



An Overview of Massive Open Online Courses on Robotics

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Abstract¹—This article reports short overview of massive open online courses for “robotic” topic. Extensive use of mobile devices opens up various opportunities for educational institutions to transfer contents to learners. Modern learners prefer to manage their learning by personal way. Many online courses are confirming this fact. Nowadays we can find unlimited number of contents on the internet. Almost all universities offer own online courses with various topics. In the last decade massive open online course (MOOC) became one of the opportunities to keep educated.

The robotics is main focus of this issue, therefore we are trying to conduct small study on online educational contents with this topic. We selected five MOOCs in our study. Main criteria of selection were personal experience of author with these MOOCs. An evaluation of MOOCs is not an aim of the article. Through this article we tried to make visible opportunities to get education on robotics free by online with your personal learning management time.

Keywords—massive open online course; open course; learner centered learning; engineering education; robot;

I. INTRODUCTION

Robot and robotics are important topic in engineering science. Development of smart algorithms, nano materials, smart sensors are supporting impact of interest to robotics. Teenagers growing up under big influence of technology. Modern society accept robots widely in many fields.

From self-driving cars to medical diagnoses, we’re witnessing a robotic takeover of a variety of jobs and tasks. For many, the prospect of being replaced by a robot or artificial intelligence program is still only a fear on the horizon. For others, it’s already happened [1].

Therefore, educators of engineering science have to reflect to this prediction. Many universities and companies started to care fundamental education for robotics. This article covers short review of online contents on robotics.

Robotics is very big topic for research and education. It covers many sub directions inside, such as artificial intelligence, DIY robots, drones, home robots, humanoid robots, industrial robots, medical robots, military robots, robotics software, and space robots. These can be long and depending on science and interest of researchers.

Our focus is “robotics”. We selected “robotics” as keyword and did search on the internet. The Google search engine returned 456 000 000 results in 0.50 seconds (28.11.2018). Not all results are fitting to our topic but almost 10% of these results cover topic of robotics. And this fact shows the interest on robotics is very high in the World and people are continuously producing different kind of information on this topic.

E-learning has been becoming worldwide more and more in the focus of education systems. Leading countries like United States, European Union Countries, Canada, Australia and Korea, for instance, show a growing interest and increase their investments in e-learning [2].

Result of big investment into e-learning is massive open online course (MOOC). This is e-learning platform where educators and educational institutions can offer online courses open. Learners from any countries of the World are equally able to take a part of such courses. The MOOC can play valuable role for education in robotics. Therefore, this article reviews existing online courses which cover topic of robotics.

II. MASSIVE OPEN ONLINE COURSE

Massive open online course has been started to be used very actively by self-motivated learners from the whole World in the last decade. MOOC is modern and effective way to increase own knowledge independently from location and time. MOOC enables to learner to manage learning time and speed. Additionally, attending to the courses are typically free in MOOC. Moreover, if the learners want to have proof on their knowledge or skill, it is possible to receive special certificate from the university where the course content is

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produced. MOOCs can cooperate with universities to accept distance attendees of learners. Some universities already started to accept certificates which awarded after successful completion of cooperating MOOC into their study program [3].

Below listed are some of the most famous MOOCs:

- edX
- Coursera
- FutureLearn
- Udacity
- Udemey

However, many MOOCs are available in the internet, we will cover above-listed most famous MOOCs in this study.

III. ONLINE COURSES OVERVIEW

The edX is MOOC founded by Harvard University and MIT in 2012 [4]. More than 130 partners from different countries supporting edX and locating their online courses in this MOOC. Online courses by edX with topic “robotics” are in Table 1.

