the maximum width allowed by the circumference of the log's barkless wood. The drawing was performed in all quadrants with points of origin in the marrow, which resulted in quadrants of different sizes. The intention was to detect bias among the calculated pieces based on the center of the log section and the pith deviated.

The thickness was fixed at 32 mm, which matches a thickness of 27 mm plus 5 mm considering the consumption of wood by the saw.

In this test, it is assessed the accuracy of the number and dimension of pieces that the program calculated to the pieces observed in the logs. Accuracy is reported per log as a function of pith displacement.

v. *Sawmill operations*

Tests 2, 3, 4, and 5 followed the operational procedure without drawing pieces in the logs and informing the operator of the number of pieces. With this, the sawmill chose the pieces of interest with their given dimensions and established the priority among them to mill.

The empirical method applied in Tests 2 and 5 by different operators in sawmills begins with sawing the lateral slab and sawing pieces up to a limit defined by the operator. Then, the log is rotated, which can be at 180° or 90° angles. This process does not precisely follow the model of the first 180° turn, as after turning 90°. It can vary from log to log too. However, this operation reduces the log to a rectangle plus two slabs where boards are milled with the same widths. The large board is sawed in its core.

d) Calculations

The following data are used to execute the cut model algorithms: dimensions of the lumber, including length, width, and thickness; and measurements of the tree, including *dbh*, total and commercial height, and bark thickness measured at each section of the log, being considered the average per tree.

In individual log algorithms, the parameters are smaller diameter, larger diameter, and log length. The wood loss established by the saw thickness was 5 mm, a parameter informed of the application according to the saw type.

In Tests 3 and 4 for the longitudinal model, the slab lateral angle was 30°. In Test 5, three medium angles for the lateral slab (10°, 20°, and 30°) and three radius proportions (0.55, 0.60, and 0.65) were chosen after monitoring the process of the empirical milling technique.

e) Statistical Analysis

The statistical comparison varied with the tests because they were adapted to sawmill procedures and the characteristic of the application. The main comparison between the results obtained in the sawmill and calculated by the software was the standard error:

$$SE\% = \left[\frac{(\text{calculated data} - \text{observed data})}{\text{observed data}}\right] x\ 100 \qquad (4)$$

In Test 5, the range of the width and quantity of pieces allowed us to arrange data in the frequency distribution. The nonparametric statistics with 0.05 significance were applied to normality tests (i.e., the Shapiro–Wilk test), calculated, and then the observed data were compared using the Chi-square test and the correlation test. Spearman's correlation was applied to errors in the number and volume of pieces to verify their dependency with the diameter of the log. To do this, the differences were converted in a module for the rank of posts to assess only the magnitude of the error as a function of the log diameter. The tendency was evaluated graphically.

In Test 6, a comparison test (i.e., the Kolmogorov–Smirnov test) was performed between the calculated and observed widths of each piece. The SE% was obtained between the observed and the calculated width.

III. Results and Discussion

a) Test 1

From the taper Kozak equations of trees 1, 2, and 3, the R^2 values were 98.2, 98.6, and 99.3%, respectively. Figure 7 shows the agreement between values estimated by the taper equation and those measured on the log. The errors were less than 10% for the diameter with bark (*di_ log*) and less than 15% for log volume (*vr*).

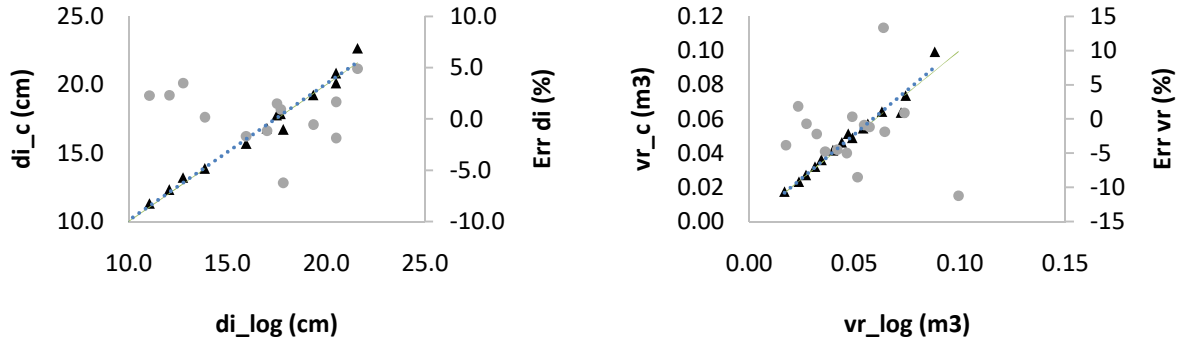
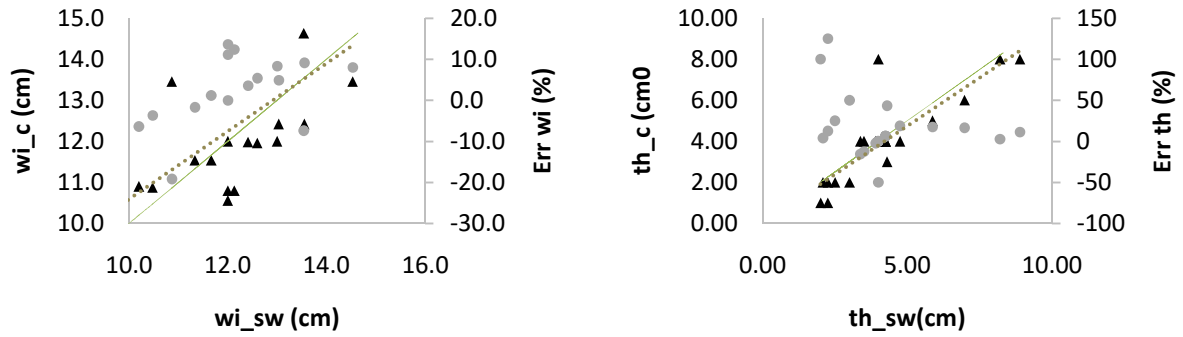


Fig. 7: a) Scattering between the observed diameter withbark (*di_ log*) and the calculated diameter with bark (*di_ c*) and its accuracy (*Err di*), and; b) scattering between the log volume (*vr_log*) and the calculated log volume (*vr_c*) and its accuracy (*Err vr*)

For the milled pieces, Figure 8a shows the piece width (*wi_c*) and the milled piece width (*wi_sw*). The comparisons between thickness (*th_c*) and thickness measured in the milled pieces (*th_sw*) are represented in Figure 8b. The more significant divergence in the thickness of the samples was due to an uncontrolled factor in the saw operation caused by fluctuation of the log on the mill track during its course. More advanced machinery would increase the accuracy between the programmed and sawed thicknesses. This tendency was more significant in widths with underestimating of the milled piece volume (Figure 8a).



a b

Fig. 8: a) Scattering between the width of the piece (*wi_c*) and the average width of the milled piece (*wi_sw*); b) the piece thickness (*th_sw*) and the average milled piece thickness (*th_c*), and its accuracy (*Err wi* and *Err th*). Note: c (calculate), sw (sawed), wi (width), th (thickness), Err (Error)

In Figure 9, the significant divergence in the volume of pieces occurred due to differences in thickness, mainly for Tree and Log 21, 23, and 25 (see the footnote of Table 2, which shows the accuracy between the number of calculated and milled pieces).

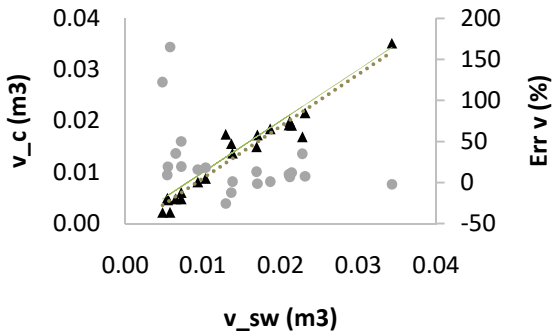


Fig. 9: Scattering between the calculated lumber volume (*v_c*), the observed lumber volume (*v_sw*), and accuracy (*Err v*)

Table 2: Number of pieces calculated (*n_c*) and milled (*n_sw*), and the difference between the quantity of calculated and milled pieces (*n_er*)

Id [0]	Piece	n_c	n_sw	n_er
11	Board	3	3	0
12	Board	2	2	0
12	Board	1	1	0
13	Board	2	2	0
13	Board	1	1	0
14	Board	2	2	0
14	Board	1	1	0
15	Board	2	2	0
15	Board	1	1	0
21 [1]	Board	3	-	
22	Board	2	2	0
22	Board	1	1	0
23	Board	2	2	0
23 [2]	Board	1		-1
24	Beam	1	1	0
25 [3]	Beam	1		-1
31	Board	2	2	0
31	Board	1	1	0
32	Board	2	2	0
32	Board	1	1	0
33 [4]	Beam	1	2	1
34	Beam	1	1	0
35	Rafter	1	1	0
36	Rafter	1	1	0
Total		33	32	-1

[0] Tree and Log.

[1] It was impossible to mill because the length was less than the minimum limit for the mill (2 meters).

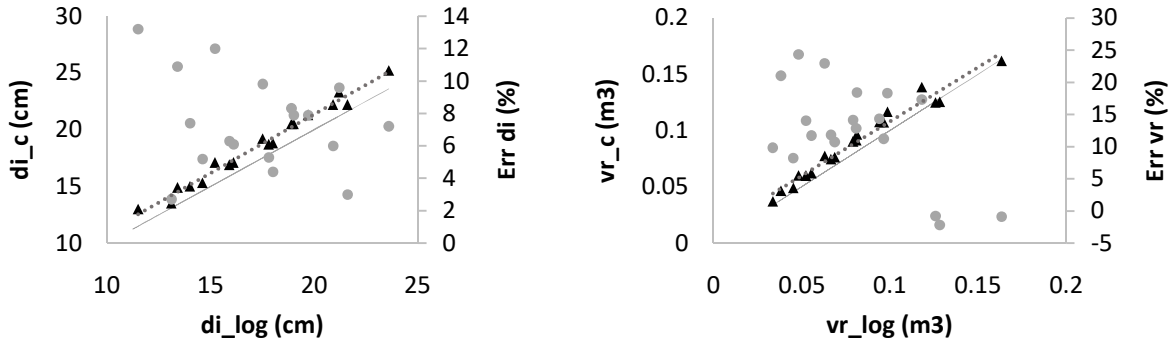
[2] It was impossible to mill the last piece: one calculated board.

