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Visibility of Industry 4.0 on social networks

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Abstract

Industrial systems today are facing challenges of resource efficiency, reduced time to market, production of personalized products and the interconnecting of system infrastructural elements. In answer to these challenges, Industry 4.0 presents the evolution of industrial systems which enables them to stay competitive. Industry 4.0 includes several building blocks such as: cyber-physical systems, additive manufacturing, augmented reality, predictive maintenance and so on. Information on Industry 4.0 can be found in journal articles, conference papers, but also in social networks. In effort to shed a new light on implementation of Industry 4.0, authors analyze the data of social network posts concerning the Industry 4.0. The data were collected over a period of time from social network called Twitter and then analysed from the aspect of the visibility and presence of Industry 4.0 and its elements.

Key words: *Industry 4.0, Cyber-Physical Systems, Social media mining, Social networks, Twitter*

1. INTRODUCTION

Industrial systems today are facing challenges of resource efficiency, reduced time to market, production of personalized products and the interconnecting of system infrastructural elements. The goal of each industrial system and every industrial revolution is to increase productivity. Companies are facing challenges in dealing with big data issues of rapid decision-making for improved productivity and many manufacturing systems are still not ready to manage big data due to the lack of smart analytic tools. Along with these challenges, industrial value creation must be geared towards sustainability and is currently shaped by the development towards the fourth stage of industrialization, the so-called Industry 4.0 [1].

Industry 4.0 is based on smart factories, smart products and smart services embedded in an internet of things. It includes several building blocks such as: cyber-physical systems, additive manufacturing, augmented reality, predictive maintenance and new business models are developing around these Industry 4.0 elements. Previous industrial revolution had impact mostly on shop-floor level, but this one looking for productivity growth in improvement of brainwork and decision making processes. Given that Industry 4.0 is in its early stages of development, disseminating information about its benefits and raising awareness about the importance of applying its elements are very important activities at this stage. On the other side, social networks are used for social interaction and can be very valuable and powerful tool for dissemination of information. Although information spread through social networks at a high speed can be both accurate and inaccurate, useful or useless, there is indication that social networks tend to favour valid information over rumours [2]. This paper is focused on exploring the use of Twitter as social network for dissemination of information connected to the Industry 4.0.

2. THEORETICAL BACKGROUND

2.1 **Industry 4.0**

Everything in Industry 4.0 has to be smart, starting with smart factories that produce smart products, where factories are supplied from smart energy sources and in which all flows are supported by smart logistics. Also, a smart data among the various elements of the system are exchanged via cloud. The paradigm of Industry 4.0 is essentially outlined by three dimensions: (1) horizontal integration across the entire value creation network, (2) end-to-end engineering across the entire product life cycle and (3) vertical integration and

networked manufacturing systems [1]. Smart factories are using embedded Cyber-Physical Systems (CPS) for value creation and by integrating CPS with production, logistics and services in the current industrial practices, it would transform today's factories into an Industry 4.0 factory with significant economic potential. CPS is defined as transformative technologies for managing interconnected systems between its physical assets and computational capabilities [3]. In general, a CPS consists of two main functional components: (1) the advanced connectivity that ensures real-time data acquisition from the physical world and information feedback from the cyber space; and (2) intelligent data management, analytics and computational capability that constructs the cyber space.

Germany is leading a transformation toward 4th Generation Industrial Revolution based on CPS-enabled manufacturing and service innovation [4] and a joint report by the Fraunhofer Institute and the industry association Bitkom showed that German gross value can be boosted by a cumulative 267 billion euros by 2025 after introducing Industry 4.0. The 4th industrial revolution, which unlike all others, is being predicted, therefore allowing companies to take specific actions before it happens and manufacturers can begin now to define their target manufacturing model and then plan a transformation roadmap [5].

