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METHODS OF DATA FILTRATION AND THEIR EFFECTS ON THE RESULTING IMAGE OF A LOG AT THE ELECTRONIC SENSING ITS DIMENSIONS

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Abstract

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The data taken at the electronic reception of logs are tasked with mistaken values and do not correspond to the real shape of a stem. The aim of the data filtration is to remove the incorrect data and replace them by the ones, closer to the real values.
The goal of presented work was to analyse the effect of different filtration methods on original data and to recommend the methods, which results correspond to the real shape of the logs with their defects on a surface as close as possible.
Methods of filtration are based on simple mathematical and statistical procedures, which are subsequently variously combined, because the simplest comparative methods did not fulfil the expectations.
More than 50 methods were combined and analyzed. Approximately 15 of them were selected and tested. The methods were applied to data scanned on ca 150 logs randomly selected from thousands of files in the sawmill log yard. The filtration effects of different methods were visually assessed. The most applicable three methods were selected and they will be tested practically at sawmill in the next step of research. These three methods are described in following paper.
Results refer, that all proposed methods correspond to necessities for log dimensions determination. It is not possible to define the best method generally. Different properties of these methods make them suitable for calculation of log dimensions if different type of use is requested. It means for mid diameter determination necessary for volume calculation by using Huber method; for section diameter determination for volume calculation by using section method; for top diameter determination necessary for sorting; for filtration of drive dogs of the conveyor passing through the measuring equipment.

data filtration, electronic measurement, log dimensions, running average, median, log diameter

The electronic reception of wood shows several drawbacks, which have not been fully worked out yet. Filtration of data taken by a measuring device ranks among them. The aim of filtration is to remove values of measurement, which do not correspond to the real shape of a stem and which result on the basis of sensing defects on its surface. It is carried out by comparing values of neighbouring measurements according to a predetermined algorithm. Thus, searching for this algorithm is the paper objective.

The electronic measuring of logs has o lot of types of use. The most important is the reception of wood. It is performed in accordance with Recommended rules for measuring and sorting the timber in the Czech Republic (KOLEKTIV, 2008).

First steps on this field of research were made by student Žižka in his diploma thesis (ŽIŽKA, L., 2008). He carry out same basic methods. This project of Internal Grant Agency develops the filtration methods to the higher level procedures. Same parts of research were published on conferences (HUNKOVÁ, JANÁK; 2008 a 2009).

MATERIALS AND METHODS

Materials

The proposed methods were tested on data obtained from a measuring device Inframat ITS 570.3 of Eltes Šumperk Ltd. It refers to 2D measurement, the basis of which consists of double sensing frames working in two directions perpendicular at each other (Fig. 1). There are two types of the construction respect to the situation of the conveyers of log in the scanner. The conveyers could pass through the scanner or could be divided with interspaces in the scanners.

For the filtration, data coming from a measuring unit to a control computer were used. Values of couples of log diameters perpendicular at each other are available (thereinafter termed X and Y diameters) in mm for every 10 cm length of a log. To elucidate effects of a filtration method data were used with marked problematic values, i.e. values considerably deviating from the anticipated course of the log surface.

Methods of filtration

Methods of filtration are based on simple mathematical and statistical procedures, which are subsequently variously combined. It is necessary to deal with two basic problems, viz first, how to find an incorrect value and second, which value should be used to replace the incorrect value.

Basic procedures

D: Mutual comparison of values of diameters measured in perpendicular directions in one place with respect to the log length. A difference in X_a and Y_a values is compared with the given value.

$$|X_a - Y_a| < k$$

k...... comparative value
X_a, Y_a .....measured values in position a
a ....position of the measured value (distance from the top of the log).

E: Mutual comparison of values of diameters measured consecutively in one direction. There, a difference between X_a and X_{a+1} (eventually X_a and X_{a-1}, X_a and X_{a+2} or X_a and X_{a-2}) is compared with a certain value. And again, it is necessary to determine the maximum possible size of a difference on the basis of experience and practical trials. Its minimum value can be based on a gradient.

$$|X_a - X_{a+1}| < k \quad \text{or}$$
$$|X_a - X_{a-1}| < k \quad \text{or}$$
$$|X_a - X_{a+2}| < k \quad \text{or}$$
$$|X_a - X_{a-2}| < k$$

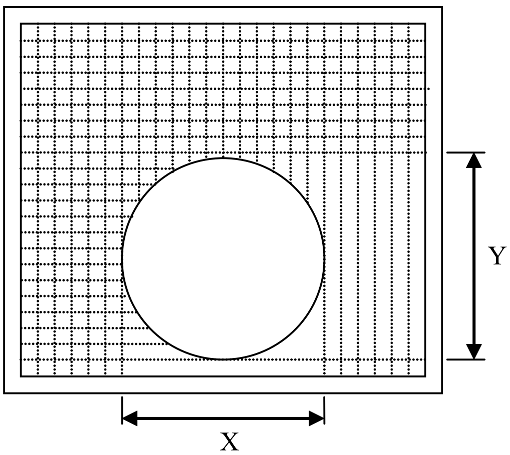
k .....comparative value
X_a ..measured values in position a
a .....position of the measured value (distance from the top of the log).