[3] It was impossible to mill because of the log tortuosity.

[4] The calculation indicated a beam, but two boards were milled.

b) Test 2

The taper Kozak equation from nine trees in Test 2 yielded an R^2 = 99%. There were fourteen results with biased results above 10% in 19 data (Figure 10a). The accuracy for the diameter with bark (*di*), although with few results above 10%, showed more significant inaccuracy than Test 1. The consistency was affected by the tendency (Figures 10a and *b*), and the expected overestimate of the milled piece number and volume.



a b

Fig. 10: a) Scattering between the diameter with bark (*/di_ log*) and the calculated diameter with bark (*di_ c*) and its accuracy (*Err di*), and, ; b) scattering between the log volume (*vr_log*) and the calculated log volume (*vr_c*) and its accuracy (*Err vr*). Note: di (diameter), vr (volume of the log)

Table 3 shows the results of the sawmill and those calculated by the software. At the sawed pieces, it was not possible to obtain boards, which are the third priority (Table 1). Milling into broad pieces to get large clapboards (priority pieces with a smaller width than the board) renders it impossible to see board widths from leftovers. The calculated results showed this condition.

The CalcMadeira software calculated one hundred and four large clapboards and fifteen clapboards, with a volume of 0.5208 m^3 and a yield of 31%. The data observed in the sawing procedure were one hundred and six big clapboards and thirty-two clapboards, with a volume of 0.5723 m^3 and a yield of 37%. An empirical method that comes close to the block was used, and the operator skill increased the yield sawing clapboards (i.e., smaller pieces) in the slabs.

The CutLog optimization module *Cut Pattern Optimizing Function*, which considers a priority region (middle boards) and a secondary one (sideboards), calculated the quantity of pieces close to the result of milled pieces, diverging in eight clapboards and four large clapboard pieces. This algorithm, in the secondary area of the log, advances to the slab area to obtain smaller pieces.

Table 3: Quantity of lumber, volume, and yield of logs obtained from the sawmill and calculated by the respective programs

	Large clapboard	Clapboard	Board	Total	Volume (m^3)	Yield (%)
Sawmill*	106	32	-	138	0.572	37
CalcMadeira	104	15	-	119	0.521	31
CutLog	110	40	-	150	0.591	38

** One log had cracked pieces, and one log had tortuosity.*

c) Test 3

The number of pieces, which is shown by log, are provided in Table 4. The most significant difference occurred in Log 2, where six fewer amounts were calculated than the number of pieces milled. In total, ninety-one clapboards were calculated with a volume of 0.2257 m^3 and a yield of 30.1%. The results obtained in the milled wood were ninety-three clapboards, with an output of 30.4%.

Table 4: Number of calculated pieces (*n_c*) and milled pieces (*n_sw*), and error (*n_er*) by log

Log	n_c	n_sw	n_er
1	20	17	3
2	13	19	-6
3	10	7	3
4	10	12	-2
5	9	9	0
6	3	1	2
7	13	15	-2
8	9	9	0
9	4	4	0
Total	91	93	-2

d) Test 4

The nineteen sampled logs had a total volume of 4.837 m^3, and the milled volume was 2.5137 m^3 in sawed lumber. There is a significant variation in shape, with logs close to the cylindrical shape, except for one log with 2.65 cm/m. The taper was 0.80 cm/m, and the final yield was 58%.

The total calculated volume was 2.7971 m^3, with a bias of 11.3%, and approximately 53% of the results per log had an error above 20%. Figure 11 shows the bias results with the overestimating of the volume milled per log.

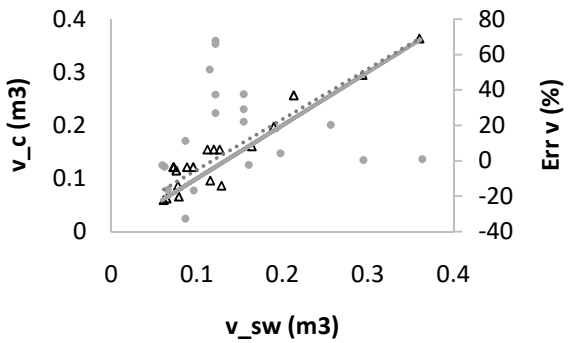


Fig. 11: Scattering between the milled volume (*v_sw*) and the calculated volume (*v_c*) of pieces per log and its accuracy (*Err v*)

e) Test 5

The fifty-one sampled logs had a total volume of 10.943 m^3 and a milled volume of 6.149 m^3 in sawed lumber. There is a significant variation in shape, with logs close to the cylindrical shape and others with more than 2 cm/m. The same is valid for yields, ranging from 24 to 72%. The average taper was 0.95 cm/m, and the final yield was 56%. Figure 12 shows a set of logs sent to the saw. The 42 cm diameter log (more extensive) had an irregular base, and the 27 cm log had protuberances of branches, showing the heterogeneity of the sampled material. High yields, near 70%, may be related to the operator skill when rotating the log and the specification, which allows small pieces, such as boards from 50 mm in width.

Fig. 12: Logs in line for milling

i. *Calculated and milled pieces*

Figure 13 shows the distribution of the number of (a) boards and (b) large boards milled and calculated by width classes in 25 mm increments, according to the average angle of the slab and the proportion of the radius. The frequency of distribution in the number of pieces calculated and the number of pieces milled did not significant by the Shapiro–Wilk test (Table 5). The frequency of the calculated boards is high in the first class of widths and approaches the expected frequency with an increase in the slab angle.

The Chi-square test for comparing the observed and expected distributions of milled pieces, as shown in Table 5, shows inequality (nonadherence) between the distributions of milled and calculated boards and large boards. Although there is inequality between the distributions assessed from a critical level of probability, an inference is possible by analyzing the magnitude of the Chi-square values. Regardless of the radius proportion, the distribution of the calculated boards at 30° for the slab was closer to that of the milled boards.

Large boards in the central part (i.e., the rectangle with two slabs) show a worse approximation between the milled and calculated distributions (Figure 13b and Table 7).

A slightly better approximation was achieved for combining the parameters (i.e., the slab angle and radius ratio) between the frequency distributions for the board with as lab angle of 30° and a radius ratio between 0.55 and 0.60. To large board, a suboptimal approximation occurred for the frequency distribution with angle of 20° and a radius ratio of 0.55.

Table 5: The Shapiro–Wilks normality test (S–W) and Chi-square test (C-S) for comparison between milled and calculated pieces distributions by 25 mm width class increments, combining the angle of the slab with the radius proportion.

Test	Ang.	Board			Milled	Large board			Milled
		0.55	0.60	0.65		0.55	0.60	0.65	
S-W	10	0.130	0.160	0.226		0.031	0.056	0.162	
C-S	10	518.1	452.5	625.4		217.0	292.0	378.8	
S-W	20	0.121	0.129	0.186		0.019	0.043	0.131	
C-S	20	157.8	150.5	282.8		90.9	291.3	438.9	
S-W	30	0.044	0.052	0.077		0.054	0.061	0.104	
C-S	30	110.4	90.7	114.1		186.9	310.3	434.5	
S-W					0.098				0.036