2.2 **Internet of Things**

The major technical background of Industry 4.0 is the introduction of Internet technologies into industry and this technical basis is often mixed with corresponding future visions [6]. Internet dramatically change the world around us and way of living in general. The Internet of Things (IoT) is a novel paradigm that is rapidly gaining ground in the scenario of modern wireless telecommunications. The basic idea of this concept is the pervasive presence around us of a variety of things or objects – such as Radio-Frequency IDentification (RFID) tags, sensors, actuators, mobile phones, etc. – which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbours to reach common goals [7]. Internet of Things must necessarily be the result of synergetic activities conducted in different fields of knowledge, such as telecommunications, informatics, electronics and social science. This adds a new dimension to this process by enabling communications with and among smart objects, thus leading to the vision of ''anytime, anywhere, any media, anything" communications. One vision of the future is that IoT becomes a utility with increased sophistication in sensing, actuation, communications, control, and in creating knowledge from vast amounts of data [8]. The cluster between IoT and social networks enables the connection of people to the ubiquitous computing universe and in this framework, the information coming from the environment is provided by the IoT and the social networks brings the glue to allow human-to-device interactions [9]. This union emerges from inheriting social networking features and values of interactivity, recommendation and filtering and services composition and suggesting a universal framework to combine users, devices and services and the interactions among them. Under the Industry 4.0 concept, astounding growth in the advancement and adoption of information technology and social media networks has increasingly influenced consumers' perception on product innovation, quality, variety and speed of delivery [4].

2.3 **Social networks**

Social media are extremely popular today and provide people with an easy and accessible forum to collaborate and share information and generate so much data. Social media employ mobile and web-based technologies to create highly interactive platforms via which individuals and communities share, co-create, discuss, and modify user-generated content [10]. The challenge is to identify and extract useful information from the data being shared through these social media. The growth of social media has populated the Web with valuable user generated content that can be exploited for many different and interesting purposes, such as, explaining or predicting real world outcomes through opinion mining [11]. The content shared among different social media is not controlled, checked and verified. Social media data are also vast, noisy, distributed, unstructured, and dynamic, which poses novel challenges for data mining [12]. Data mining of social media can expand researchers' capability of understanding new phenomena due to the use of social media and improve business intelligence to provide better services and develop innovative opportunities. This is multidisciplinary area where researchers of different backgrounds can make important contributions that matter for social media research and development.

Social media can be grouped in six types: collaborative projects, blogs and microblogs, content communities, social networking sites, virtual game worlds, and virtual social worlds [13]. Web 2.0 sites have become the most popular Internet services. Social networks (Facebook), video sharing tools (Youtube), blogging platforms (Blogger), collaborative encyclopaedias (Wikipedia) and microblogging applications (Twitter) are in the top ten most visited websites on the Internet nowadays [14]. The focus is on user-generated content (UGC), where users provide, share and use information.

Twitter is a popular micro blogging/social medium for broadcasting news, staying in touch with friends and sharing opinions using 140 characters long message known as *tweet*. The most important elements on Twitter are [15]:

1. Hashtag - allows to explicitly mark the topic of a tweet, start with character '#" and can be common word or concatenation of several words. Tweet can contain any number of hashtags and these hashtags can be placed at any position in the text.
2. User References - users are identified by their names prefixed with the character "@" Twitter users can make references to other users.

3. METHODOLOGY FOR DATA COLLECTION AND ANALYSIS

Data is collected via registered Twitter application which is used for authentication and communication with the Twitter as social network. This enables the user to gather the live tweets for certain hashtags, or to gather the tweets published by registered user.

All data is collected and analyzed by using the Python language scripts from [16]. The data collection script [16] s uses Twitter Streaming API (Application Programming Interface). Data collection was done on three different working days (each one was done two or three days after the previous one). Each data collection was done in time span of at least 7 hours. Data was collected by certain hashtag words and by a keyword required by the data collection script. The collected data is stored in a JSON file (JavaScript Object Notation).

Data analysis has been done by using scripts from [16] and it was done separately for each day the data was collected:

- hashtag frequency – shows which hashtags are covered within the collected tweets and in what number
- hashtag stats – shows how many tweets contain a certain number of hashtags (ranging from 0 to n, where n is the max number of hashtags that tweets contain)
- term frequency – shows the results of tweets text analysis
- tweets geo-mapping – presents tweets on world map, and also on maps of continents
- tweets time series – presents frequencies for tweets on a timeline

4. RESEARCH RESULTS

Tweets are collected using the hashtags *#industry40*, *#industrie40*, *#iiot*, *#iot*, *#smartfactory*, and the keyword was *manufacturing*. The *#iiot*, *#iot* stand for Industrial Internet of Things and Internet of Things respectively.

Table 1. presents the date and the time period in which the tweets are collected and the number of collected tweets.