F: Comparison of the coefficient of growth of successive values. The X_a/X_{a+1} ratio is termed coefficient of growth. And again, it is compared with a certain determined value and similarly as in the previous case successive measured values need not be members of the ratio. However, even here, it would be necessary to determine changes in comparison with respect to the end of a series.

$$X_a / X_{a+1} < k \quad \text{or}$$
$$|1-(X_a / X_{a+1})| < k$$

k .....comparative value
X_a ..measured values in position a
a .....position of the measured value (distance from the top of the log).

G: Fitting the surface curves by means of running averages. "Running average" is a statistical method used to evaluate time series, e.g. in meteorology or economy. To every moment on the time series (in case of filtration, to every place of measurement)



Length of the stem	Diameter	
a	X	Y
0	354	348
10	336	357
20	345	351
30	369	357
40	354	351
50	336	351
60	336	351
70	339	357
80	345	360
90	345	375
…	…	…
…	…	…
…	…	…
…	…	…

1: *Scheme of 2D measurement and example of input values* a value is assigned calculated as a mean from a series of values, the centre of which is created by the original value. In using the even number of values it is necessary the assigned value to be further calculated. Thus, for the purpose of filtration, it is simpler to use the odd number of values. A figure giving the number of members serving for the running average calculation is termed width of smoothing. If there are special requirements for data smoothing it is possible to apply the smoothing algorithm several times. A figure giving the number of repetitions of the smoothing algorithm is termed depth of smoothing.

$$A_a = \overline{X}_a(X_{a-1}, X_a, X_{a+1}) \text{ or } A_a = \overline{X}_a(X_{a-2}, X_{a-1}, X_a, X_{a+1}, X_{a+2}) \text{ or } A_a = X_a(X_{a-3}, X_{a-2}, X_{a-1}, X_a, X_{a+1}, X_{a+2}, X_{a+3})$$

X_a ..measured values in position a
a.....position of the measured value (distance from the top of the log)
A_a...supposed value on position a
$\overline{X}_a$ ..average

H: Fitting the surface curve of a stem by means of “running” medians. The calculation procedure is the same as in the previous method and only the mean value is replaced by a mid value.

$$M_a = \widetilde{X}_a(X_{a-1}, X_a, X_{a+1}) \text{ or } M_a = \widetilde{X}_a(X_{a-2}, X_{a-1}, X_a, X_{a+1}, X_{a+2}) \text{ or } M_a = \widetilde{X}_a(X_{a-3}, X_{a-2}, X_{a-1}, X_a, X_{a+1}, X_{a+2}, X_{a+3})$$

X_a ..measured values in position a
a.....position of the measured value (distance from the top of the log)
M_a..supposed value on position a
$\widetilde{X}_a$...median

I: Linear regression. Linear regression represents the approximation of given values by the first order polynomial (straight line) using the least squares method.

It is possible to carry out the inexhaustible amount of combinations on the basis of simple methods described above. It is given not only by their various sequences but also by possibilities, which are provided by each of the methods.

Combined procedures

More than 50 of combinations were tested during the research. The methods were applied to ca 150 sets of data randomly selected from thousands of files scanned in the sawmill and visually assessed. The most applicable methods were selected and they will be tested practically at sawmill in the next step of research. These methods are described here.

J: The method could be calculated in following order:

1. Calculation of running medians (width of smoothing 5).
2. Comparison of running medians with the original value (the value of an acceptable maximum of difference 15 mm).
3. Values deviated too much replaced by values of running medians.
4. Extrapolation of limit values by using the minimum value from 10 values: the last 5 values of adjusted data and the last 5 values of original data together.

Alternative of the step 4:
Extrapolation of limit values by calculation of running medians from last 5 values from adjusted data.

K:

1. Calculation of running medians (width of smoothing 3).
2. Comparison of running medians with the original value; values deviated too much are replaced by values of running medians (the value of an acceptable difference maximum: 15 mm).
3. Extrapolation of limit values by the minimum value from the last 3 values.
4. Smoothing the curve by running medians (width of smoothing 5) by calculation from original values without extremes.
5. Extrapolation of limit values by the minimum value from last 5 values of adjusted data and from the original data together.

