



Challenges and attempts at solutions

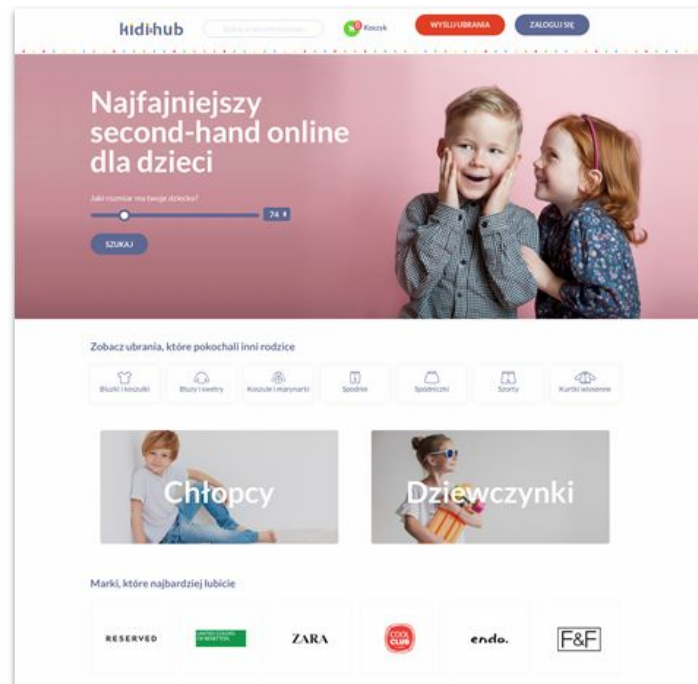
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Kidihub - the business

Kidihub Platform offers an all-inclusive re-sale service for used child clothing.

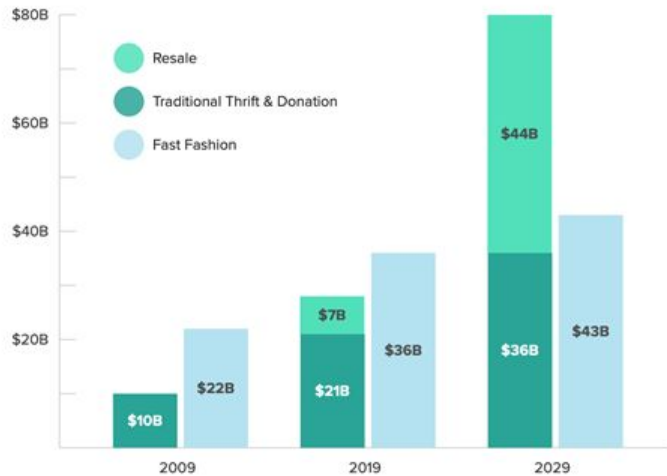
- **Second-hand** for kids clothes offering all the e-commerce advantages.
- Top brand clothes taken into **consignment** directly from parents.
- **Complete handling process:** selection, ironing/conditioning, photo, listing, dispatch/delivery, payments.



Why Kidihub is a business for the future?

Resale Expected to Be Bigger Than Fast Fashion by 2029

Total secondhand market projected to grow to almost twice the size of fast fashion by 2029.¹



Consumer trends: price awareness
sustainability
less waste
sharing

kidihub

Ecology:
Countering
climate change

E-commerce:
Market dynamics
better than
projected

Kidihub project - general idea

To develop the platform by adding new, innovative services



Partly **automated selection process** for clothes to be offered on the platform.