Table 1. Courses of edX MOOC

No.	Course	University	Length weeks	Effort h/w	Fee	Certificate, €
1.	Robotisc	Columbia University	12	8-10	Free	218
2.	Robotisc*	University of Pennsylvania	12	8-10	1256 USD	-
3.	Hello (Real) World with ROS – Robot Operating System	TU Delft	6	8-12	free	44
4.	Diseña, fabrica y programa tu propio robot	University Polytechnic de Valencia	6	8-10	free	66
5.	Mind of the Universe - Robots in Society: Blessing or Curse?	TU Delft	5	1-2	free	44
6.	Robotics: Vision Intelligence and Machine Learning*	University of Pennsylvania	12	8-10	free	305
7.	Robotics: Dynamics and Control*	University of Pennsylvania	12	8-10	free	305
8.	Robotics: Locomotion Engineering*	University of Pennsylvania	12	8-10	free	305
9.	Robotics: Kinematics and Mathematical Foundations*	University of Pennsylvania	12	8-10	free	305

10.	Robotics Foundations I - Robot Modeling	Università degli Studi di Napoli Federico II	8	8-10	free	52
11.	Future Robots. Towards a Robotic Science of Human Beings	Università degli Studi di Napoli Federico II	5	6-8	free	52
12.	Le robot Thymio comme outil de découverte des sciences du numérique	École polytechnique fédérale de Lausanne	6	4-6	Free	44
13.	Underactuated Robotics	MIT	11	8-10	free	87
14.	Robot Mechanics and Control, Part I	Seoul National University	6	5-8	free	-
15.	Robot Mechanics and Control, Part II	Seoul National University	8	5-8	free	-
16.	Cognitive Neuroscience Robotics – Part A	Osaka University	4	3-4	free	43
17.	Autonomous Navigation for Flying Robots	TU Muenchen	8	4	free	-
18.	The Fascinating World of Robots and Robotics	Peking University	14	2	free	-
19.	Autonomous Mobile Robots	ETH Zurich	15	4-8	free	44

*This MicroMaster program for “Robotics” consists of six separated modules.

The Udacity began as an experiment in online learning, when Stanford instructors Sebastian Thrun and Peter Norvig elected to offer their "Introduction to Artificial Intelligence" course online to anyone, for free. Over 160,000 students in more than 190 countries enrolled. The potential to educate at a global scale was awe-inspiring, and Udacity was founded to pursue a mission to democratize education [5]. Online courses by Udacity with topic “robotics” are listed in Table 2.

Table 2. Courses of Udacity MOOC

No.	Course	University	Length months	Effort h/w	Fee	Certificate, €
1.	Robotics Software Engineer Nanodegree**	Udacity with Nvidia and Electric Movement	8	15	free	999
2.	Advanced Robotics Software**	Udacity with Nvidia and Electric Movement	8	15	free	999
3.	Artificial Intelligence for Robotics	Georgia Tech	2	-	free	-

**Nano degree from Udacity. This program forces with NVIDIA and Electric Movement to create a groundbreaking

learning experience that features world-class curriculum. Nano degree for “Robotics Software Engineering” by complete e-learning solution is available only from Udacity.

The Udey has huge data of online courses. According to the statistics in 2018, more than 80 000 courses are available on this learning platform [6]. The Udey founded in 2007 but launched as learning platform since 2010. Search by keyword “robotics” returned 153 results. Online courses by Udey with topic “robotics” are listed in Table 3.

Table 3. Courses of Udey MOOC

No	Course	Number of Learners	Evaluation	Lectures	Study fee, €
1.	Robot Framework Selenium Tutorial	64	3.2	-	19.99
2.	Electricity & electronics - Robotics, learn by building	11351	4.6	54	99.99
3.	ROS Basics: Program Robots	3791	3.9	22	64.99
4.	Fundamentals in Robot C and VEX Robotics	2234	4.3	12	19.99
5.	Tech Explorations™ Arduino Robotics with the mBot	918	4.4	39	99.99
6.	Digital Electronics: Robotics, learn by building module II	4731	4.6	55	99.99
7.	Tech Explorations™ Make an Arduino Robot	932	4.6	57	99.99
8.	Black Algo Trading: Build Your Trading Robot	30527	4.3	228	199.99
9.	Robotics Programming & Math 4 kids & Parents : No Hardware	1155	4.1	36	29.99
10.	Industrial Robotics	483	4.4	62	24.99
11.	Forex Robots: Expect To Earn 175% P.A. Forex Robot Included	18014	4.5	43	199.99
12.	Learn Arduino for Robots	344	4.9	11	199.99
13.	Introduction to Robotics & Entrepreneurship	3751	4.3	44	29.99
14.	Aprende Robot Structural Analysis Professional	428	4.4	37	49.99
15.	Raspberry Pi Robotics	1469	4.4	20	94.99
16.	Learning electronics and robotics	2448	3.1	19	19.99
17.	Smartphone Control Robotics using Arduino and Android	1391	3.6	54	99.99
18.	Build and Program Smart LEGO	56	4.9	37	124.99