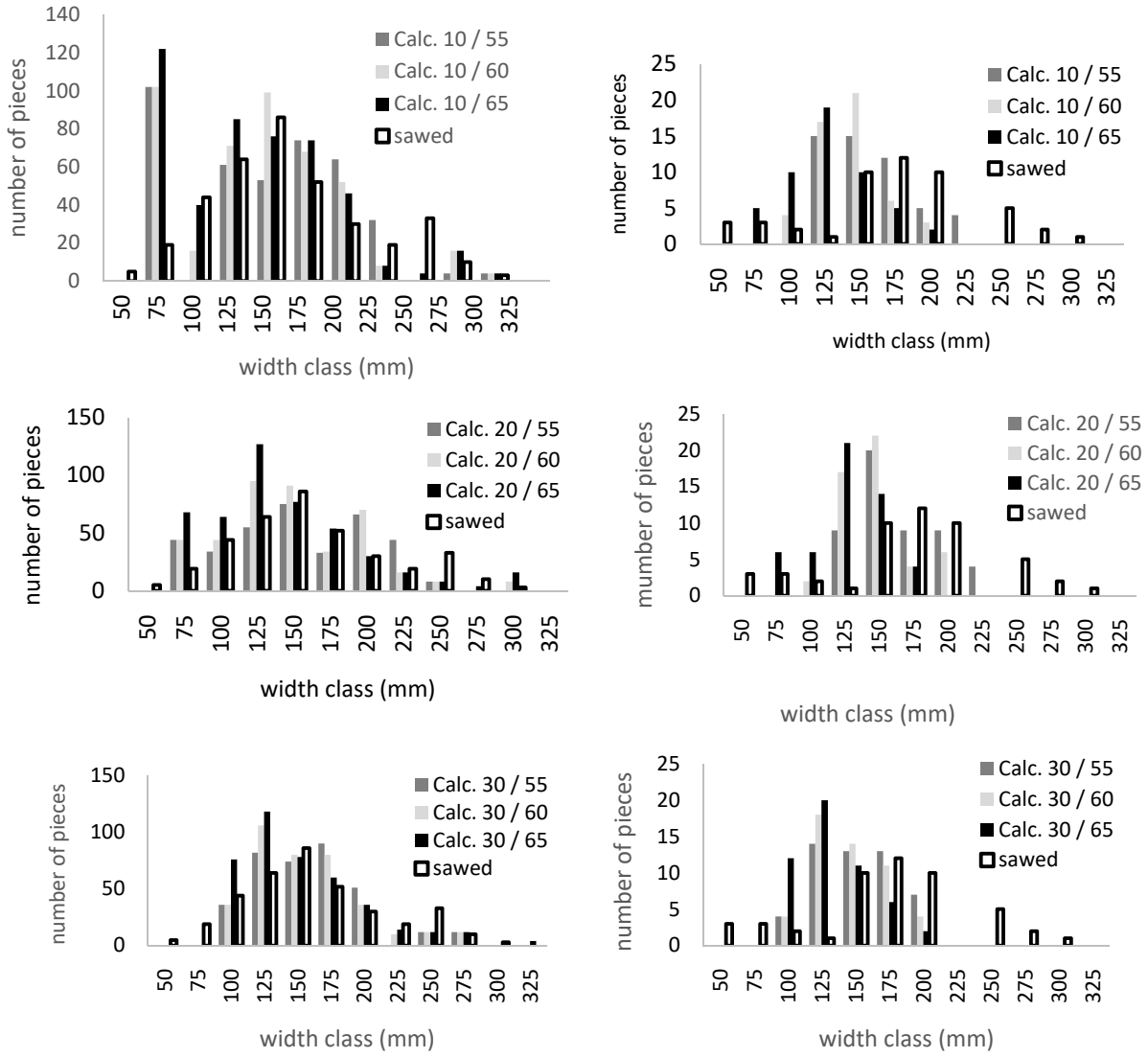


Fig. 13: Frequency of a) boards and b) large boards milled and calculated by width class with 25 mm increments, and an average angle of the slab of 10°, 20° and 30°

In evaluating errors between the calculated and milled pieces according to the diameter of the log and the occurrence of trends (Table 6), there were two positive correlations for the number of pieces and five negative correlations for the volume of pieces with a significance level of 0.05.

Based on the significance and the signal and magnitude of the correlations, these results did not indicate that the error in the number of pieces will increase with the diameter of the log. However, they did suggest a tendency to reduce the error in the volume of pieces in logs with larger diameters.

Table 6: Spearman's correlation between the number error (*n err*) and *err v (%)* with log diameter by slab angle and radius ratio

Ang.	n err			err v (%)		
	0.55	0.60	0.65	0.55	0.60	0.65
10	0.211	0.355 *	0.041	-0.292 *	-0.280 *	-0.216
20	0.053	0.257	0.331 *	-0.233	-0.210	-0.249
30	0.020	0.087	0.242	-0.362 *	-0.389 *	-0.434 *

Figure 14 shows the scattering between the observed and estimated piece volumes per log for slab angles of 10, 20 and 30°, and varying radius ratios of 0.55, 0.60 and 0.65. The lowest deviations occurred for the 30° angle, regardless the radius proportions.

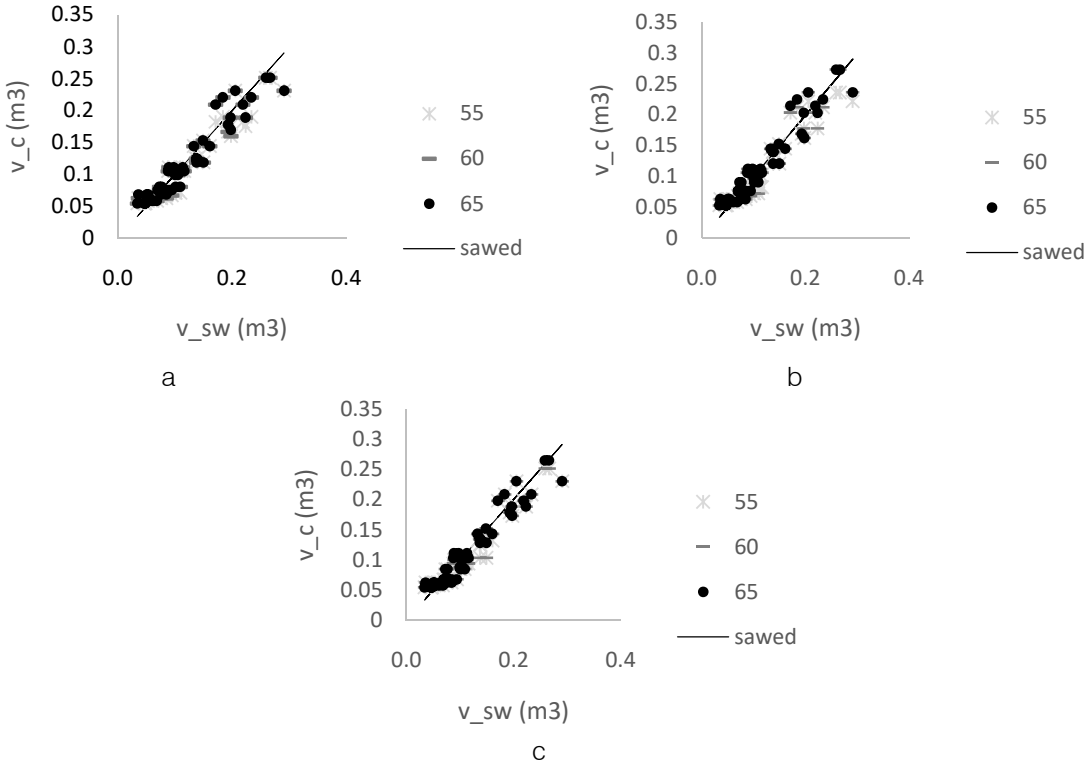


Fig. 14: Scattering between the volume of calculated and milled pieces per log for slab angles of a) 10°, b) 20°, and c) 30°

Table 7 shows the totals calculated and the accuracy about the total number of milled pieces. The accuracy varied from -1.4 to 27.1% for the number of pieces and from -7.6 to -0.7% for the volume of pieces. Overestimates are noted for the number of pieces and underestimates for the volume of pieces, showing an optimal combination between the angle defined for the slab and the limit to the longitudinal cut by the proportion of the radius. The errors in the number and volume of pieces are inversely proportional.

For the total number of pieces, the best combination in terms of accuracy was the 20° slab angle and 0.55 radius ratio. For total volume, the best accuracy was obtained using the 20° angle and 0.65 radius ratio; It was achieved an accuracy of 0.7%. It was obtained the best combination of total values using the 30° angle for the slab with a radius ratio of 0.60; accuracies of 2.2 and -5.4%, respectively, were obtained. The estimated yield was 53% yield, and the actual yield obtained at the sawmill was 56%.

Table 7: Number (*n*), volume (*v*) and yield of pieces calculated by the proportion of the radius and angle of the slab and their accuracies compared to the actual milled piece values

	n				v			Yield	
	0.55	0.60	0.65	0.55	0.60	0.65	0.55	0.60	0.65
10	445	487	526	5.71	5.94	6.04	0.52	0.54	0.55
20	410	461	515	5.68	5.97	6.19	0.52	0.55	0.57
30	408	423	461	5.76	5.82	5.97	0.53	0.53	0.55
Milled		414			6.15			0.56	
Error%									
10	7.5	17.6	27.1	-7.1	-3.4	-1.7			
20	-1.0	11.4	24.4	-7.6	-2.9	0.7			
30	-1.4	2.2	11.4	-6.3	-5.4	-2.8			
Total Vr					10.94				

Note: Large boards and boards were added because one large board is calculated per log; that is, the constant value of the fifty-one large boards. In the milled material, forty-nine large boards were obtained; that is, it was not possible to extract two boards.

f) Test 6

Figure 15 shows designed pieces in a small section of the logs with a source on marrow.

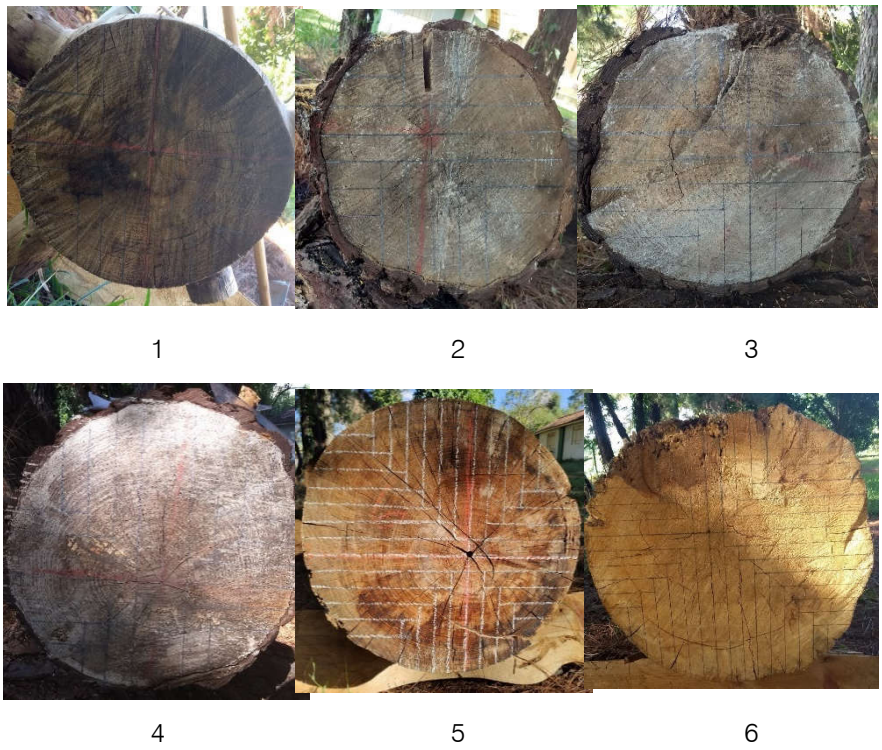


Fig. 15: Designed sections of Logs 1–6 with pieces of thickness 32 mm (27 + 5 mm) and width >= 50 mm and marrow bias of 2 cm (log 1); 4 cm (log 2); 4.5 cm (log 3); 5.3 cm (log 4); 6 cm (log 5) and 6.5 cm (log 6)

Figure 16 shows that a perceptual error of width between -30 and 30 represents 65% of the pieces. The software did not calculate 12 pieces (-100%) when it was possible to draw the piece. because the radial model calculates the pieces from the circumference center. However, the logs used in this work have marrow bias (Figure 15).