Software module providing **explanation for selection/rejection decisions**



Software module for **optimally pricing** used kids clothes offered on the platform



Monetization opportunity: creating and selling market reports regarding brand perception



Software module for **combining available clothes into sets**



Monetization opportunity: Licensing to third parties

Kidihub project - handful of facts

- **Title:** System wspierający sprzedaż używanych ubrań online - System supporting the sale of used clothes online
 - Fast track (Szybka Ścieżka 2020) **R&D project within POIR** fund, financed by EU and supervised by NCBiR, POIR.01.01.01-00-0420/20
 - **Start:** November 2020 - **End:** August 2023
 - **Three phases:** Research (16 months - 2 stages), Development (12 months), Initial Implementation (4 months)
 - **Budget:** around PLN 7.4 million including little over PLN 5.5 million in EU financing.
 - **Main contractor:** Bakers sp. z o.o. - owner of Kidihub portal
 - **Main R&D Subcontractor:** QED Software
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QED Software in Kidihub project

- **In research phase (Stage 1&2):**
 - design, construct and evaluate AI/ML models qualifying incoming clothes for sale;
 - design, construct and evaluate AI/ML models suggesting possible combination of clothes into sets.
 - provide specifications and guidelines for data collection process at main contractor.
 - design, construct and evaluate AI/ML models that, in interaction with the user (human expert), suggest product prices. Development of method for selecting examples to present to users (experts).
 - provide a XAI tool for explaining the decisions of AI/ML models that qualify clothes for sale.
 - develop a model detecting pairs of similar clothes for the purpose of combining them into sets.
-

QED Software in Kidihub project

- **In development phase (Stage 3):**
 - installation of the AI/ML model for selection/qualification of clothes, optimization, debugging, testing, monitoring and implementation of functionality (in REST API) for prediction quality assessment.
 - implementation of system facilitating selection of cases to be evaluated (priced), suggestions about Front-End.
 - developing mechanism for updating/adapting AI/ML model for clothes pricing (created in stage 2) by using newly collected pricing data.
 - Installation in production environment, monitoring and evaluation of implemented models and methods.
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Original challenges for Kidihub project

- **Challenge:**
How to make a tool for effective recognition of the condition of clothes?
 - **Challenge:**
How to determine the correct prices of clothes accepted for sale?
 - **Challenge:**
How to construct sets sets of clothes (recommendations) that can be purchased together ?
-

Current, detailed challenges for Kidihub project

- **Challenge:**
How to recognise the category for the piece of clothing in the picture?
 - **Challenge:**
 - **How to determine the attributes from the picture in order to use them for tagging?**
 - Colour
 - Pattern
 -
 - **Challenge:**
How to construct sets sets of clothes (recommendations) that can be purchased together ?
-

Clothes' categories

Model for recognizing clothes' categories

Real class: Bluzki i koszulki
Predicted class: Bluzki i koszulki



Real class: Bluzki i koszulki
Predicted class: Bluzki i koszulki



Real class: Koszule i marynarki
Predicted class: Koszule i marynarki



Real class: Sukienki
Predicted class: Kurtki



Real class: Kurtki
Predicted class: Kurtki



Real class: Bluzki i koszulki
Predicted class: Bluzki i koszulki



Real class: Bluzy i swetry
Predicted class: Bluzki i koszulki



Real class: Bluzki i koszulki
Predicted class: Czapki, szaliki, rękawiczki



Real class: Koszule i marynarki
Predicted class: Koszule i marynarki



Real class: Spodnie
Predicted class: Spodnie



Real class: Czapki, szaliki, rękawiczki
Predicted class: Czapki, szaliki, rękawiczki



Real class: Bluzy i swetry
Predicted class: Kurtki



Real class: Bluzki i koszulki
Predicted class: Bluzki i koszulki



Real class: Kurtki
Predicted class: Kurtki



Real class: Bluzki i koszulki
Predicted class: Bluzki i koszulki



Real class: Czapki, szaliki, rękawiczki
Predicted class: Czapki, szaliki, rękawiczki