	Mindstorm EV3 Robot				
19.	Intro to sumo robot with Rokit Smart (Arduino, Programming)	1374	3.9	-	24.99
20.	Arduino Robotics for Kids & Parents: Step by Step	715	4.1	47	29.99
21.	RoboGrok Robotics 1	2430	4.3	45	24.99

The Coursera was founded in 2012 by two Stanford Computer Science professors who wanted to share their knowledge and skills with the world [7]. According to the statistics, 35 000 000 learners enrolled into course, more than 150 universities cooperating as partner, available more than 2700 courses on learning platform Coursera. Online courses by Coursera with topic “robotics” are listed in Table 4.

Table 4. Courses of Coursera MOOC

No	Course	University	Number of Learners	Evaluation	Approx. time to complete	Working time h/w
1.	Spezialisierung Robotics	University of Pennsylvania	-	-	7 m	6
2.	Robotics: Aerial Robotics*	University of Pennsylvania	1790	4.5	25 h	4
3.	Robotics: Computational Motion Planning*	University of Pennsylvania	675	4.2	11 h	3
4.	Robotics: Mobility*	University of Pennsylvania	398	3.8	23 h	4
5.	Robotics: Perception*	University of Pennsylvania	402	4.4	29 h	4
6.	Robotics: Estimation and Learning*	University of Pennsylvania	297	4.2	13 h	4
7.	Robotics: Capstone*	University of Pennsylvania	62	4.5	17 h	6
8.	Modern Robotics, Course 1: Foundations of Robot Motion**	Northwestern University	76	4.7	19 h	7.5
9.	Modern Robotics, Course 2: Robot Kinematics**	Northwestern University	27	4.9	16 h	7.5
10.	Modern Robotics,	Northwestern	13	4.8	15 h	7-8

	Course 3: Robot Dynamics**	University				
11.	Modern Robotics, Course 4: Robot Motion Planning and Control**	Northwestern University	6	4.7	15 h	8-11
12.	Modern Robotics, Course 5: Robot Manipulation and Wheeled Mobile Robots**	Northwestern University	4	4.3	24 h	9
13.	Modern Robotics, Course 6: Capstone Project, Mobile Manipulation**	Northwestern University	3	4.7	9 h	20
14.	Spezialisierung Modern Robotics: Mechanics, Planning, and Control	Northwestern University	-	-	6 m	5
15.	Control of Mobile Robots	Georgia Tech	1060	4.8	21 h	12-14
16.	Building Arduino robots and devices	Moscow Institute of Physics and Technology	166	4.4	28 h	6
17.	機器人學一 (Robotics (1))	National Taiwan University	28	4.6	31 h	6
18.	My Friend is a Robot: Introduction to Social Robotics	Tomsk State University	27	4.9	13 h	2-7

*The program for Robotics from University of Pennsylvania which consists of 6 separate courses.

**The program for Modern Robotics from Northwestern University which consists of 6 separate courses.

The FutureLearn team launched first courses in September 2013 and since then millions of people have joined FutureLearn. Owner of this MOOC is the Open University from UK. They have of over 40 years of their experience in distance learning and online education [8]. Online courses by FutureLearn with topic “robotics” are listed in Table 5.

Table 5. Courses of FutureLearn MOOC

No	Course	University	Length, w	Effort h/w	Study fee	Cert. €
1.	Robotic Vision: Making Robots See	Queensland University of Technology	3	3	free	74
2.	Robotic Vision: Processing Images	Queensland University of Technology	4	3	free	74
3.	Robotic Vision: Principles of Vision	Queensland University of Technology	3	3	free	74
4.	Begin Robotics	University of Reading	4	3	free	64
5.	Introducing Robotics: Build a Robot Arm	Queensland University of Technology	5	3	Free	74
6.	Building a Future with Robots	University of Sheffield	3	3	free	49
7.	Introducing Robotics: Robotics and Society	Queensland University of Technology	3	3	free	74
8.	Introducing Robotics: Making Robots Move	Queensland University of Technology	3	3	Free	74

IV. THE ANALYSE OF SELECTED MOOCs

Five MOOCs were studied. The results of search with keyword “robotics” were different. The Udey MOOC has 153 courses for this content. The Coursera MOOC from first glance was not able to find information about study fee or certificate fee. Information about fees of other four MOOC are visible. In general audition of course is almost free. This means learner can enroll to course and can receive all materials of enrolled course.