Table 1. Date and time period of the data collection and the number of collected tweets

Date	7.7.2017.	11.7.2017.	13.7.2017.
Time period	8:30 -15:30	6:30 – 19:00	6:30 – 19:30
Duration in hours	7	12,5	13
Number of collected tweets	6490	8289	11638

Tweet hashtag frequencies for the three dates are presented in the Table 2.

Table 2. Tweet hashtag frequencies

7.7.2017.	11.7.2017	13.7.2017.
manufacturing: 1544 job: 786 hiring: 718 jobs: 272 mfg: 113 ukmfg: 109 brexit: 97 iot: 63 3dprinting: 56 engineering: 56 usa: 38 uk: 35 business: 35 ukmanufacturing:34	manufacturing: 3087 job: 1497 hiring: 1276 jobs: 473 ukmfg: 212 engineering: 200 iot: 180 mfg: 121 3dprinting: 117 industry40: 115 digitaltransformation: 95 iiot: 85 usa: 81 iran: 78 startsmartdata: 74	manufacturing: 3657 job: 1624 hiring: 1423 jobs: 435 iot: 273 industry40: 179 iiot: 177 steel: 160 mfg: 143 ukmfg: 139 ioe: 134 internetofthings: 134 engineering: 126 usa: 101 3dprinting: 99

Tweet hashtag stats for the three dates are presented in tables 3, 4 and 5 respectively.

Table 3. Tweet hashtag stats for 7.7.2017.

Number of tweets (% of total tweets)
3746 tweets without hashtags (57.72%)
2744 tweets with at least one hashtag (42.28%)
434 tweets with 2 hashtags (6.69%)
774 tweets with 1 hashtags (11.93%)
538 tweets with 5 hashtags (8.29%)
1 tweets with 11 hashtags (0.02%)
282 tweets with 4 hashtags (4.35%)
190 tweets with 6 hashtags (2.93%)
434 tweets with 3 hashtags (6.69%)
6 tweets with 10 hashtags (0.09%)
15 tweets with 8 hashtags (0.23%)
14 tweets with 9 hashtags (0.22%)
56 tweets with 7 hashtags (0.86%)

Table 4 Tweet hashtag stats for 11.7.2017.

Number of tweets (% of total tweets)
3254 tweets without hashtags (39.26%)
5035 tweets with at least one hashtag (60.74%)
1271 tweets with 1 hashtags (15.33%)
795 tweets with 5 hashtags (9.59%)
95 tweets with 7 hashtags (1.15%)
660 tweets with 4 hashtags (7.96%)
973 tweets with 2 hashtags (11.74%)
421 tweets with 6 hashtags (5.08%)
716 tweets with 3 hashtags (8.64%)
12 tweets with 12 hashtags (0.14%)
45 tweets with 8 hashtags (0.54%)
35 tweets with 9 hashtags (0.42%)
6 tweets with 11 hashtags (0.07%)
6 tweets with 10 hashtags (0.07%)

Table 5. Tweet hashtag stats for 13.7.2017.

Number of tweets (% of total tweets)
5150 tweets without hashtags (44.25%)
6488 tweets with at least one hashtag (55.75%)
917 tweets with 2 hashtags (7.88%)
2403 tweets with 1 hashtags (20.65%)
822 tweets with 3 hashtags (7.06%)
98 tweets with 7 hashtags (0.84%)
969 tweets with 5 hashtags (8.33%)
454 tweets with 6 hashtags (3.90%)
751 tweets with 4 hashtags (6.45%)
16 tweets with 9 hashtags (0.14%)
52 tweets with 8 hashtags (0.45%)
5 tweets with 10 hashtags (0.04%)
1 tweets with 11 hashtags (0.01%)

Figures 1, 2 and 3 present time series for collected tweets for three dates respectively.

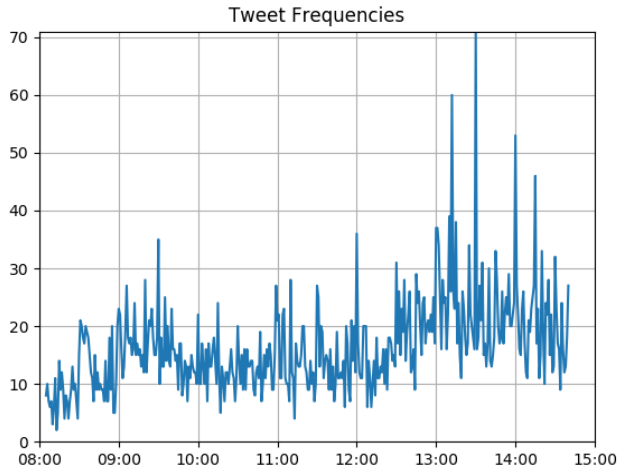

Figure 1. Collected tweets time series for 7.7.2017.