Real class: Kurtki
Predicted class: Bluzy i swetry



Real class: Sukienki
Predicted class: Sukienki



Clothes' condition

Model for recognizing the condition of clothes

Real class: Nowy z metką
Predicted class: Jak nowy



Real class: Nowy z metką
Predicted class: Nowy z metką



Real class: Jak nowy
Predicted class: Lekkie ślady noszenia



Real class: Jak nowy
Predicted class: Jak nowy



Real class: Lekkie ślady noszenia
Predicted class: Ślady noszenia



Real class: Ślady noszenia
Predicted class: Nowy z metką



Real class: Lekkie ślady noszenia
Predicted class: Jak nowy



Real class: Jak nowy
Predicted class: Jak nowy



Real class: Jak nowy
Predicted class: Jak nowy



Real class: Jak nowy
Predicted class: Lekkie ślady noszenia



Real class: Ślady noszenia
Predicted class: Jak nowy



Real class: Jak nowy
Predicted class: Jak nowy



Real class: Lekkie ślady noszenia
Predicted class: Lekkie ślady noszenia



Real class: Jak nowy
Predicted class: Jak nowy



Real class: Jak nowy
Predicted class: Jak nowy



Real class: Nowy z metką
Predicted class: Nowy z metką



Real class: Jak nowy
Predicted class: Jak nowy



Real class: Nowy z metką
Predicted class: Nowy z metką



Some issues and (some) remedies

- Lack of data - there are not nearly enough examples of clothes in bad condition
 - Creation of special-purpose dataset.
 - Scraping data from on-line resources
 - Lack of data - some categories/colours/patterns are underrepresented
 - Scraping data from on-line resources
 - Purpose-driven data gathering
 - Rethinking ontology and categories
 - Unbalanced/skewed data - some concepts are inherently misrepresented
 - Rethinking ontology
 - Embeddings
 - Scraping data from on-line resources
 - Lacking reference/ground truth/performance measure
-

Dimensioning

Purpose - getting the dimensions of different types of clothes

Method:

- using ArUco marker to get the pixel / cm ratio
 - finding contour of the piece of clothing
 - localizing the key points used for getting the dimensions
 - calculating distances between the points
-

Dimensioning

Our input - photos (824 after filtering) of different garments grouped into (known) categories.

Categories

- Tops (coats, jerseys, shirts, tops, jackets)
 - Pants (shorts, trousers)
 - Skirts
 - Sleeveless dresses
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Dataset filtering

What caused the rejection of some photos?

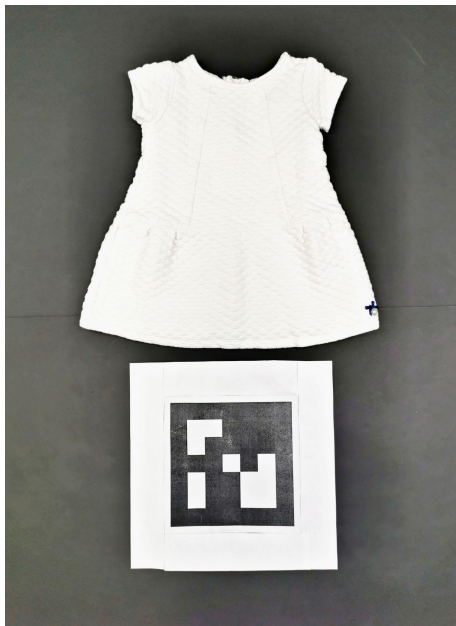
- some pictures were flipped by 90 degrees; we could easily correct this by checking the ArUco marker orientation and flipping the image based on this information, however, the marker was also very often flipped
 - the contrast between the background and the garment was too subtle
-

ArUco marker detection

How do we establish pixel-to-centimetre ratio?