Most important information for self-motivated learners by online can be: title of course, short description about course, study fee, estimated time for completion of course, evaluation of course by other learners, comments from learners to course, and offering university.

The learning platform of MOOC covers above listed information in their web site. Such information helps the learners’ selection. Most of online learners prefer to enroll free. But if the course content has high quality and learner could successfully finish the course then learners usually apply to receive corresponding certificate.

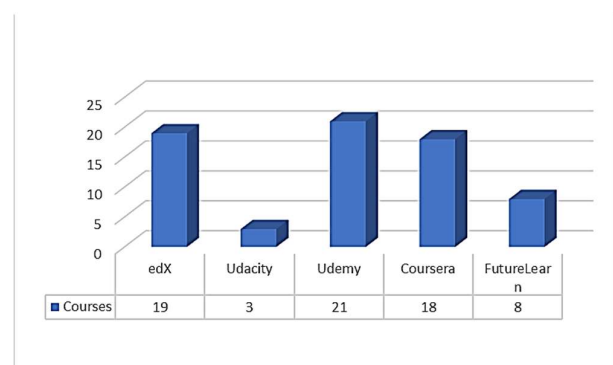


Figure 1. Number of courses with topic “robotics”

Figure 1 shows that Udemy MOOC has more courses with topics “robotics” comparing with other four MOOCs.

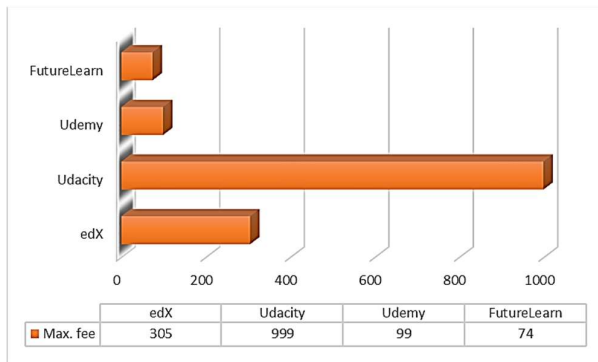


Figure 2. Maximum fee of courses

Maximum prices of courses are shown In Figure 2. The Coursera MOOC is not shown in first page of course information about price. By minimum price Udemy MOOC was in the first place. 19.99 euro is minimum fee of Udemy, other for MOOCs it was around 40 euros.

The edX, Udacity, Coursera and FutureLearn MOOCs showed estimated time for course by weeks and months. The Udemy case giving number of lectures and total hours of these lectures. But all five MOOCs report on web site expected working hours per week.

V. CONCLUSION

We are living in era of technology. We are living in era of education. These two facts request to educators to work for educated society. Internet of things extend opportunity to develop new ideas and learn nonstop everytime and everywhere. Single requirement for such online learning is internet connection. Even with this critical issue e-learning will be the best learning way to educate [14].

The robotics is very complex topic. It has many different branches for theory and application. From year to year robot and robotics became more familiar to society. In modern industry we cannot image mass production without robotics [1]...[13]. Therefore, education on this topic is highlighted in this article.

The massive open online courses are one of the example of online learning platforms. This type of platform is fashion because of well-designed learning environment and high quality of offering contents. Most critical problem for learning is a study fee. Online courses are cheaper than traditional courses in university classroom. But content is almost same what is hearing on the face to face teaching. Because of this we are agree to produce more online educational content for various topics not only for robotics.

One issue for discussion remains. On the internet, it is easy to find information about MOOCs. But, some kind of comparison evaluation of MOOCs is missing. It will be supportive to lifelong learners to find information about comparison evaluation of MOOCs from internet, because it will save time to make decision to select courses. Maybe structure oriented evaluation model can be one of the solution to this issue [3].

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