Figures 4, 5, and 6 represent tweets allocation on a world map for three dates respectively. Figures 7 and 8 represent the most active areas in Europe and North America, with number of tweets summed up for the areas.

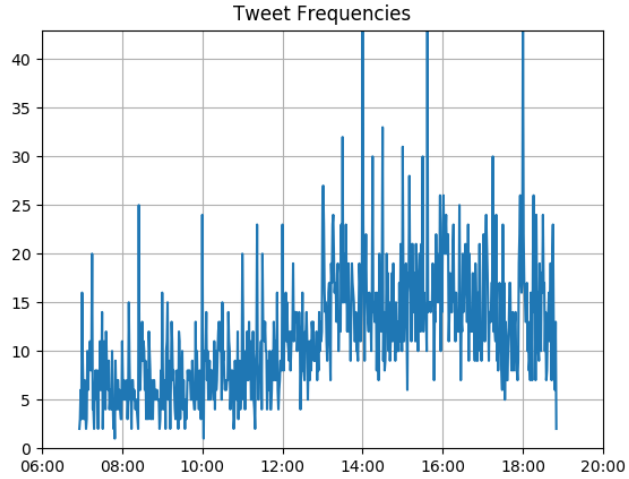

Figure 2. Collected tweets time series for 11.7.2017.

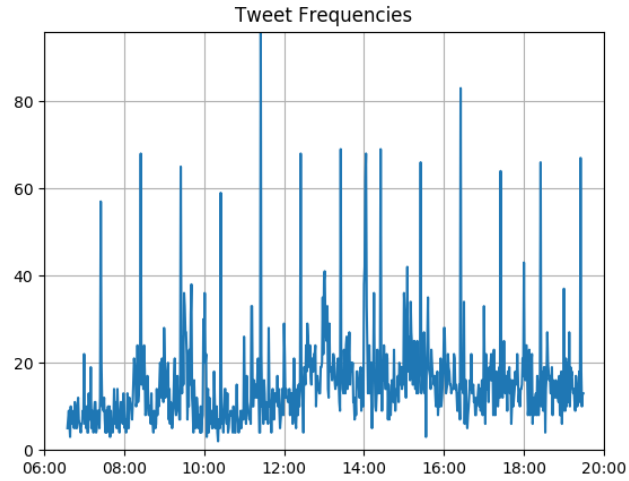

Figure 3. Collected tweets time series for 13.7.2017.