- the printed ArUco marker, that is present on the photos is a square of side 10cm
 - the function from OpenCV (Open Computer Vision Python library) returns the coordinates of four corners of the ArUco marker
 - we calculate the length of each marker side in pixels and take an average of those measures
 - to get the pixel-to-centimetre ratio we divide 10cm by the average marker side length
-

Dimensioning - dataset examples

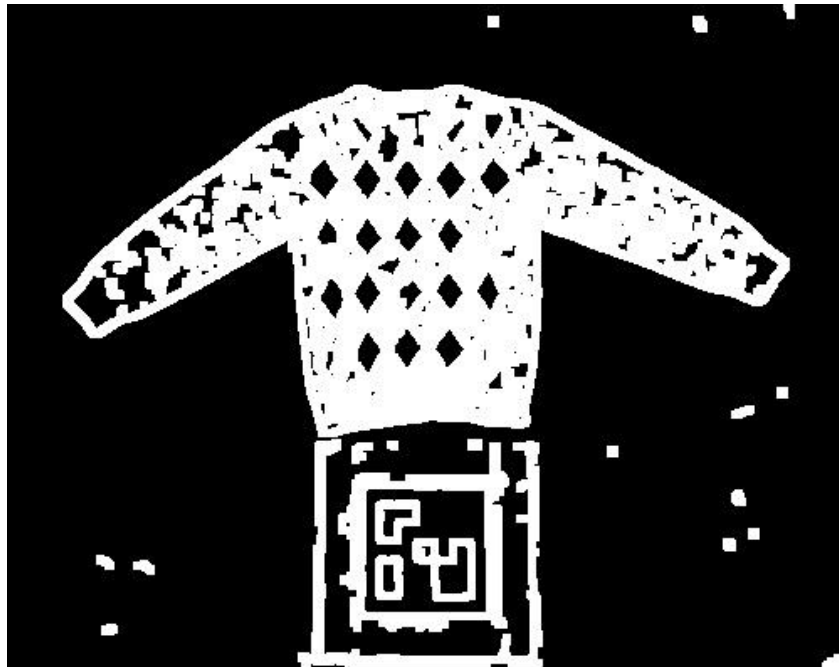


Data preparation

Steps of data preparation:

- reduce the width of the image to 500 pixels (keeping the original aspect ratio)
 - we apply gamma correction ($\gamma=0.4$) to brighten the image
 - contrast is increased by multiplying each pixel value by 2
 - we apply Canny edge filter
 - we apply dilation twice to avoid the situation, where the parts of the contour are separated from each other
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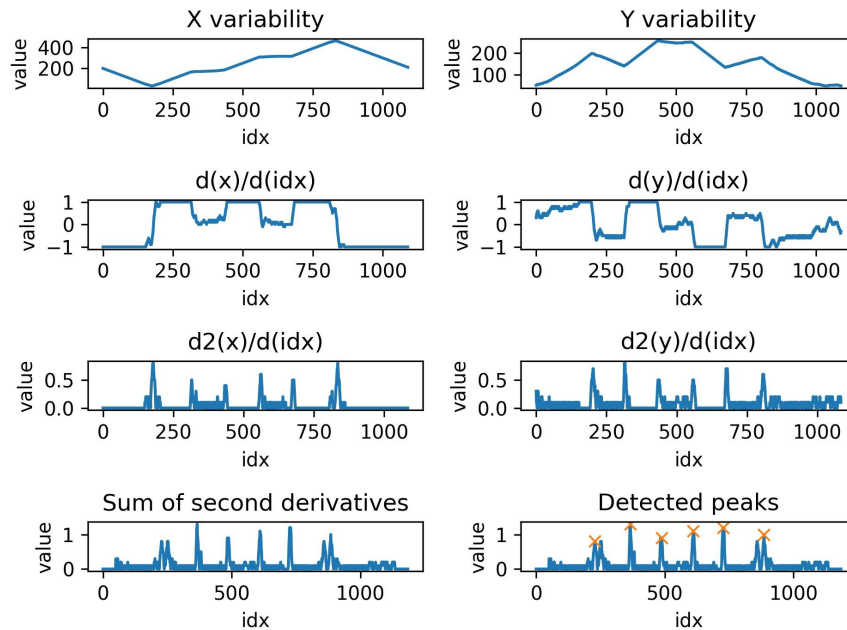
Data preparation



