

The choice of the pyrometers used for pyrogravure devices

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Abstract: - The paper presents the results of a market study performed about devices for the contactless temperature measurement. Technical data was collected from prospects provided by manufacturers. Technical data was processed and analysed using statistical rules. Scope of work is to find a correlation between the main characteristics of these devices. Main characteristics are: maximum IR temperature; measurement error of the measured value; report between measurement distance and measurement surface; the maximum response time; weight; price. The device which has equability between these parameters is the best. Of course the ideal case is when all these reports are equals, but this is just a theoretical case. For this study we keep just devices which measure temperatures over $500^{\circ} C$.

Key-Words: - pyrometers; contactless temperature measurement; temperature measurement with IR radiations; statistical analysis; polar chart; multivariate statistical analysis; pyrogravure.

1 Introduction

The temperature is the most important characteristic of the pyrogravure process. The pyrogravure quality depends on the temperature. The temperature measurement with contact methods is dangerous because it can do an electrical shock. For the temperature measurement is difficult to use contact methods because the warmest point is very small and the temperature sensor influences negative the measurement. The contactless temperature measurement is an innovative measurement process. The value is not influenced by the environment.

The temperature varies depending on distance from edge to measuring point in material. The contact methods provide an average temperature between these values. It is a mistake for this case because in the pyrogravure process is important just the edge temperature. This temperature can be measured using an IR radiation technology.

Temperature measuring with IR radiations is wide used in electronics and medicine domains.

Contactless devices used for temperature measurement are two types: with IR sensor and with IR camera. This article studies just the devices with IR sensor.

2 Problem Formulation

Nowadays it has more pyrometer types, many of them with IR camera or with PC interface. It is difficult when it wants to buy such a device. The technical data will be analysed using statistical methods. On this way it tries to find the best offers.

3 Exploratory analysis of multidimensional data

The values for main characteristics from pyrometers are centralized in table 1. These characteristics are:

- Maximum temperature measured. This parameter is important because a out of range temperature does errors;

- Measurement error of the measured value is important because a too big value of this parameter does a wrong measurement;

Table 1

Technical data for pyrometers [1-3]

Model	Max. IR temperature [°C]	Precision [+/-%]	D:S	The maximum response time, [ms]	Weight, [g]	Price, [RON]
Voltcraft - IR 550-10S	550	1	10	1000	180	309,00
Voltcraft - IR 650-12D	650	1	12	150	180	369,00
Voltcraft - IR 800-20D	800	1	20	500	180	449,00
Voltcraft - IR 900-30S	900	1,5	30	1000	290	479,00
Voltcraft - IR 1000-30D	1000	1	30	150	320	899,00
Voltcraft - IR-365 RF	1050	1,5	30	1000	290	989,00
Voltcraft - IR 1200-50D USB	1200	1	50	150	320	999,00
Voltcraft - IR1000-50CAM	1000	1	50	150	410	1899,00
Raytek - 3i	1200	1	30	700	470	2027,56
Sonel - IR Sonel DIT-500	1600	1	50	500	965	2156,11
Fluke - IR Fluke 566	650	1	30	500	965	2361,46
Fluke - IR Fluke 568	800	1	50	500	1025	3108,68
Fluke - IR de precizie Fluke 572	900	0,75	60	250	480	5202,05
Fluke - IR de precizie Fluke 574	900	0,75	60	250	480	7757,44
XTemp CTLS -	1800	0,3	300	500	150	199,00

- The report between measurement distance and measurement surface (D:S) is important parameter because of it depends of the distance from measurement device to measurement point;
- The maximum response time is important parameter especially when we have a lot of measurements or when temperature varies much in short time.
- Weight is another important parameter especially when the measurement device is mounted on a mobile device.
- The price is a guide parameter. It is also a parameter which defined the quality device.

4 Descriptive studies of variables

A study of main statistical parameters is shown in table 2.