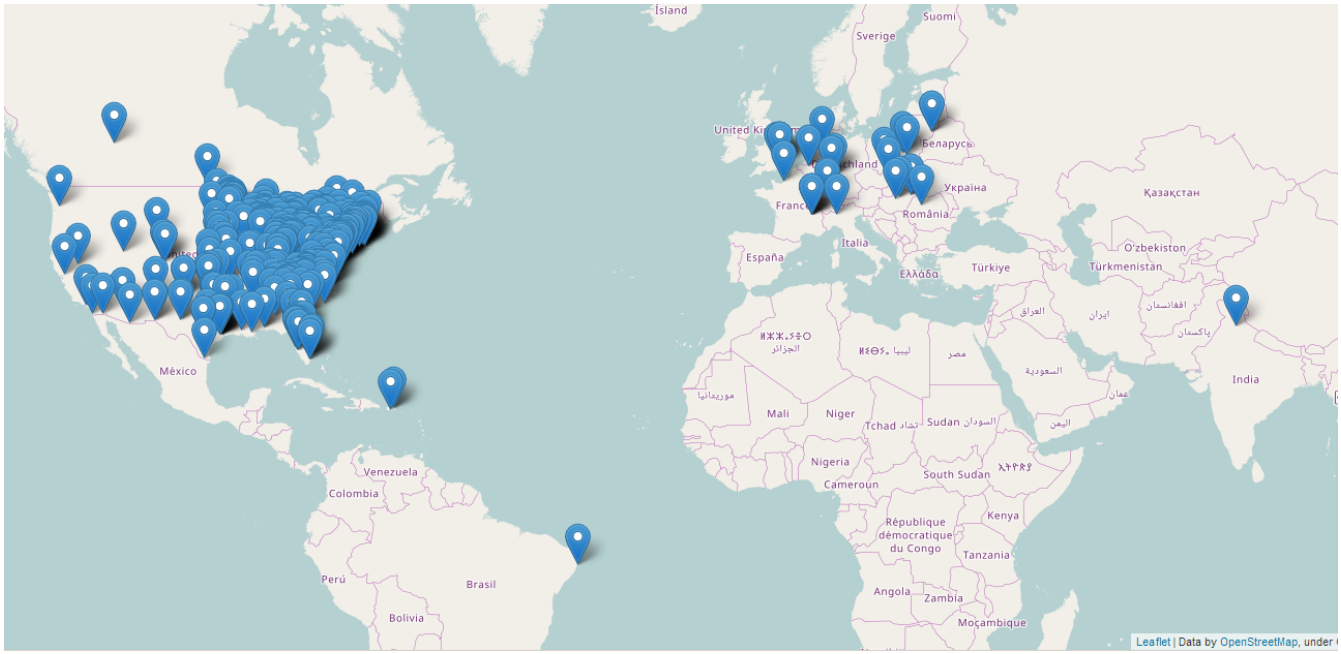

Figure 4. Collected tweets on the world map (7.7.2017.)

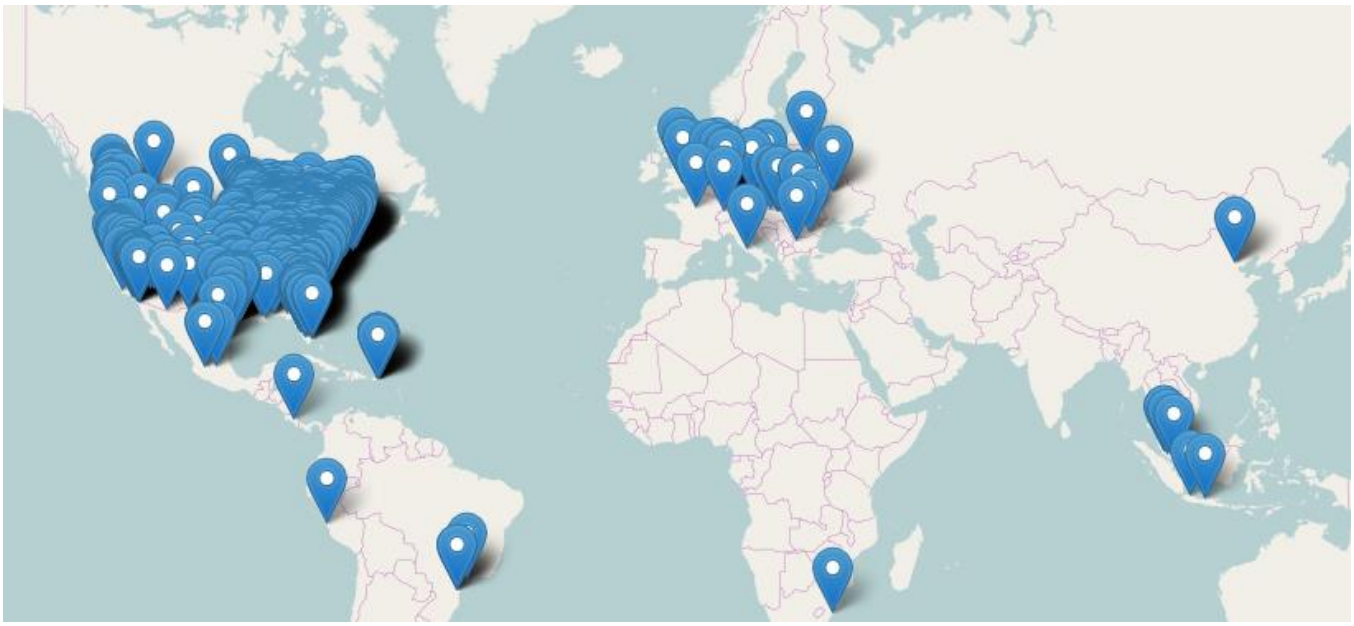

Figure 5. Collected tweets on the world map (11.7.2017.)