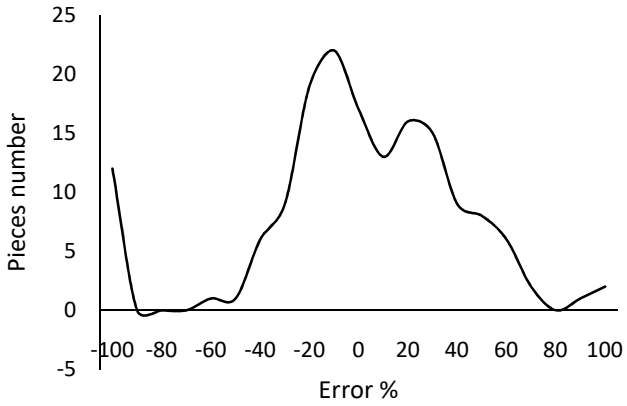


Fig. 16: Perceptual error frequencies in classes of 10%

As the bias of marrow increases, the positive and negative errors will be more significant due to the quadrant differences among sources in marrow and sources in the circumference center. Figure 17 shows the error frequencies of the largest to smallest width per quadrant in each log. In the Log 1 it is possible to view the effect of the difference among center and marrow position. The drawn piece width was larger than the calculated pieces in quadrants 1 and 2, inverting the error in quadrants 3 and 4. The section of this log has the smallest marrow bias, which was 2 cm (Figure 15).

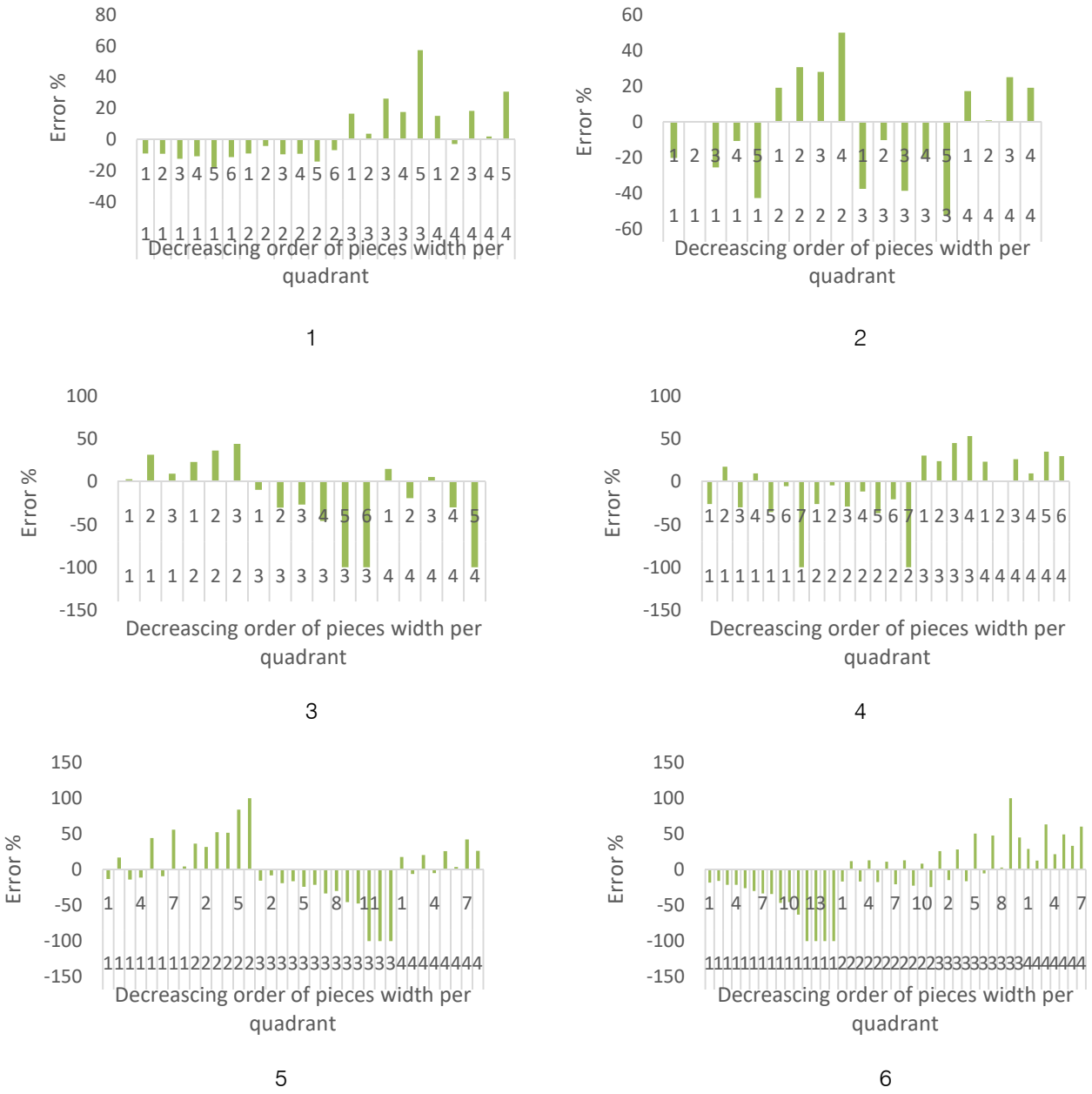


Fig. 17: Errors % in decreasing order of piece width per quadrant per log (for Logs 1–6)

The difference between the yield coefficients (i.e., sawed volume/log volume) of the observed and calculated piece volumes was not significant than 11% (Figure 18). The bias of the marrow did not cause significant differences between the calculated and observed yields.

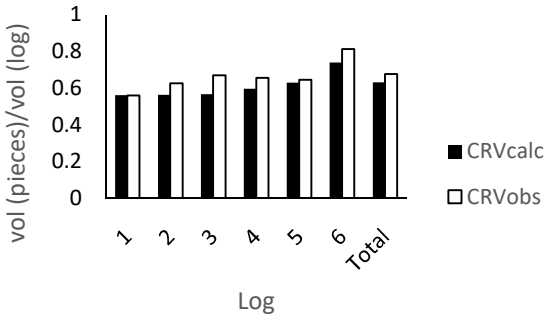


Fig. 18: Yield coefficient (i.e., sawed volume/log volume) of the observed and calculated piece volumes

It was applied the Kolmogorov–Smirnov test to compare two samples, the calculated and observed widths.The data were groupedinto observed and calculated width classes by 10 mm increments, and the cumulative frequencies of the calculated and observed widths were calculated. The total calculated pieces were 147, and the observed pieces were 158.

The larger value of K-S was 0.0806, which was smaller than the table value for the size of 30 samples and a significance level of 5%, considering statistically equal samples (drawing in log and calculated by the software) (Figure 19).

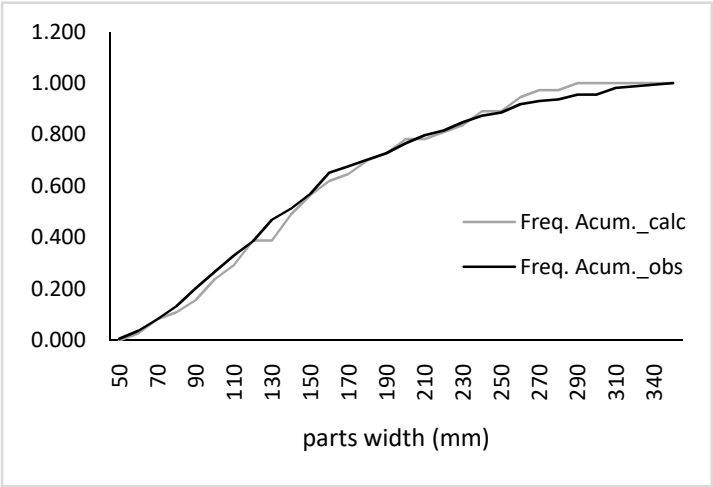


Fig. 19: Cumulative observed and calculated frequencies

It is usual to estimate the shape of trees using equations that include data from many trees. As a result, these equations can be applied to other trees with similar shape characteristics. However, the data per tree should be used to obtain the best shape estimate for a specific tree, even with little data. Test 1 shows the best accuracy for log dimensions when the log equation is used. The loss of accuracy for the log dimension in Test 2 was due to using an equation that was not specific to the tree.

Another insight is that other applications, such as CutLog, can have good results for the empiric procedure in the sawmill (Murara et al. 2013; Anjos and Fontes, 2017), but it works on logs individually. However, the new software used for this work processes many logs or trees at once. When the cut pattern was the same as the cut model applied, good overall results were achieved, as seen from Tests 1, 3, and 4.

The model that rotates 180°/90°the log obtained reasonable accuracy in the production of milled pieces by log, although the sawing operation performed at the sawmill is empirical, as seen in Tests 2 and 5. This operation does not precisely follow a cut pattern with pre-established parameters. It was observed that this model required a small simulation between the angle of the slab and the radius ratio to achieve closer operation parameters.

The parameters change the values according to the log size. Thus, the better approximation of the average of these values assigned in the software with the average of the radius proportions and the angles of the slab conducted by the operator, the greater the accuracy between the quantity and volume of pieces.

The calculation with trigonometric operations is accurate for obtaining pieces in a circle. The errors are

related to the variations in the angles of the slab, the radius ratio that limits the cut to rotate the log and restart the cut, defects of the wood in the process (i.e., cracks or hollow wood), incorrectly defining the parameter of consumption of wood by the saws, and the difference between the theoretical cut model and that executed at the sawmill. In the case of the radial model, more significant errors are related to the bias of the marrow.

These results indicate that the application of this software can be an alternative to relationships between forest management and legal commerce of lumber products, as well as being a management tool to obtain sawmill revenue forecasts.