Table 2

Descriptive studies of variables

Statistical test	Max. IR temperature [°C]	Precision [+/-%]	D:S	The maximum response time, [ms]	Weight, [g]	Price, [RON]
Average	1000,00	0,99	54,13	486,67	447,00	1946,95
Dispersion	709333,33	0,66	6317,43	235595,56	203781,40	6372561,80
Deviation	842,22	0,81	79,48	485,38	451,42	2524,39
Minimum	495,00	0,27	9,00	135,00	135,00	179,10
Maximum	1800,00	1,50	300,00	1000,00	1025,00	7757,44

In this table it can see some interesting values:

- The average price is around 2000 RON.
- The average weight is around 450 grams.
- The data dispersion and data deviation are large because data are heterogeneous.
- Values from measurement error of the measured value and the report between measurement distance and measurement surface are less. That means all these devices respect the quality standards.

The other values do not have importance significance using these statistical criteria. For that, in next section we will search correlation between parameters.

5 Correlations

In previous section we set some observations about price and weight. Apparently these parameters have no link with the others parameters. We keep these two parameters for demonstration.

The statistical data were processed in two ways:

- Correlations between main parameters;
- Correlations between main parameters for each device.

5.1. Correlations between main parameters

That helps it to observe the links between parameters and their statistical importance.

Correlations between main parameters are shown in table 3.

The greatest correlation is between measurement error of the measured value and the report between measurement distance and measurement surface. It is a feedback average link because it is negative.

The weakest link is between weight and maximum measured temperature. Statistical there is no link.

Table 3

Correlations between statistical parameters

	Max. IR temperature [°C]	Precision [+/-%]	D:S	The maximum response time, [ms]	Weight [g]	Maximum
Precision, [+/-%]	-0,396					0,396
D : S	0,715	-0,722				0,722
The maximum response time, [ms]	-0,071	0,498	-0,090			0,498
Weight, [g]	0,017	0,029	-0,159	-0,081		0,159
Price, [RON]	-0,104	-0,273	-0,057	-0,325	0,422	0,422

Model	Max. IR temperature [°C]	Precision [+/-%]	D:S	The maximum response time, [ms]	Weight, [g]	Price, [RON]
Sonel - IR Sonel DIT-500	1,312	0,900	0,516	0,752	1,839	0,783
Fluke - IR Fluke 566	0,184	0,900	0,264	0,752	1,839	0,865
Fluke - IR Fluke 568	0,362	0,900	0,516	0,752	1,972	1,161
Fluke - IR de precizie Fluke 572	0,481	0,592	0,642	0,237	0,764	1,990
Fluke - IR de precizie Fluke 574	0,481	0,592	0,642	0,237	0,764	3,002
XTemp CTLS -	1,549	0,037	3,661	0,752	0,033	0,008

5.2. Correlations between statistical parameters for each device

It processed correlations for each device and for each parameter.

Correlations between statistical parameters for each device are shown in table 4.

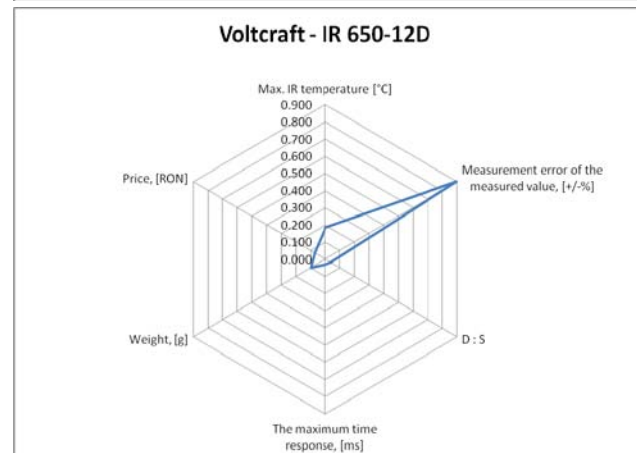
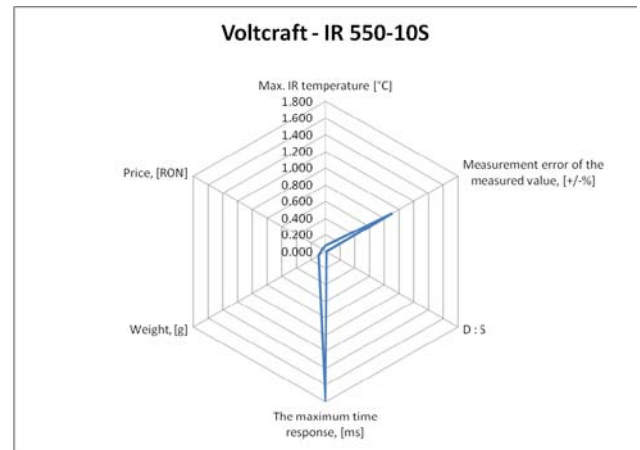
Table 4