L:

1. Comparison of values of diameters measured consecutively in one direction; are compared farther values: $X_a - X_{a+3}$ and $X_a - X_{a-3}$.
2. Comparison of differences with a certain value (15 mm). If the differences pass the assessed value in both directions of the comparison, the original value is considered extreme and replaced by value of running median (width of smoothing 5).
3. Extrapolation of limit values by calculation of running medians from the last 5 values from adjusted data.

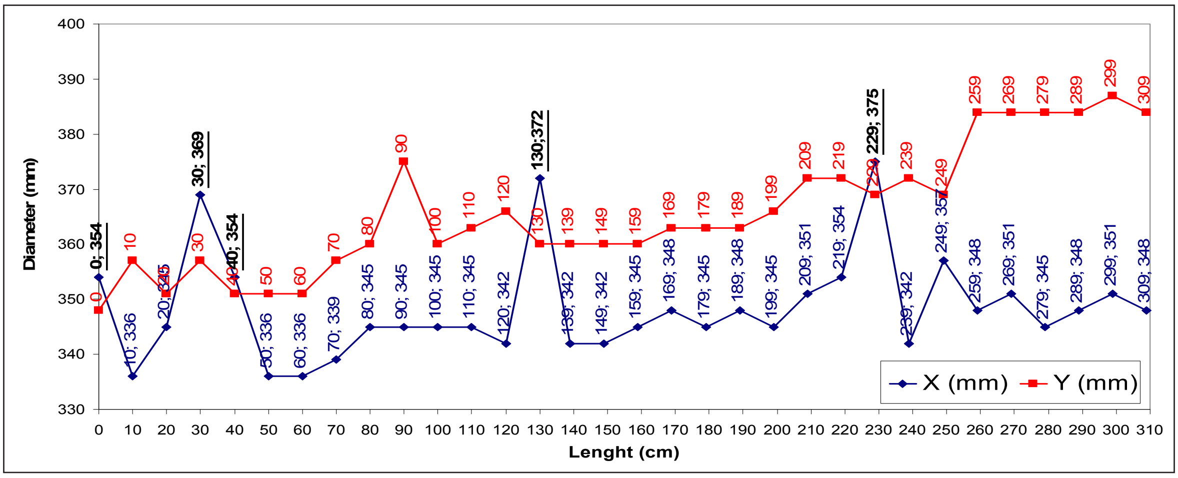
Alternative of the step 3:
Linear regression calculation – for the total fitting the curve or calculation of limit values.

To modify any of previous procedures could be omitted the first and the last two or three values. The aim of the procedure is to remove effects of root swelling and obliquely cut butt ends on the resulting curve if linear regression is used.

RESULTS AND DISCUSSION

Basic procedures A, B, C could be used to find an incorrect value, but don’t offer any value usable for its replacement. These procedures are compared in Tab. I.

A set of data scanned with passing transporters for a log with indispensable flattening was selected for demonstration of advantages and disadvantages of each basic procedure. The flattening and the transporters are evident in the Fig. 2. The distance between blue and red lines (diameters measured in each direction of the scanning) shows the flattening.



2: *Data scanned with passing transporters for one log with flattening*

I: *Comparison of basic procedures A, B, C on the set of data scanned on passing through conveyer for one log with flattening ("0" means useful and "1" incorrect value)*