IV. Conclusion

The circumscribed square model is accurate in the control test with a taper model per tree. Still, when applied to compare with empiric procedures of sawmills, it results in an underestimate of the lumber, mainly in small pieces.

The longitudinal model had a reasonable accuracy in cut patterns with slight discrepancies.

The model of turning the log 180 and 90 degrees, combining two cut patterns, i.e., the longitudinal and circumscribed square, obtained good accuracy for some of the combinations between the angle of the slab and radius ratio when estimating the empirical milling procedure. To get the best results, observation during the milling operation is required to monitor both parameters in a heterogeneous sample of logs.

Better results of the radial model are obtained in trees with a negligible bias of the marrow relationship at the center of the circumference.

Acknowledgments

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UAV Application with Moving Human Face Detection and Tracking

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Abstract- Unmanned aerial vehicles are a technology that has been used in many fields such as civil, military, industry and personal hobby in recent years and is developing rapidly in terms of technology day by day. In this study, human face detection and tracking application was carried out with a four-motor UAV. As an unmanned aerial vehicle, the DJI Tello EDU Drone has been used because it can be programmed with several different software languages, cheap cost, and material quality. The application was carried out in the PyCharm environment using the Python software language and OPENCV version 4.3.0 due to the availability of easy-to-learn and source studies. The OPENCV library was used to perform human face detection and tracking in the application. This process was carried out as the process of deciding and following without any selection process by the user that the object to be detected in the real-time image obtained from the frame of the fixed camera in the UAV is a human face. Dependent factors were evaluated in order to obtain the desired results in indoor and outdoor flights. As a result, human face tracking application was carried out autonomously in this study.

Keywords: Moving object tracking, Unmanned aerial vehicle, Moving human face tracking, OPENCV.

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UAV Application with Moving Human Face Detection and Tracking

Hareketli İnsan Yüzü Tespit ve Takibi Yapabilen İha Uygulaması

Engin GÜZEL [α] & Mustafa YAĞCI [σ]

ÖZ- İnsansız hava araçları son yıllarda sivil, askeri, sanayi, kişisel hobi gibi birçok alanda kullanımı bulunan ve her geçen gün teknolojik anlamda hızlı gelişen bir teknolojidir. Bu çalışmada dört motorlu insansız hava araçları ile insan yüzü tespit ve takibi uygulaması gerçekleştirilmiştir. İnsansız hava aracı olarak DJI Tello EDU Drone, birkaç farklı yazılım dili ile programlanabilir olması, ucuz maliyeti ve malzeme kalitesi özelliklerine sahip olmasından dolayı kullanılmıştır. Uygulama, kolay öğrenilebilir ve kaynak çalışmaların bulunmasından dolayı Python yazılım dili ile OPENCV 4.3.0 versiyonu kullanılarak PyCharm ortamında gerçekleştirilmiştir. Uygulamadaki insan yüzü tespiti ve takibi işlemi gerçekleştirilmesi için OPENCV kütüphanesi kullanılmıştır. İnsansız hava aracında bulunan sabit kameranın kadrajından elde edilen gerçek zamanlı görüntüde tespit edilecek nesnenin insan yüzü olduğuna kullanıcı tarafından herhangi bir seçme işlemi olmaksızın, karar vermesi ve takip etmesi işlemi gerçekleştirilmiştir. Gerçekleştirilen iç mekân ve dış mekân uçuşlarında istenilen sonuçların alınması için bağımlı olunan etkenler değerlendirilmiştir. Sonuç olarak bu çalışmada otonom olarak insan yüzü takibi uygulaması gerçekleştirilmiştir.

Anahtar Kelimeler: *hareketli nesne takibi, insansız hava aracı, hareketli insan yüzü takibi, opencv.*

Abstract- Unmanned aerial vehicles are a technology that has been used in many fields such as civil, military, industry and personal hobby in recent years and is developing rapidly in terms of technology day by day. In this study, human face detection and tracking application was carried out with a four-motor UAV. As an unmanned aerial vehicle, the DJI Tello EDU Drone has been used because it can be programmed with several different software languages, cheap cost, and material quality. The application was carried out in the PyCharm environment using the Python software language and OPENCV version 4.3.0 due to the availability of easy-to-learn and source studies. The OPENCV library was used to perform human face detection and tracking in the application. This process was carried out as the process of deciding and following without any selection process by the user that the object to be detected in the real-time image obtained from the frame of the fixed camera in the UAV is a human face. Dependent factors were evaluated in order to obtain the desired results in indoor and outdoor flights. As a result, human face tracking application was carried out autonomously in this study.

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I. Giriş

İnsansız hava aracı (İHA); içerisinde kendisini kontrol eden pilot ve taşımak amacıyla yolcu bulundurmayan, amacına uygun olarak ekipman (video kayıt kamerası, fotoğraf kamerası, gps sensorü, vb.) bulunduran uzaktan kontrol ve/veya otomatik uçuş gerçekleştirebilen bir çeşit uçaktır [1]. İHA sivil, bilimsel, askeri vb. birçok alanlarda kullanılmaktadır. Bu alanlardaki kullanımlar gerek ülkemizde gerekse dünya da hızla artmaktadır. Artan bu kullanımların temel nedeni olarak kullanıldıkları alanda (örneğin arama-kurtarma) yüksek doğruluk, maliyet ve zaman tasarrufu sağlaması gösterilmektedir [1].

İHA'nın kullanım alanlarının bu denli geniş olması, görüntü işleme teknolojisinin alt konularından olan nesne takibi konusunun ortaya çıkmasına neden olmuştur. Görüntü işleme (image processing) ve nesne takibi (object tracking) konuları bilgisayarlı görme (computer vision) teknolojisinin alt dalları olarak kabul edilmektedir. Nesne takibi başta askeri alanda olmak üzere İHA'ların kullanıldıkları bütün alanlarda çalışmaların yapıldığı önemli bir alandır [2]. Nesne takibi, kameradan elde edilen görüntü dizileri veya videolardaki hareketli nesnelere ait çeşitli (hız, konum, şekil, renk, ışık etkisi vs.) bilgilerin tam olarak belirlenmesi işlemidir [3].

Nesne tespiti ve takibi görüntü işleme teknolojisinin önemli konularından biri konumundadır. Örneğin radar, yüz tanıma ve güvenlik sistemleri, radyoloji (tomografi vb.) gibi uygulamalar görüntü işleme teknolojisinin yaygın olarak kullanıldığı uygulamalardandır [4]. Ayrıca uydulardan alınan görüntülerde nesne tanımlama ve sınıflandırma uygulamaları coğrafi alanların sınıflandırılması amacıyla kullanılmaktadır.

Nesne tespiti ve takibi konusu, endüstriyel alanlarda ürün kontrolü, hata tespiti, hatalı ürünlerin ayrılması gibi birçok konuda da çalışmalar yapılmasına olanak sağlamaktadır. Bu çalışmalar görüntü işleme teknolojisinin endüstriyel alanlarda kullanılmasının ne denli önemli olduğunu ortaya koymaktadır. Nesne tespit, takip, sayım vb. işlemlerin gerçekleştirilmesi için yapılan çalışmalarda kullanılan görüntü işleme

teknolojisi, yapay zekâ teknolojilerine de destek vermektedir. Yapay zekâ teknolojisi ile kullanılması sayesinde endüstriyel alanda özellikle robotik uygulamaların çeşitliliğine katkı sağlamaktadır. Bu iki teknolojinin bütünleşmiş olarak çalışabilmesi günlük yaşam dahil olmak üzere birçok alanda hayatı kolaylaştırmaktadır.

Günümüzde güvenlik sistemleri söz konusu olduğunda, görüntü işleme teknolojisi çok büyük öneme sahiptir. Güvenlik sistemlerinde en önemli amaç gözetim işleminin yapılmasıdır. Yüksek güvenlik gerektiren alanların (örneğin havaalanı, büyükelçilik vb.) gözlemlenmesi için kullanılmaktadır. Bu sistemler güvenlik gerektiren alanlarda giriş-çıkış yapan insanların takibi, sahipsiz bagaj vb. nesnelerin tespit ve takibi gibi işlemlerde kullanılarak oluşabilecek olumsuzlukların önüne geçilmesine olanak sağlamaktadır [3].

Gözetim amaçlı kişi ve nesne takibi kritik öneme sahip bölgelerde kısa sürede, hızlı ve güvenli bir şekilde sağlanabilir. Hareketli insan ve/veya nesne takibi, sabit nesne ve/veya insan takibi konusu ile karşılaştırıldığında daha karmaşık bir problemdir. Açık alanlarda yapılacak takip uygulamalarında olumsuz hava koşulları vb. nedenler kamerada nesne ve/veya insan algısının azalmasına ve görüntü işleme teknolojisi konusunda bazı problemler sebep olmaktadır. İHA'lar insan yoğunluğunun fazla olduğu alanlarda nesne tespiti (örneğin tren istasyonları, otogar vb.), hareketli trafikte araç tespiti gibi pek çok uygulama alanında kullanılmaktadır [5]. Güvenlik uygulamalarında önemli bir bölüm ise parmak izi, iris, yüz tanıma sistemleridir. Bu sistemlerin etkili bir şekilde kullanılmasında insan yüzü tespiti çok büyük öneme sahiptir. İnsan yüzü tespiti, görüntü işleme teknolojisinin sağladığı birçok avantaj ve faydalardan sadece biridir. Bu fonksiyon görüntü işleme kütüphaneleri kullanılarak yüksek doğrulukta sonuç veren sistemlerde kullanılmaktadır. OPENCV bu kütüphanelerden olup görüntü işleme uygulamasının daha az komut satırı ile yapılabilmesi ve daha hızlı sonuç vermesine olanak sağlamaktadır.

Bu çalışmanın insan ve/veya nesne tespit ve takibi konularında literatüre katkı sağlayacağı düşünülmektedir. Bu bağlamda özellikle ulusal ve uluslararası açık kaynak projelerine katkı sağlaması beklenmektedir. Buna ek olarak nesne ve/veya insan takibi yapabilen İHA projesi kapsamında ülkemizde az sayıda çalışma olması; ürünün ticarileştirilmesi ve geliştirilebilir bir ürün olarak patent başvurusu yapılmasını mümkün kılmaktır.