Correlations between statistical parameters for each device

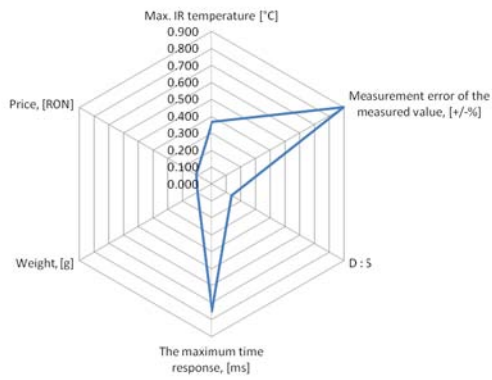
Model	Max. IR temperature [°C]	Precision [+/-%]	D:S	The maximum response time, [ms]	Weight, [g]	Price, [RON]
Volcraft - IR 550-10S	0,065	0,900	0,013	1,782	0,100	0,051
Volcraft - IR 650-12D	0,184	0,900	0,038	0,031	0,100	0,075
Volcraft - IR 800-20D	0,362	0,900	0,138	0,752	0,100	0,107
Volcraft - IR 900-30S	0,481	1,516	0,264	1,782	0,343	0,119
Volcraft - IR 1000-30D	0,600	0,900	0,264	0,031	0,410	0,285
Volcraft - IR-365 RF	0,659	1,516	0,264	1,782	0,343	0,321
Volcraft - IR 1200-50D USB	0,837	0,900	0,516	0,031	0,410	0,325
Volcraft - IR1000-50CAM	0,600	0,900	0,516	0,031	0,609	0,681
Raytek - 3i	0,837	0,900	0,264	1,164	0,742	0,732

5.3. Descriptive study for processed data

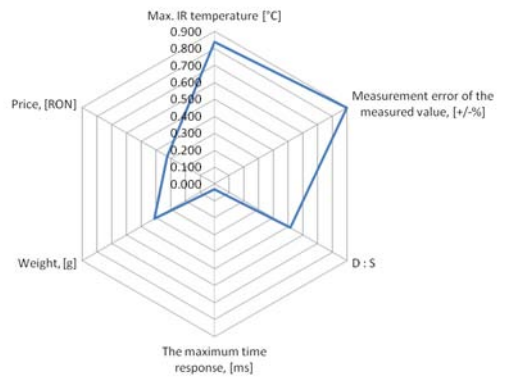
The data from table 4 can be shown using the star charts.