Figure 6. Collected tweets on the world map (13.7.2017.)

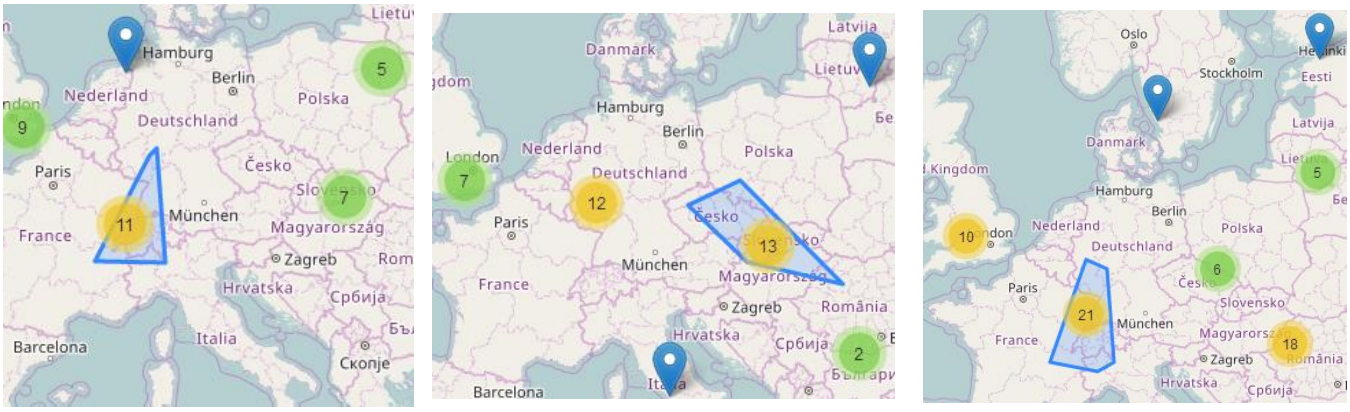

Figure 7. Most active areas in Europe (left: 7.7.2017., centre: 11.7.2017., right: 13.7.2017)

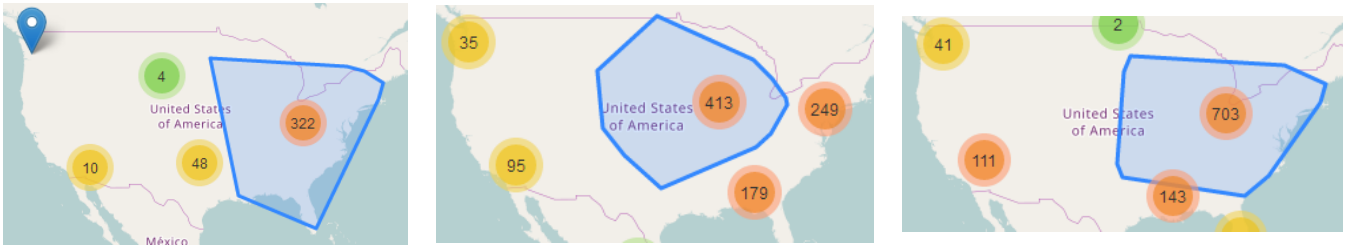

Figure 8. Most active areas in North America (left: 7.7.2017., centre: 11.7.2017., right: 13.7.2017)

4. RESULTS DISCUSSION

The research conducted in three working days, showed that people are talking about Industry 4.0 on Twitter. Maybe the most interesting thing observed in research is that most people conect words job and hiring with this topic. Also, this topic is the most popular in America (especially East side) and Europe, especially in Germany. That is probably because there are most users of Twitter in USA, on one side, and Industry 4.0 first time has appeared in Germany, on the other side. The most intensive frequency of mentioning this topic is the middle of day. Also, interesting fact is that most tweets have one hashtag connected with this topic.