Bu çalışma beş bölümden oluşmaktadır. İkinci bölümde görüntü işleme, nesne tespit ve takibi alanlarında yapılan önceki çalışmalar yer almaktadır. Üçüncü bölümde insansız hava araçları hakkında ayrıntılı bilgi verilmiştir. Dördüncü bölümde, çalışma kapsamında kullanılan görüntü işleme algoritması hakkında bilgiler ve çalışmanın işleyiş adımları anlatılmıştır. Son bölümde ise yapılan çalışmanın önemi ve sonucuna ilişkin bir değerlendirme yapılmıştır.

II. Literatür Çalışması

Literatürde insansız hava araçları, görüntü işleme, nesne tespit ve takibi teknolojilerinin kullanıldığı çeşitli uygulamalar bulunmaktadır. Çoşkun [3] yaptığı çalışmada dört rotorlu AR. Drone ile sürekli uyarlamalı ortalama kayma algoritması kullanarak kapalı alanda hareketli nesne takibi uygulaması gerçekleştirmiştir.

Peker ve Zengin [6] hareket tespit algoritmalarından olan arka plan fark yöntemi algoritmasını kullanarak hareketli nesne tespit ve takibi uygulamasını gerçekleştirmiştir. Bu uygulama ile belirtilen bir alanda izinsiz giriş tespiti amaçlanmıştır.

Meduri ve Telles [7] çalışmalarında Haar-cascade algoritması ile akıllı park sistemi çalışması ortaya koymuştur. Bu sistem, alınan görüntüdeki alandaki araçların ve boş olan park yerlerinin tespiti işlemini gerçekleştirmiştir.

Hareketli nesne ve/veya insan takibi uygulamaları akla ilk olarak güvenlik sistemlerini getirse 'de, teknolojik ürün geliştirmeler alanında büyük öneme sahiptir. Öncü [8] yaptığı çalışmada cansız bir mankene yerleştirilen kameralar, ses algılayıcılar ve hareket motorları ile aynı anda hem görüntü hem de ses işleme teknolojilerini kullanarak hareketli nesne takibi çalışmasını ortaya koymuştur. Bu çalışma aynı zamanda insansı robot uygulamalarının temelini oluşturmaktadır.

Bayram [9] metal sektöründe sac kesim işlemlerinden sonra ortaya çıkan üründe bulunan dairesel boşlukların görüntü işleme teknolojisi kullanılarak belirtilen hata toleransı içerisinde olup olmadığının kontrol edildiği ve böylece hatalı ürünlerin otomatik ve hızlı bir şekilde tespit edilmesi işlemlerini gerçekleştirmiştir.

Kadiroğulları vd. [10] çalışmalarında yapay zekâ ve görüntü işleme teknolojilerini bütünleşmiş bir şekilde kullanarak otonom bir trafik sinyalizasyon çalışması ortaya koymuşlardır. Bu çalışma ile trafiğin yoğun olduğu noktalardaki araç ve insan sayılarına göre trafik ışıklarının en uygun performans ile otonom şekilde çalışması gerçekleştirilmiştir.

Solak ve Altınışık [11] yaptıkları çalışmada ortamda bulunan fındık meyvelerinin görüntü işleme teknolojisi kullanarak hem tespit hem de küçük, orta ve büyük olarak üç sınıflandırma işlemi gerçekleştirmiştir.

Yiğit ve Uysal [12] yaptıkları çalışmada nesne tabanlı sınıflandırma detay çıkarımı kullanarak insansız hava aracı ve uydudan alınan görüntülerden yol tespiti yapmıştır.

Yıldız ve Kavzoğlu [13] çalışmalarında Quickbird ve Landsat uydularından alınan görüntülerin nesne tabanlı sınıflandırma yöntemini kullanarak Trabzon iline ait görüntülerden arazi örtüsünün sınıflandırılması çalışmasını ortaya koymuşlardır. Bu çalışmada orta

seviye işlemler bölümünde uygulanan segmentasyon adımının kalitesinin sınıflandırmanın doğruluğunu önemli düzeyde etkilediğini sonucu ortaya çıkmıştır. İki farklı uydudan alınan görüntülerdeki çözünürlük farkının sınıflandırma işlemindeki kaliteyi doğrudan etkilediği ve ne kadar önemli olduğu görülmüştür.

Apache Hadoop, büyük veri kümelerinin işlenmesini sağlayan açık kaynak kodlu bir platformdur. Apache Hadoop, yapılandırılmış, yarı-yapılandırılmış ya da yapılandırılmamış büyük veri kümelerin işlenmesi ve depolanması işlemleri için maliyeti düşük bir sitem sağlar. Kachin [14] çalışmasında Apache Hadoop platformu üzerinde Haar-Cascade algoritması kullanarak insan yüzü tespit uygulaması ortaya koymuştur.

Tekin [15] yaptığı çalışmada ev ortamındaki çocuğun hareketlerinin izlenmesi ve belirlenen durumların oluşması halinde ebeveynlerin cep telefonlarına alarm bildirilmesi sistemini geliştirmiştir. Bu çalışmada kalman filtresi kullanarak priz, ısıtıcı vb. seçilen tehlikeli bölgelere çocuğun yaklaşması gibi hareketlerin belirlenen eşik seviyelerinin dışına çıkması durumunda alarm sisteminin çalışması gerçekleştirilmiştir.

Turhan [16] ortalama kayma yöntemi ile iki farklı görüntüde takip edilen nesnenin ani hareketlerini ve nesnenin engele maruz kaldıktan sonra takibini gerçekleştirmiştir.

Aktaş [17] çalışmasında *farkların mutlak değerlerinin toplamı* metodunu kullanarak işlenmek istenen imgenin satır ve sütunlarında ilerleme adımlarındaki işlem yükünü azaltmıştır. Nesne tespit işlemi yüksek doğruluk oranı ile gerçekleştirilmiştir.

Şahin ve Oktay [18] yaptıkları çalışmada ZANKA-II isimli sabit kanatlı İHA tasarlamıştır. Kanat uçlarını hareket edebilen bir sistem kontrol etmiştir. Bu çalışma kanat uçlarındaki menteşeli bir tasarımın servo sistem yardımı ile kontrol edilmesi esasına dayanmaktadır. Kanat uçları kontrol edilerek uçuşun bütün safhalarında yüksek verim elde edilmiştir.

Ajoy vd. [19] ise siluet tabanlı nesne takip yöntemi kullanarak görüntüler içerisinde tespit edilecek nesne sınırlarının çizilerek sonraki framelerde nesnelerin aranması ve tespiti işlemini gerçekleştirmiştir.

III. İnsansız Hava Araçları

İHA; fiziksel olarak içerisinde insan bulundurmayan üzerinde video kamera, fotoğraf makinesi, çeşitli sensörler vb. gibi araçlar bulunan bir çeşit uçaktır [20]. İHA uzaktan ve/veya otomatik olarak hareket edebilmektedir. Günümüzde gelişen teknoloji sayesinde İHA çok geniş kullanım alanlarına sahiptir. Askerî alan başta olmak üzere ticari, sivil, bilimsel, hobi gibi alanlarda aktif bir şekilde kullanılmaktadır. Doğal afetler, trafik denetimleri, nesne ve/veya insan tespit takipleri vb. olaylarda insan hayatının kolaylaşmasına olanak sağlamaktadır [2]. İHA kullanım amaçlarına göre sivil ve askerî olmak üzere iki ana sınıfa ayrılmaktadır. Askerî kullanım alanları Tablo 1' de sunulmuştur [21].

Tablo 1: İnsansız hava araçları askeri kullanım alanları [22].

Keşif / Gözetleme Desteği	Saldırı	Elektronik Savaş	Hedef Benzetimi	Özel Görevler
Taktik Saha Keşif / Gözetleme	İç güvenlik	Hedef Uçak	Sinyal İstihbaratı	Haberleşme Desteği
Stratejik Keşif / Gözetleme	Yakın Hava Desteği	Sahte Uçak	Radyo Elektronik Harp	Mayın / Patlayıcı Tespit
	Hava Savunma Sistemlerinin İmhası		Muhabere Elektronik Harp	Kimyasal, Biyolojik, Radyoaktif, Nükleer Tespit

Tablo 1(devam): İnsansız hava araçları askeri kullanım alanları [22].

Keşif / Gözetleme Desteği	Saldırı	Elektronik Savaş	Hedef Benzetimi	Özel Görevler
	Hava Sahası Savunma		Önleyici Elektronik Harp	Kentsel Harp
				Çoklu İHA Görevi - Kol uçuşu ya da geniş alan gözetlemesi
				Deniz Karakol / Denizaltı Savunma Harbi
				Kargo Taşıma
				Arama-Kurtarma / Lojistik

a) Sabit Kanatli İnsansiz Hava Araçlari

Sabit kanatlı insansız hava araçları genel yapısı ve kanat görünümü ile günümüzdeki uçaklara benzemektedir. Sahip olduğu sabit kanatlar sayesinde yüksek hız, yüksek irtifa, uzun uçuş sürelerine sahiptir. Uçuş gerçekleştirebilmesi için bir piste ihtiyaç duymaktadır. Ayrıca bakım ve onarımının daha kolay olması kullanım açısından sağladığı en önemli faydalardandır [23].

b) Döner Kanatli İnsansiz Hava Araçlari

Döner kanatlı insansız hava araçları; dikey şafta bağlı olan kanatların yerçekimi kuvvetine karşı daha büyük bir kuvvet uygulayarak uçuş gerçekleştiren hava araçlarıdır. Kanatların şaftlara bağlı olduğu sisteme rotor adı verilir. Döner kanatlı insansız hava araçları değişken rotor sayılarına sahip olabilmektedir. Hafif malzemeler tercih edilerek üretilir. Bu hafiflik manevra kabiliyetlerinin yüksek olmasını sağlamaktadır. Uçuş hızı olarak yüksek hızlara ulaşamamakla birlikte havada asılı kalabilme, üç boyutlu hareketler yapabilme, piste gerek duymadan uygun birçok alandan iniş-kalkış yapabilme özelliklerine sahiptirler. Bu özelliklerinden dolayı genellikle keşif görevlerinde kullanılmaktadırlar. Gerçekleştireceği görevlere göre pervane sayıları değişkenlik göstermektedir [24].

c) İnsansiz Hava Araçlarinin Ülkemizde Siniflandirilmasi

İnsansız hava araçları sahip oldukları birçok özeliklere göre sınıflandırılabilir. Dünyada insansız hava araçlarının sınıflandırılmasında kullanılan evrensel özellik İHA'nın kütlesi olarak kabul edilmektedir. Gerçekleştireceği görev ve amaçlar doğrultusunda çok küçük boyutlardan birçok farklı boyutlarda İHA'lar üretilmektedir. Boyutlarla doğru orantılı olarak İHA'ların kütleleri değişkenlik göstermektedir. Ülkemizde insansız hava araçlarının sınıflandırılması Sivil Havacılık Genel Müdürlüğü (SHGM) tarafından yapılmaktadır. Bu sınıflandırma yapılırken insansız hava araçlarının kütle değerleri kullanılmaktadır. Tablo 2'de SHGM'nin İHA sınıflandırma tablosu sunulmuştur [25].