Input values			A		B1					B2					C		
Longitud (cm)	X (mm)	Y (mm)	$X_a - Y_a$	$\lvert X_a - Y_a \rvert < k_1$, $k_1 = 15$	$X_a - X_{a+1}$	$\lvert X_a - X_{a+1} \rvert < k_2$, $k_2 = 16$	$X_a - Xa_{-1}$	$\lvert X_a - X_{a-1} \rvert < k_2$, $k_2 = 16$	results	$X_a - X_{a+2}$	$\lvert X_a - X_{a+2} \rvert < k_3$, $k_3 = 17$	$X_a - X_{a-2}$	$\lvert X_a - X_{a-2} \rvert < k_3$, $k_3 = 17$	results	$1-(X_a / X_{a+1})$	$\lvert 1-(X_a / X_{a+1}) \rvert < k_4$: $k_4 = 0{,}05$	$k_4 = 0{,}08$
0	**354**	348	**6**	**0**	**18**	**1**	**354**	**1**	**1**	**9**	**0**	**354**	**1**	**0**	**-0,054**	**1**	**0**
10	336	357	-21	1	-9	0	-18	1	0	-33	1	336	1	1	0,026	0	0
20	345	351	-6	0	-24	1	9	0	0	-9	0	-9	0	0	0,065	1	0
30	**369**	357	**12**	**0**	**15**	**0**	**24**	**1**	**0**	**33**	**1**	**33**	**1**	**1**	**-0,042**	**0**	**0**
40	**354**	351	**3**	**0**	**18**	**1**	**-15**	**0**	**0**	**18**	**1**	**9**	**0**	**0**	**-0,054**	**1**	**0**
50	336	351	-15	1	0	0	-18	1	0	-3	0	-33	1	0	0,000	0	0
60	336	351	-15	1	-3	0	0	0	0	-9	0	-18	1	0	0,009	0	0
70	339	357	-18	1	-6	0	3	0	0	-6	0	3	0	0	0,017	0	0
80	345	360	-15	1	0	0	6	0	0	0	0	9	0	0	0,000	0	0
90	345	375	-30	1	0	0	0	0	0	0	0	6	0	0	0,000	0	0
100	345	360	-15	1	0	0	0	0	0	3	0	0	0	0	0,000	0	0
110	345	363	-18	1	3	0	0	0	0	-27	1	0	0	0	-0,009	0	0
120	342	366	-24	1	-30	1	-3	0	0	0	0	-3	0	0	0,081	1	1
130	**372**	360	**12**	**0**	**30**	**1**	**30**	**1**	**1**	**30**	**1**	**27**	**1**	**1**	**-0,088**	**1**	**1**
139	342	360	-18	1	0	0	-30	1	0	-3	0	0	0	0	0,000	0	0
149	342	360	-18	1	-3	0	0	0	0	-6	0	-30	1	0	0,009	0	0
159	345	360	-15	1	-3	0	3	0	0	0	0	3	0	0	0,009	0	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
269	351	384	-33	1	6	0	3	0	0	3	0	-6	0	0	-0,017	0	0
279	345	384	-39	1	-3	0	-6	0	0	-6	0	-3	0	0	0,009	0	0
289	348	384	-36	1	-3	0	3	0	0	0	0	-3	0	0	0,009	0	0
299	351	387	-36	1	3	0	3	0	0	351	1	6	0	0	-0,009	0	0
309	348	384	-36	1	348	1	-3	0	0	348	1	0	0	0	0,017	0	0

Legend: A, B, C … basic procedures (B1 … differences between neighbors values, B2 … differences between farther values)
Colours: 357 and 384 … input values, **354** …values which should be found (extremes), yellow / grey … well / wrong founded

The extreme values apparent each 1 m and marked by black colour correspond to the conveyers.

The comparative value was determined by a reasonable estimate after consultation with many people working in forestry. Its value was set at 15 mm (current defects are smaller). It has to be increased in conformity with natural gradient.

Advantages and disadvantages of the basic procedures

A: The method is useful when the log is not flatted. In such a case, of course, only values considerably differing are termed erroneous. Thus, different values is possible to filter off, for instance the values measured at outstanding bark, torn fibres or part of a branch. Moreover, it would be possible to eliminate effects of flattening by comparing several successive values between X and Y differences.

In case of flatted log big errors could come out as in our example could be seen. Every right values in real set of data was considered wrong and vice versa.

B: This method does not find a defect, which will deviate in several successive measurements (typical example could be obtained on line with conveyer, which pass through the scanner and there is a waste towed by them). It can be modified by comparing not with neighbouring values (method B1) but with farther values (method B2). Comparison of each value with value up and down by the position of the measuring could help with it (eg extreme value in method B2: $|X_a - X_{a+2}| > k$ $|X_a - X_{a-2}| > k$).

C: This method presents a percentage calculation. It means that the comparative value correspond to the percentage expression of defects on the stem surface with respect to its diameter. In practice some defects could have the same size on thin stem as on the stem with larger diameter. In case of thick log the coefficient of growth could be so small, that the extreme values could be treated as normal.

At the experimental application of proposed methods it appeared that the simplest comparative methods did not fulfil our expectations.

Errors in their use only shift to another place. The calculated value is affected by an error and thus an inaccessible difference occurs at its comparison with the original value.

Basic procedures D, E, F could be used to find an incorrect value and offer value usable for its replacement. These procedures are compared by graphic in Fig. 3, 4 and 5.