5. CONCLUSION

The aim of this paper was to show how important Industry 4.0 is for surveillance of industrial systems, on one side, and how powerful tool are social networks for information and knowledge sharing, on the other side. This was just first step in analysis of Industrial 4.0 presence on Twitter and which elements are most mentioned and influential as well as which areas are most covered with this topic. Existing preliminary success in social media mining research efforts convincingly demonstrates the promising future of the emerging social media mining community and will help to expand research and development and explore online and offline human behaviour and interaction patterns [12]. Given the fact that the total number of monthly active Twitter users is about 317 million and total number of tweets sent per day is 500 million, Twitter can be very powerful and useful tool for promotion Industry 4.0 concept. Further work will be directed on applying Social Network Analysis (SNA) is a sociological approach for analysing patterns of relationships and interactions between social actors. Also, other elements of Industry 4.0 will be taken into consideration such as smart factory, smart produst, smart logistics, etc.

6. REFERENCES

[1] Stock, T. and Seliger, G. (2016), “Opportunities of Sustainable Manufacturing in Industry 4.0”, Procedia CIRP 40 on 13th Global Conference on Sustainable Manufacturing - Decoupling Growth from Resource Use, pp. 536 – 541

[2] Cheong, F. and Cheong, C. (2011) “Social media data mining: a social network analysis of tweets during the Australian 2010-2011 floods”, available at: http://aisel.aisnet.org/pacis2011/46/ (accessed: 15 July 2017)

[3] Lee, J., Bagheri, B. and Kao, H-A. (2015) “A Cyber-Physical Systems architecture for Industry 4.0-based manufacturing systems”, Manufacturing Letters 3, pp. 18-23

[4] Lee, J., Kao, H-A. and Yang, S. (2014) “Service innovation and smart analytics for Industry 4.0 and big data environment”, Product Services Systems and Value Creation. Proceedings of the 6th CIRP Conference on Industrial Product-Service Systems, pp. 3-8

[5] Almada-Lobo, F. (2015) “The Industry 4.0 revolution and the future of Manufacturing Execution Systems (MES)”, Journal of Innovation Management, Vol. 3, No. 4, pp.16-21

[6] Drath, R. and Horch, A. (2014) “Industrie 4.0: Hit or Hype?”, IEEE industrial electronics magazine, pp. 56-58

[7] Atzori, L., Iera, A. and Morabito, G. (2010) “The Internet of Things: A survey”, Computer Networks, Vol. 54, pp. 2787–2805

[8] Stankovic, J. A. (2014) “Research Directions for the Internet of Things”, IEEE Internet of Things Journal, Vol. 1, No. 1, pp. 3-9

[9] Oritz, A.M. and Han, S.N. (2014) “The Cluster Between Internet of Things and Social Networks: Review and Research Challenges” IEEE Internet of Things Journal, Vol. 1, No. 3, pp. 206-215

[10] Munoz-Garcıa, O. and Navarro, C. (2012) “Comparing user generated content published in different social media sources”, Proceedings on the International Conference on Language Resources and Evaluation, Available at: http://www.lrec-conf.org/proceedings/lrec2012/workshops/21.LREC2012%20NLP4UGC%20Proceedings.pdf (accessed: 15 July 2017)

[11] Kietzmann, J. H., Hermkens, K., McCarthy, I.P. and Silvestre, B. S. (2011) “Social media? Get serious! Understanding the functional building blocks of social media”, Business Horizons, Vol. 54, pp. 241—251

[12] Gundecha, P. and Liu, H. (2014) “Mining Social Media: A Brief Introduction”, In INFORMS Tutorials in Operations Research

[13] Kaplan, A. M. and Haenlein, M. (2010) “Users of the world, unite! The challenges and opportunities of Social Media”, Business Horizons, Vol. 53, No. 1, pp. 59-68

[14] Mosquera, A. and Moreda P. (2012) “A Qualitative Analysis of Informality Levels InWeb 2.0 Texts: The Facebook Case Study”, Proceedings on the International Conference on Language Resources and Evaluation, Available at: http://www.lrec-conf.org/proceedings/lrec2012/workshops/21.LREC2012%20NLP4UGC%20Proceedings.pdf (accessed: 15 July 2017)

[15] Atserias, J. and Codina J. (2012) “What is the text of a Tweet?” Proceedings on the International Conference on Language Resources and Evaluation, Available at: http://www.lrec-conf.org/proceedings/lrec2012/workshops/21.LREC2012%20NLP4UGC%20Proceedings.pdf (accessed: 15 July 2017)

[16] Bonzanini, M. (2016). Mastering social media mining with Python. Packt Publishing Ltd.