Tablo 2: SHGM İHA sınıflandırması [25]

SINIF	KÜTLE
İHA0	500 gr (dâhil) – 4kg aralığı
İHA1	4 kg (dâhil) – 25 kg aralığı
İHA2	25 kg (dâhil) – 150 kg aralığı
İHA3	150 kg (dâhil) ve daha fazla

Ülkemizde SHGM'nin sınıflandırmalarına göre ayrılan İHA'ları kullanabilmek için SHGM tarafından onaylı eğitim kurumlarından alınacak eğitim sonucunda sahip olunacak pilotluk lisanslarına göre kullanım sağlanabilmektedir.

IV. Materyal Ve Yöntem

Bu çalışmada görüntü işleme teknolojisini kullanabilmek için OPENCV kütüphanesinden yararlanılmıştır. Bu bağlamda insan yüzü tespiti işlemi için OPENCV kütüphanesinin içerisinde barındırdığı birçok algoritmadan birisi olan Haar-Cascade sınıflandırıcısı kullanılmıştır. Sınıflandırıcı hızlı, doğruluk oranının yüksek olması ve kolay uygulanabilir olmasından dolayı tercih edilmiştir [26]. Haar-Cascade sınıflandırıcısının özellikleri kullanılarak İHA'nın kamerasından alınan görüntüdeki insan yüzünün tespit işlemi ve sınıflandırma işlemi yapılmıştır. Tespit işlemi sonrasında İHA'nın kamera kadrajına giren insan yüzünün kamera kadrajından çıkana kadar ki sürede gerçek zamanlı olarak takip işlemi gerçekleştirilmiştir. Uygulamaya ait akış şeması Şekil 1'de, çalışmada kullanılan İHA ise Şekil 2.'de sunulmuştur.

Şekil 2: DJI Tello EDU İnsansız hava aracı

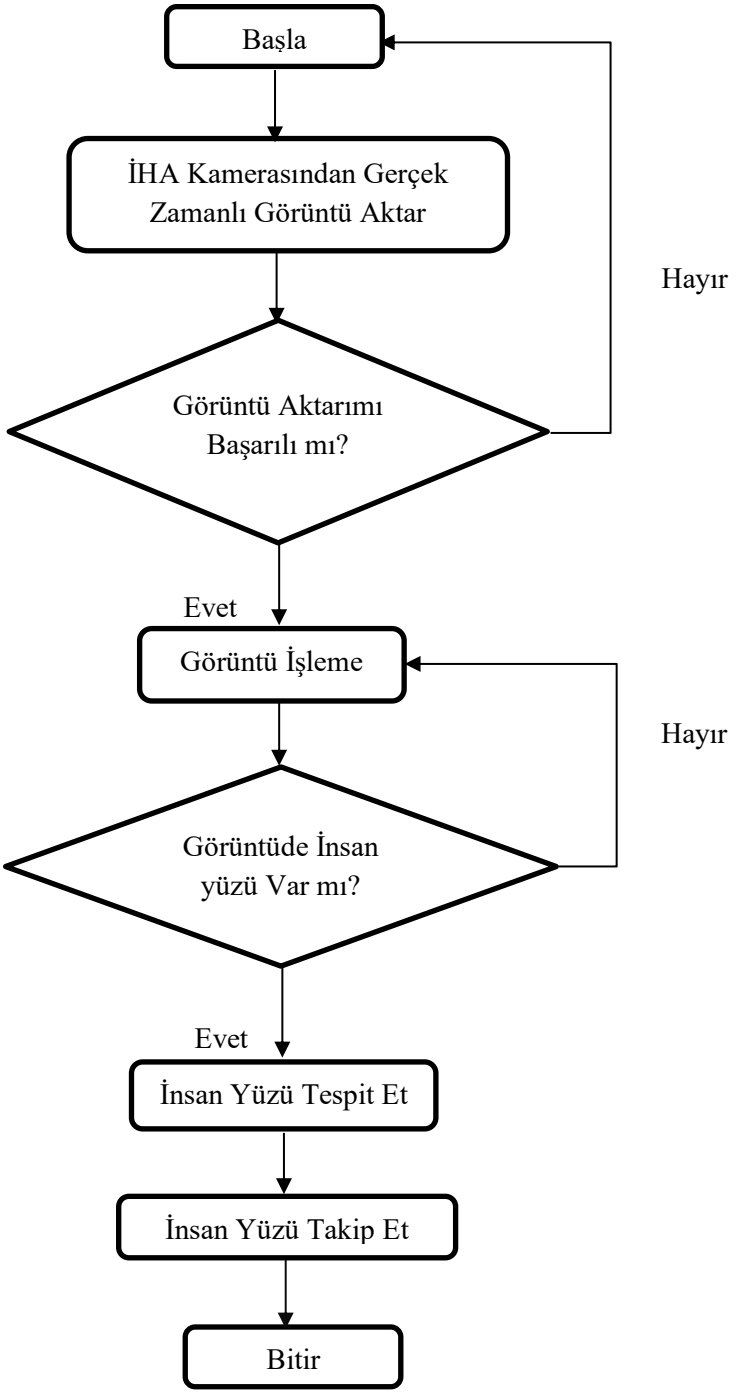
Uygulama kodlarının uygulanabilmesi için ücretsiz bir bütünleşmiş geliştirme ortamı (IDE) olan PyCharm uygulaması kullanılmıştır. Proje yapım aşamasında kullanılan teknolojiler ile alakalı toplanan her türlü bilgi, belge, eğitim gibi unsurlara kolay ve hızlı bir şekilde ulaşılma durumu ve uygulanabilirliği projede kullanılan teknolojilerin seçiminde etkili olmuştur. Çalışma temel olarak iki adımda gerçekleştirilmiştir.

a) İha Kamerasindan Alinan Görüntüde İnsan Yüzü Tespiti

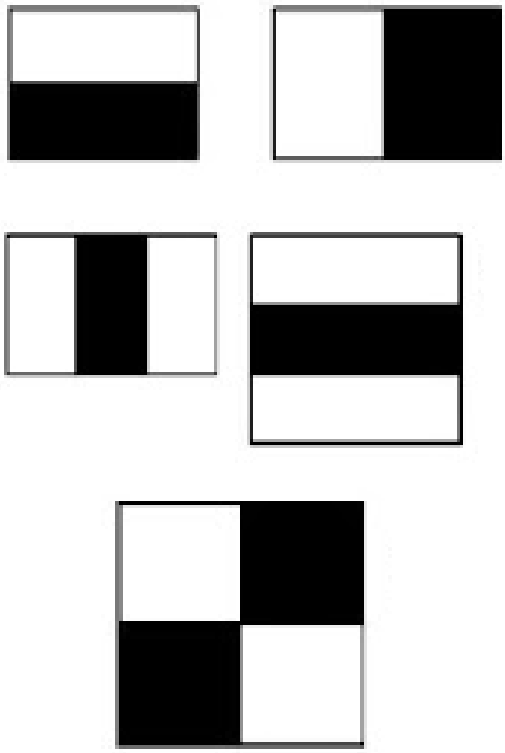
Haar-Cascade algoritmasının haar özellikleri kullanılarak insan yüzündeki alanların renk dağılımı ve yoğunluğuna bağlı olarak insan yüzündeki organların tespiti yapılarak görüntüde insan yüzü olup olmadığı tespit edilmiştir. Haar özelliklerinin kullanımında sınıflandırıcının sahip olduğu dikdörtgenlerin altında kalan bölgelerin piksel yoğunluk farkları, yüz üzerindeki bölgeleri ayrı ayrı tespit edilmesine olanak sağlayarak insan yüzündeki göz, burun gibi organlar tespit edilir, böylece insan yüzü diğer objelerden ayırt edilir. Alanlar arasındaki farklara bağlı olarak insan yüzündeki organ tespiti bu şekilde gerçekleştirilmiştir [27]. Kullanılan algoritmanın özellikleri ve işleyiş adımları sırasıyla aşağıdaki gibidir.

i. *Haar Özelliklerin Hesaplanması*

Hesaplama, görüntüdeki bütün bölgelerin piksel yoğunluklarının toplanması ve bu toplamların arasındaki farkların bulunması şeklinde yapılmaktadır. Haar özelliklerinden örnekler Şekil 3'de sunulmuştur.



Şekil 1: Akış şeması



Şekil 3: Köşe özellikleri, hat özellikleri, dört dikdörtgen özellikleri [28].