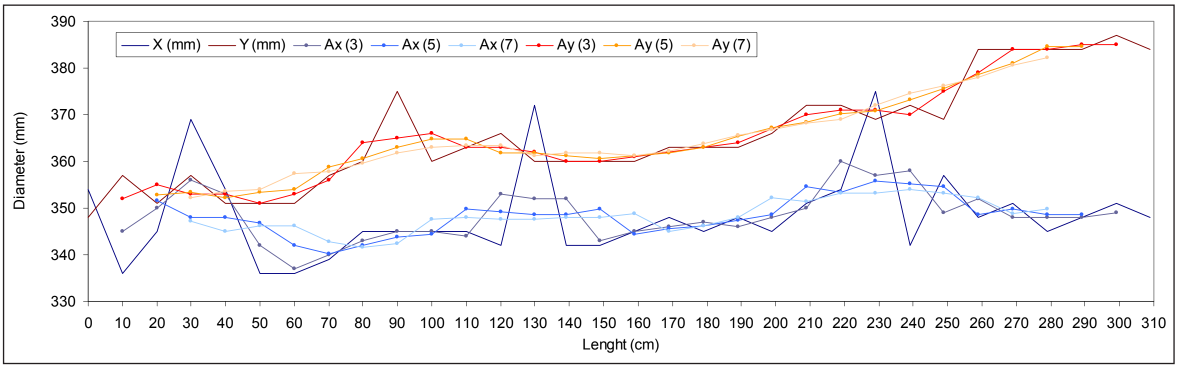
D: Comparison of original values with values calculated by means of running averages appeared to be more suitable. It is valid for running averages that the larger the width of smoothing the smoother the curve. However, there are also more biased values due to one extreme value. Using the larger width of smoothing (7 values) for the calculation of comparative values at the first filtration appears to be useful. Thus, it is possible to filter off advantageously extreme values.

A disadvantage of this method is a fact that it is not possible to calculate values for edge data. If the objective of filtration consists in the determination of mid diameter of logs for the calculation of its volume, limit values are not important. However, they are necessary for the determination of a top diameter and in using running averages, it is necessary to approximate them by another method. One of possibilities consists in fitting the curve of calculated running averages by, for example, linear regression (Fig. 3).

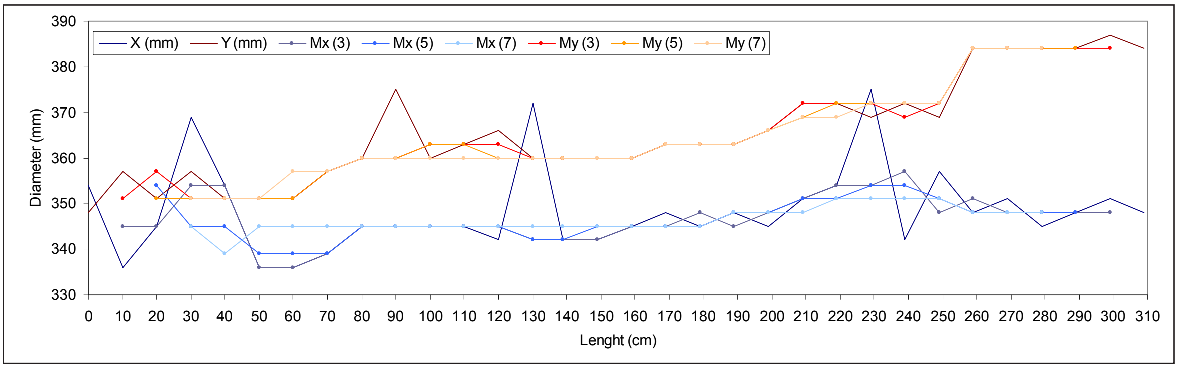
Other possibilities to approximate of limit values:

1. using of values of running averages that correspond to last running average value
2. using of values of running averages that correspond to last running average value increased by increment calculated in conformity with an average gradient of the diameter of the log (eg in the Czech Republic is used gradient 1 cm of diameter of the log per 1 m of the log length for the *Picea abies*)

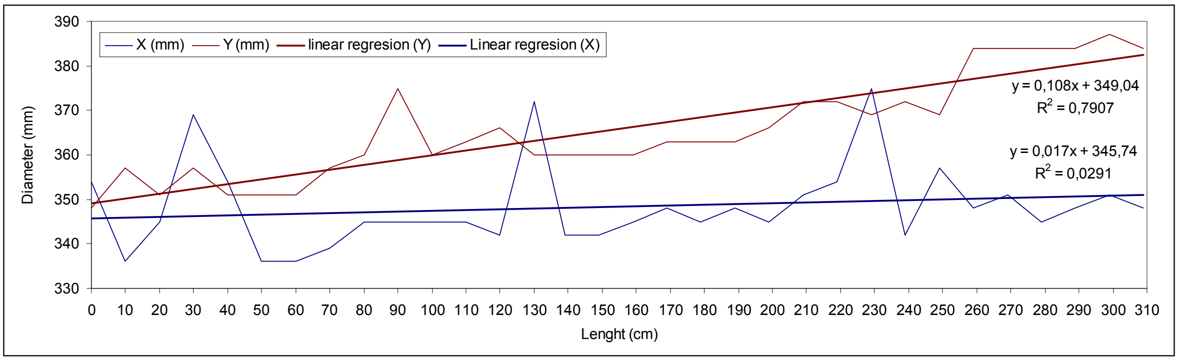
E: Even better results than the one with running averages were achieved using medians instead of running averages. Medians are not affected by extreme values. For the number of used values the same rule is valid as for averages (Fig. 4).