Feature points extraction

- we extract maximal outer contour using OpenCV function
 - we analyze the variability of the coordinates of the contour points to find corner points
 - corner points are the candidates for feature points which are used to measure the garment
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Feature points extraction



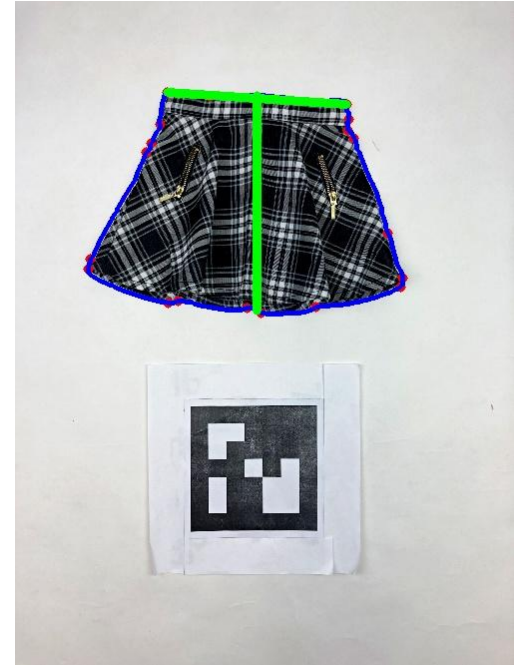
Feature points extraction - pants

- we measure waist width and pantleg length
- our feature points are the extreme points - the corner points that are the furthest points from each of the corners of the image



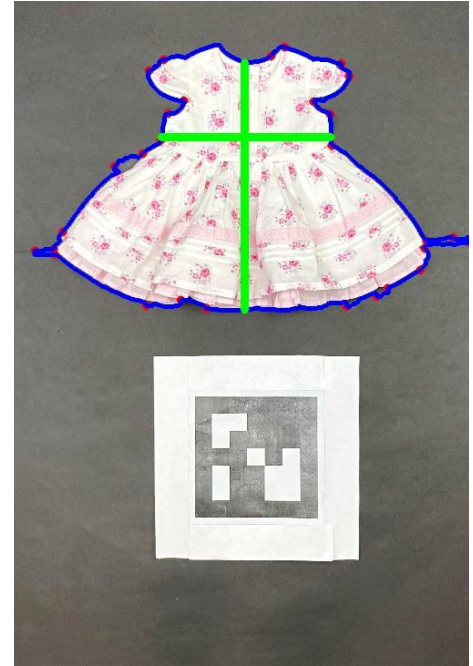
Feature points extraction - skirts

- we measure waist width and total length
- waist feature points are found in the same manner as in the case of pants
- to find total length we determine vertical symmetry axis by calculating the average value of x coordinates of waist points
- then we find two points that are the intersection points of the symmetry axis and the contour



Feature points extraction - sleeveless dresses

- we measure chest width and total length
- total length is measured in the same way as it was in the case of skirts
- to find chest width we first define the chest area to $0.3h - 0.85h$ where h is the vertical span of the dress
- then we split the contour using vertical axis into two parts
- for each y from the range $0.3h - 0.85h$ we find pairs of points from two parts of the contour with the same value of y
- our chest width is the smallest distance found between those pairs of points