Haar özellikleri kullanılarak büyük görüntülerde kullanılması performans açısından dezavantajlıdır. Bu yüzden integral görüntü aşaması burada devreye girmektedir.

ii. *İntegral Görüntünün Oluşturulması*

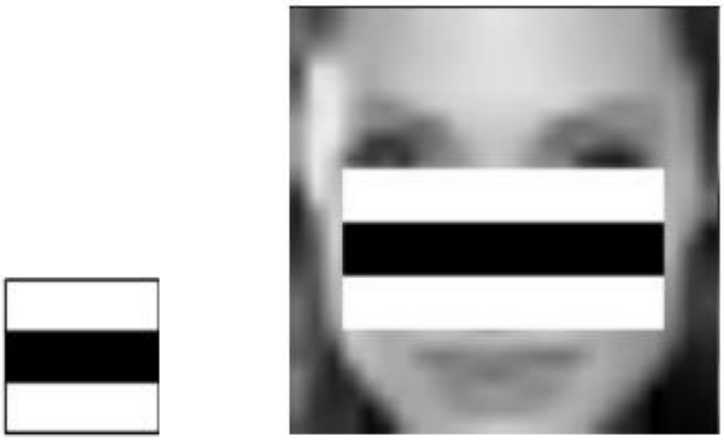
İntegral görüntü oluşturulmasının esas amacı haar özelliklerinin hızlandırılmasını sağlamaktır. Her pikselde hesap yapmak yerine alt dikdörtgenler oluşturulur ve bu dikdörtgenlere dizi referansları verilir. İntegral görüntü denklemi, Denklem (1)'de sunulmuştur.

$$ii(x,y) = \sum_{x' \leq x, y' \leq y} i(x',y') \qquad (1)$$

İntegral görüntüde hesaplanan ve kullanılması gereken haar özelliklere karar verilmesi gerekmektedir. Bu aşamada ise Adaboost devreye girmektedir.

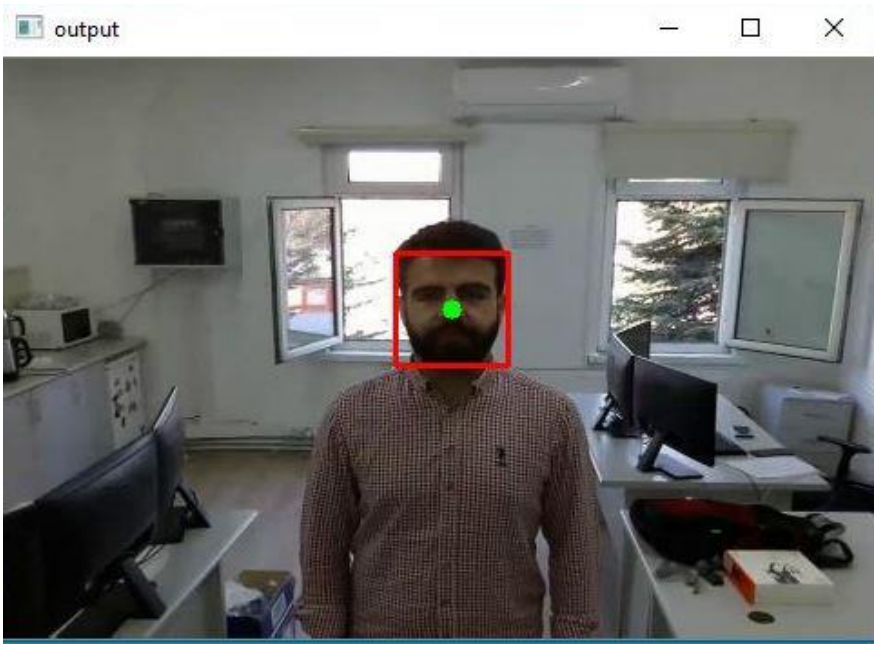
iii. *Adaboost Kullanımı*

Adaptive Boosting'in kısaltması olan AdaBoost, Yoav Freund ve Robert Schapire tarafından formüle edilmiş bir istatistiksel sınıflandırma meta algoritmasıdır. Performansı artırmak için diğer birçok öğrenme algoritması türüyle birlikte kullanılabilir. Adaboost, esasen en iyi özellikleri seçer ve sınıflandırıcıları bunları kullanmaları için eğitir. AdaBoost haar-cascade algoritmasının nesneleri algılaması için kullanabileceği bir "güçlü sınıflandırıcı" oluşturmak için "zayıf sınıflandırıcılar" kombinasyonunu kullanır [29]. Haar özellikleri ile burun seçme işlemi görüntüsü Şekil 5'de sunulmuştur. İnsan yüzündeki yanak bölgesinin renk durumunun burun bölgesindekine göre daha açık renkte olması ile yüzdeki organ sınıflandırılması gerçekleştirilir. Böylece insan yüzü değişse bile insan yüzü tespiti gerçekleştirilir.



Şekil 5: Haar özellikleri ile burun seçimi [27].

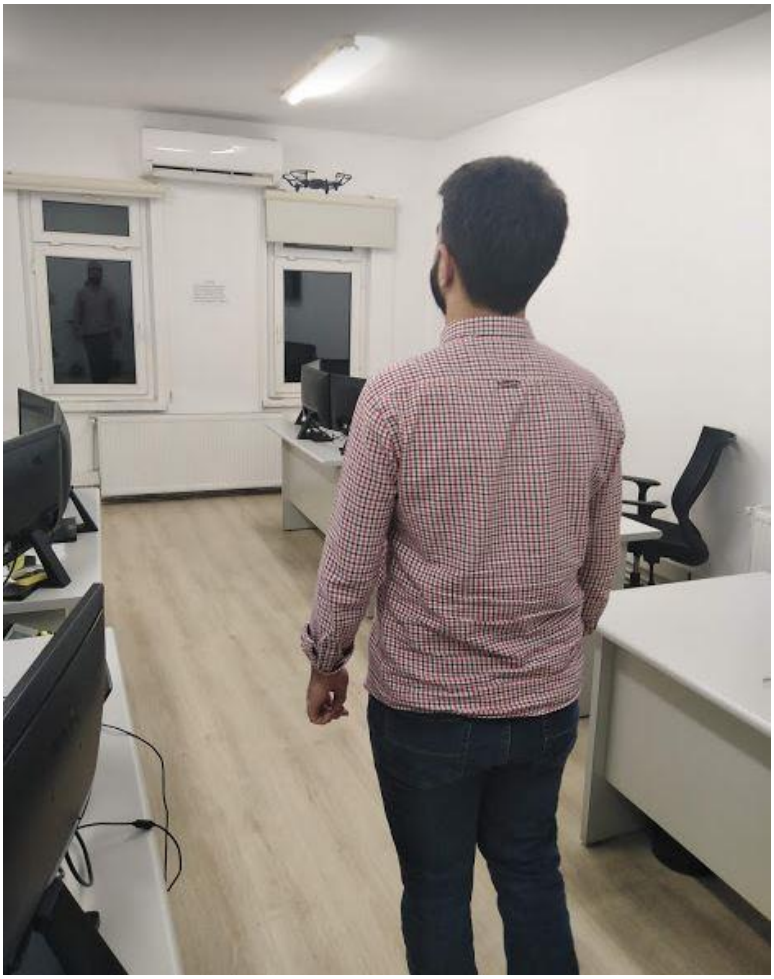
İHA kamerasında alınan gerçek zamanlı görüntüde insan yüzü tespit işleminin görüntüsü Şekil 6'da sunulmuştur.



Şekil 6: İHA kamerasından alınan gerçek zamanlı görüntüdeki yüz tespiti.

b) Tespit Edilen İnsan Yüzünün Gerçek Zamanli Takip Edilmesi

İnsan yüzü tespit işlemi başarı ile uygulandıktan sonra, tespit edilen insan yüzünün gerçek zamanlı olarak yer değişimlerinin takip edilmesi işlemi gerçekleştirilmiştir. Takip işleminin yapıldığı kapalı ortam ve takip işlemin gerçekleştiğini gösteren görüntü Şekil 7'de sunulduğu gibidir.



Şekil 7: Kapalı ortamda insan yüzü tespiti ve takibi işlemi gerçekleştirilmesi

Kapalı ortamda gerçekleştirilen uçuş başarı ile uygulanmıştır. Dış ortamda uçuşu olumsuz anlamda etkileyen unsurların güneş ışığının parlaklığı ve rüzgâr hızı olduğu belirlenmiştir. Haar-Cascade algoritmasının insan yüzündeki bölgesel parlaklık farklarını kullanarak gerçekleştirmesi, güneş ışığının yoğunluğu karşısında istenilen sonuçları vermekte zorluk çekmesine neden olmaktadır. İHA gece uçuşlarında başarılı bir tespit işlemi gerçekleştirememiştir. Bunun sebebi kameranın gece görüşü özelliğine sahip olmaması olabilir.

V. Sonuç Ve Değerlendirme

Bu makalede, döner kanatlı bir İHA ile otonom şekilde hareketli insan yüzü tespit ve takibi uygulaması önerilmiştir. Uygulama geliştirme süresince nesne tespit ve takibi, görüntü işleme teknolojileri ve uygulama yöntemleri araştırılmıştır. İnsan yüzü kamera kadrajından çıktığında veya insan yüzü ile kamera arasına başka bir nesne girdiğinde takip işlemi başarısız olmaktadır. İnsan yüzünün kamera kadrajına tekrar girmesiyle yeniden başlamaktadır. İnsan yüzü tespit ve takibi durumunun gerçekleşmesi için kamera kadrajında herhangi bir insan yüzü olması yeterli olacaktır. Bu makaleden elde edilen sonuçlar, İHA uygulamaları geliştirilmesi açısından ülkemizdeki literatüre katkısıyla önemlidir. Bu makaleden elde edilen sonuçlar sayesinde makine öğrenmesi teknolojisi de kullanılarak İHA'ya öğretilen insan yüzünü takip edebilen bir sistem gerçekleştirilmesi değerlendirilmiştir. Değerlendirilen bu sistem günümüz Türkiye'sinde, seçilen kırsal araziler, şehir içi bölgeler, kalabalığın yoğun olduğu bölgelerde suçlu tespit ve takibi yapan sistemler geliştirilmesine olanak sağlayacaktır.

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17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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