3: *Method D*



4: *Method E*



5: *Method F*

F: This procedure can be applied right on measured values, but considerably farther values can markedly deflect the whole straight line. It is more suitable to use the procedure on the set of values, which was already modified by means of another method (Fig. 5).

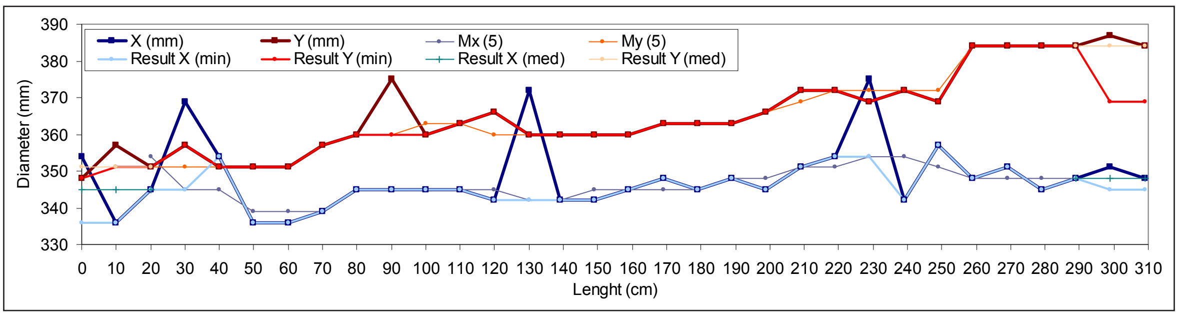
Nevertheless, the method is very suitable if it is applied on data smoothed by means of running averages or medians. On the basis of a determined straight line it is possible to calculate missing limit values.

G: There are two alternatives of use of this method demonstrated in this paper (Fig. 6).

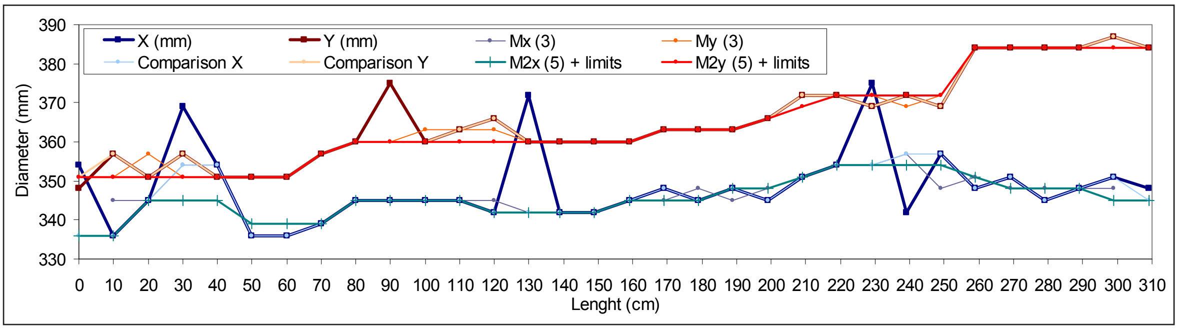
The calculation of running medians with width of smoothing 5 at the first filtration appears to be useful. There are not so more biased values due to one extreme value. Thus, it is possible to filter off advantageously extreme values (eg transporters). Majority of the real values stay in the resulting curve, ie the method don't change a lot the real measured shape. Extrapolation of limit values by calculation of running medians from last 5 values from adjusted data smoothes well the curve and could be used for calculating of the volume of the log if it is carried out as the sum of volumes of particular sections. Extrapolation of limit values by the minimal value from last 5 values of adjusted data and from the original data together finds its usage at grading logs according to butt end diameter or searching of the best cutting scheme.

H: Method H is demonstrated on Fig. 7.