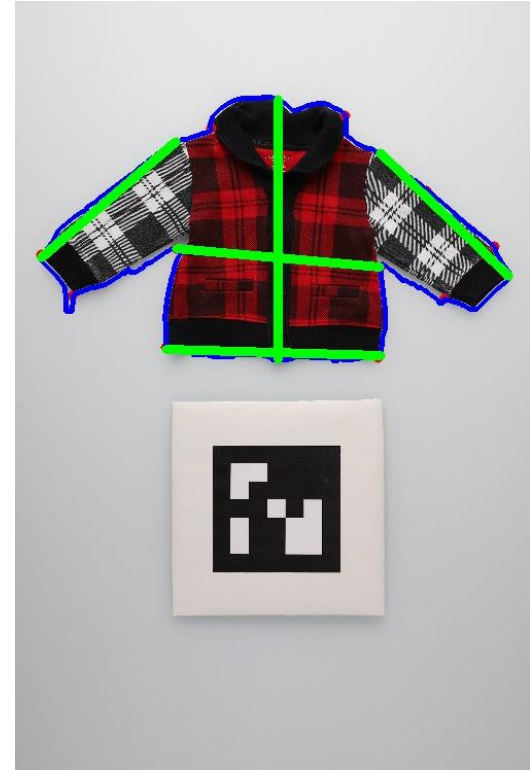
Feature points extraction - tops

- we measure waist width, chest width, sleeves length and total length
 - we again split the contour into two parts using vertical axis
 - we define the area, where the waist points should be as an area that is below the line of $0.85h$, where h is the vertical span of the garment
 - we filter out the parts of the contour which are part of the sleeves
 - we find the waist width as the maximal distance between two corner points that are included in the defined area
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Feature points extraction - tops

- to find chest points we once again define the potential area
- chest points are selected from the corner points of which the x coordinate is included in the $x_b \pm 0.15 * I_{width}$ range and y is included in $y_b - 0.1 * I_{height}$ range
- in such a way we select the potential pairs of chest points
- the pair of which the distance is the smallest is the chest width



Feature points extraction - tops

- we define the shoulders points as the intersection points of the contour with the vertical lines which are defined by the x coordinates of the chest points
- to find the sleeves points we apply corner points detection algorithm
- sleeves lengths are the overage of distances between shoulders points and sleeves points



Error correction neural network

- there are many possible sources of errors, main of which is the camera calibration error
 - to overcome these issues we designed error correction neural network
 - the input to the network is 14-dimensional vector; it includes x and y coordinates of all four ArUco marker corners and two feature points
 - the two remaining elements are image width and height
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Error correction neural network

- the model itself consists of 5 fully connected layers with 64, 128, 64, 32 and 1 features
 - ground truth values are measured by Kidihub employees
 - dataset consists of 2369 elements
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Error correction neural network experimental results

	Mean percentage error [%]	Error SD [%]	Reduced mean percentage error [%]	Reduced error SD [%]	Percentage corrected [%]
Tops	6.36	5.24	4.10	3.30	66.4
Skirts	4.56	3.30	4.20	3.44	69.2
Pants	7.13	5.29	4.01	2.91	76.7
Dresses	6.08	4.82	3.92	2.66	63.6
All	6.45	5.14	4.07	3.16	69.2

Dimensioning - Conclusions

- we proposed fast automatic garment measuring system
 - we introduced error correction neural network which reduced the error of our baseline system significantly
 - our system is comparable with other state of the art measuring systems described in the literature, however it needs much simpler setup
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Paper submitted to Advances in Engineering Software

1 Neural Network Enhanced Automatic Garment Measurement System*

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11 **Abstract**

The measurement of garments is most often a very laborious task. Automatic garment measurement systems may be thus a great convenience in fashion e-commerce cataloguing issues. In this paper, we propose an automatic garment measurement system that uses classical computer vision algorithms, as well as an error correction neural network, which reduces the overall error. We make use of data collected by our partner, which contains photographs of garments with ArUco markers. Using such data, we estimate the coordinates of feature points, which are used to calculate a specific size of a garment. We apply the error correction neural network to this measured size to minimize the error. The conducted experiments show, that our method is a useful tool that meets the requirements of practicality and its results are comparable with the current state of the art methods. Additionally, our error correction neural network is a novelty in the field of automatic garment measurement and there is no need for the garments templates, which are used in the previous solutions.

12 *Keywords:* automatic garment measurement, deep neural network, machine learning, computer
13 vision

Thank You!

Any questions or comments?