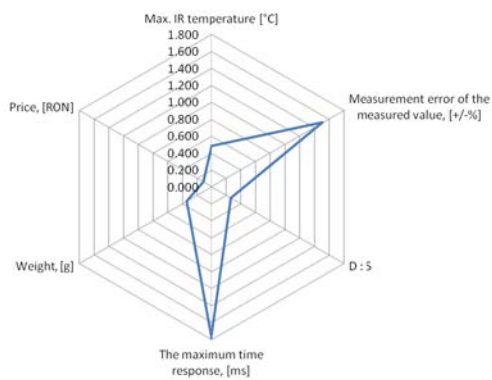
Voltcraft - IR 800-20D



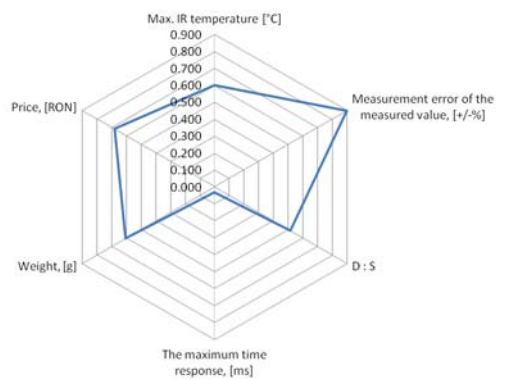
Voltcraft - IR 1200-50D USB



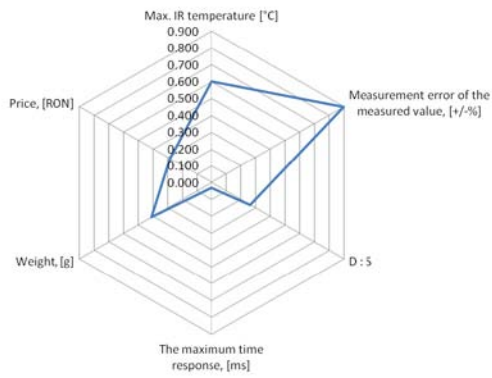
Voltcraft - IR 900-30S



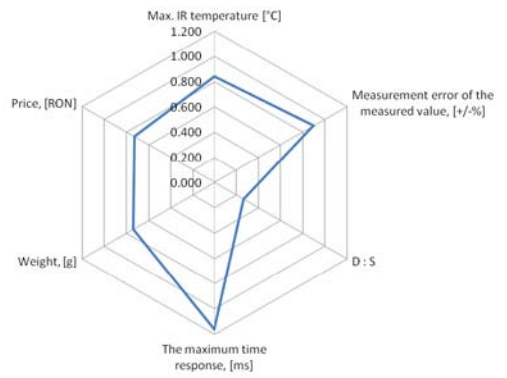
Voltcraft - IR1000-50CAM



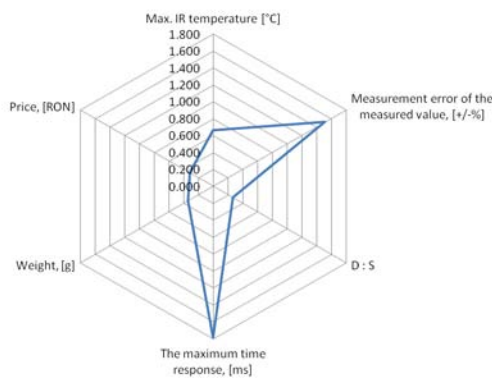
Voltcraft - IR 1000-30D



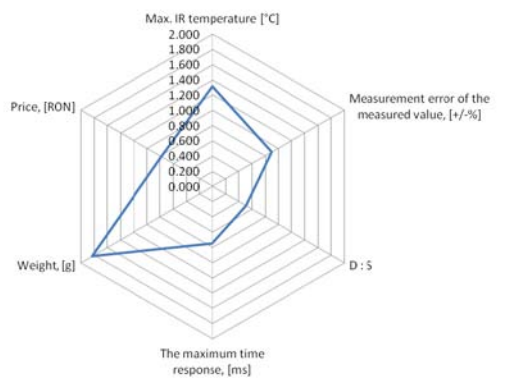
Raytek - 3i



Voltcraft - IR-365 RF



Sonel - IR Sonel DIT-500



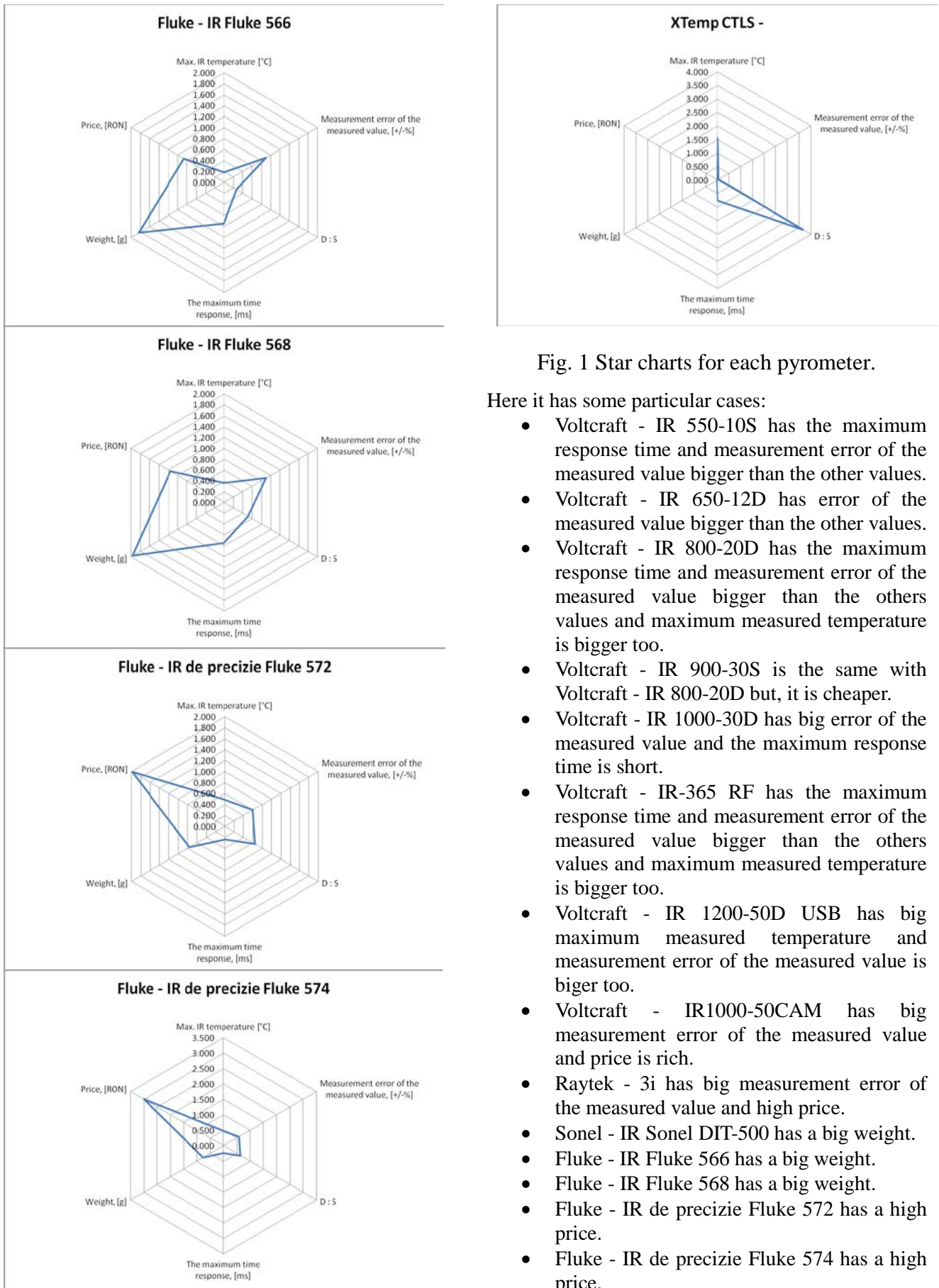


Fig. 1 Star charts for each pyrometer.

Here it has some particular cases:

- Voltcraft - IR 550-10S has the maximum response time and measurement error of the measured value bigger than the other values.
- Voltcraft - IR 650-12D has error of the measured value bigger than the other values.
- Voltcraft - IR 800-20D has the maximum response time and measurement error of the measured value bigger than the others values and maximum measured temperature is bigger too.
- Voltcraft - IR 900-30S is the same with Voltcraft - IR 800-20D but, it is cheaper.
- Voltcraft - IR 1000-30D has big error of the measured value and the maximum response time is short.
- Voltcraft - IR-365 RF has the maximum response time and measurement error of the measured value bigger than the others values and maximum measured temperature is bigger too.
- Voltcraft - IR 1200-50D USB has big maximum measured temperature and measurement error of the measured value is bigger too.
- Voltcraft - IR1000-50CAM has big measurement error of the measured value and price is rich.
- Raytek - 3i has big measurement error of the measured value and high price.
- Sonel - IR Sonel DIT-500 has a big weight.
- Fluke - IR Fluke 566 has a big weight.
- Fluke - IR Fluke 568 has a big weight.
- Fluke - IR de precizie Fluke 572 has a high price.
- Fluke - IR de precizie Fluke 574 has a high price.

- XTemp CTLS – has the report between measurement distance and measurement surface bigger than the other parameters.

6 Conclusions

Using statistical methods it can compare and it chooses the best device.

The weight and the price were studied using average values. These parameters do not influence technical parameters.

The technical parameters were studied using correlations criteria.

The pyrometers are divided in 2 parts:

- Pyrometers which have a characteristic more than the others.
- Pyrometers which have all characteristic closer.

The model Voltcraft - IR 1200-50D USB is interesting because it has a balance between characteristics and the price is a half under average.

The model Voltcraft - IR1000-50CAM has a balance between characteristics and the price is around average.

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