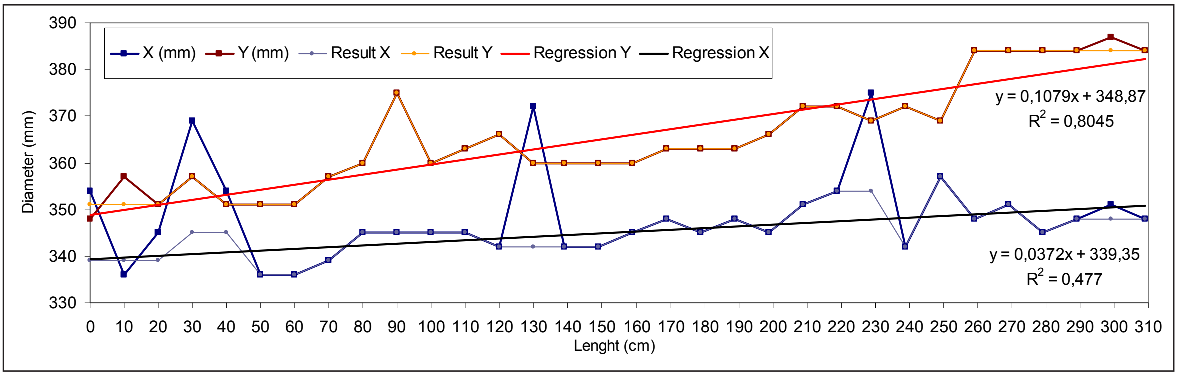
This method is more time-consuming then the method G, because of the second smoothing by running medians. The second smoothing brings the possibility to make the first calculation of median with width of smoothing 3. Thus, only the big extremes are filtrated in first step and less limit va-



6: *Method G*



7: *Metod H*



8: *Method I*

lues are lost. The curve is adjusted at the second smoothing. Good image of the log is obtained.

I: Two alternatives of use of this method are demonstrated on (Fig. 8).

Method I is relatively fast one. It filters well considerably extreme values and doesn't change others values. It's good for quick filtration of conveyers, passing through the measuring device.

Application of linear regression finds its use if the image of the convergence of the log is needed and the exact values of the diameter of each part of the log is not so important.

The methods G, H, I appear to be the most suitable between the proposed methods of filtration. Each of the combinations has some advantages and disadvantages. These properties are intended for their use in various conditions and requirements for measurement. However, it is necessary all methods to be tested practically on sawmill.

SUMMARY

The electronic reception of wood shows several drawbacks, which have not been fully worked out yet. Filtration of data taken by a measuring device ranks among them. The aim of filtration is to remove values of measurement, which do not correspond to the real shape of a stem and which result on the basis of sensing defects on its surface. It is carried out by comparing values of neighbouring measurements according to a predetermined algorithm. Thus, searching for this algorithm is the paper objective.

The proposed methods were tested on data obtained from a measuring device Inframat ITS 570.3 of Eltes Šumperk Ltd. It refers to 2D measurement, the basis of which consists of double sensing frames working in two directions perpendicular at each other. For the filtration, data coming from a measuring unit to a control computer were used. Values of couples of log diameters perpendicular at each other are available (thereinafter termed X and Y diameters) in mm for every 10 cm length of a log.

Methods of filtration are based on simple mathematical and statistical procedures, which are subsequently variously combined. It is necessary to deal with two basic problems, viz. first, how to find an incorrect value and second, which value should be used to replace the incorrect value.

Basic procedures of filtration:

A: Mutual comparison of values of diameters measured in perpendicular directions; B: Mutual comparison of values of diameters measured consecutively in one direction; C: Comparison of the coeffi-

cient of growth of successive values; D: Fitting the surface curves by means of running averages; E: Fitting the surface curve of a stem by means of "running" medians; F: Linear regression.
Basic procedures A, B and C could be used to find an incorrect value, but don't offer any value usable for its replacement.
Errors in their use only shift to another place. The calculated value is affected by an error and thus an inaccessible difference occurs at its comparison with the original value.
Thus, comparison of original values with values calculated by means of running averages or medians (methods D, E) or by linear regression (F) appeared to be more suitable. These procedures could be used to find an incorrect value and offer value usable for its replacement.
At the experimental application of proposed methods it appeared that the simplest comparative methods did not fulfil our expectations.
More than 50 methods were combined and analyzed. Approximately 15 of them were selected and tested. The methods were applied to data scanned on ca 150 logs randomly selected from thousands of files in the sawmill log yard. The filtration effects of different methods were visually assessed. The most applicable three methods were selected and they will be tested practically at sawmill in the next step of research. These methods are described in this paper.
Methods G, H, I, how were they named, combine running medians with width of smoothing 3 or 5 (basic method E), mutual comparison of values of diameters measured consecutively in one direction (B) and linear regression (F).
Results refer, that all proposed methods correspond to necessities for log dimensions determination. It is not possible to define the best method generally. Different properties of these methods make them suitable for calculation of log dimensions if different type of use is requested:
It is possible to filter off advantageously extreme values (eg transporters) by method G. Majority of the real values stay in the resulting curve, ie the method don't change a lot the real measured shape. It could be used for calculating of the volume of the log if it is carried out as the sum of volumes of particular sections.
The curve is adjusted at the second smoothing of the method H. Good image of the log is obtained and the method could be use for volume calculation by Huber's method.
The method is good for quick filtration of conveyers, passing through the measuring device.

SOUHRN

Způsoby filtrace dat a jejich vliv na výsledný obraz kmene při elektronickém snímání jeho rozměrů

Elektronická přejímka dříví je zatím zatížena několika nedořešenými problémy. Mezi ně patří filtrace dat, která jsou sejmuta měřicím zařízením. Cílem filtrace je odstranit hodnoty měření, které neodpovídají reálnému tvaru kmene a vznikly na základě sejmutí vad na jeho povrchu. Provádí se vzájemným porovnáním hodnot sousedních měření podle určitého předem stanoveného algoritmu. Hledání tohoto algoritmu je cílem této práce.
Navržené metody byly zkoušeny na datech z měřicího zařízení Inframat ITS 570.3 firmy Eltes Šumperk. Jedná se o tzv. 2D měření, jehož základ tvoří zdvojené snímací rámy, pracující ve dvou na sebe kolmých směrech. Pro filtraci byla použita data, která přicházejí z měřicí jednotky do řídicího počítače. K dispozici jsou hodnoty dvojic na sebe kolmých tlouštěk výřezu (dále označované jako tloušťky X a Y) v milimetrech pro každých 10 cm délky výřezu.
Metody filtrace jsou založeny na jednoduchých matematických a statistických operacích, které jsou následně různě kombinovány.
Je třeba řešit dva základní problémy: jak nesprávnou hodnotu nalézt a následně jakou hodnotou má být nahrazena.
Základní postupy
A: Vzájemné porovnání hodnot tlouštěk naměřených v kolmých směrech; B: Vzájemné porovnání hodnot tlouštěk po sobě naměřených v jednom směru; C: Porovnání koeficientu růstu po sobě následujících hodnot; D: Vyrovnání povrchové křivky kmene pomocí klouzavých průměrů; E: Vyrovnání povrchové křivky kmene pomocí „klouzavých" mediánů; F: Lineární regrese.
Základní postupy A, B a C mohou být použity pro hledání nesprávné hodnoty, ale neposkytují žádnou hodnotu, kterou by bylo možno použít jako náhradní.
Chyba se při jejich samostatném použití pouze přesouvá do jiného místa. Vypočtená hodnota je zatížena chybou, a tudíž při jejím porovnání s hodnotou původní vychází nepřípustný rozdíl.
Vhodnější se ukázalo porovnávání původních hodnot s hodnotami vypočtenými pomocí klouzavých průměrů nebo mediánů (metody D, E) nebo lineární regresí (F).
Při pokusné aplikaci navržených metod se ukázalo, že ty nejjednodušší srovnávací metody nesplňují očekávání.

Během výzkumu bylo testováno více než 50 kombinovaných metod. Metody byly aplikovány na přibližně 150 souborech dat, které byly vybrány náhodným výběrem z tisíců souborů měřených na pile, a byly vizuálně posouzeny. Byly vybrány nevhodnější metody, které budou následně testovány v praxi. Tyto metody jsou popsány v této práci.
Metody G, H, a I, jak byly pojmenovány pro účely tohoto článku, kombinují klouzavé mediány se šířkou vyhlazení 3 nebo 5 (základní metoda E), vzájemné porovnání hodnot tlouštěk po sobě naměřených v jednom směru (B) a lineární regresi (F).
Výsledky ukazují, že navržené metody jsou použitelné pro stanovení tvaru výřezu. Není možné definovat nejlepší metodu. Různé vlastnosti těchto metod je předurčují pro použití při jiných požadavcích:
Metoda G dobře slouží pro odfiltrování extrémně odlehlých hodnot. Většina reálně naměřených hodnot se objevuje ve výsledné (upravené) křivce, tzn. metoda nemění příliš původně naměřený tvar. Metoda je vhodná při následném výpočtu objemu výřezu z jednotlivých sekcí.
U metody H je při druhém kroku křivka vyhlazena. Výsledkem je vhodnost jejího použití při výpočtu objemu dle Hubertovy metody.
Metoda I je vhodná pro rychlé odstranění hodnot, které odpovídají unášečům dopravníku procházejícího měřicím zařízením.

filtrace dat, elektronické měření, rozměry kulatiny, klouzavý průměr, median, tloušťka kulatiny

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