Robot Economics Doctrine

Total robotization. It is inevitable that robots will be an essential part of every human's life. Machines are capable of performing tasks impossible for humans, they are more effective in many types of business activities and they are already saving people time every day.

The development of robotics has reached the point where the problem of communication have arisen between physically and logically separated autonomous agents (robots). Robots have the capacity to decide which actions are appropriate within constantly changing environment. Technologies that are now being used in the world of machines constantly expand the set of decisions available to the robot, which increases its level of autonomy.

The communication problem between autonomous robots is most noticeable in such spheres as Industry 4.0 and Internet of Things. The authors of this paper distinguish these questions as the most significant for including autonomous robots in human life:

1. How to provide the transfer of ownership to the consumer of any product, if no human participated in the production and logistics process?
2. How can a fully autonomous factory understand the changing needs of customers?
3. How to organize direct interaction between robots of two different corporations?
4. How to levy taxes on robots' activities and what is considered a separate robotic unit?

The variety of answers to these questions bear various risks of instability and even the possible collapse of the world system - this is a challenge in building a society where is no place for slavish human labor.

The doctrine of robot economics (robonomics in some articles) is contrary to the current and most rapidly growing way of organising the world of machines (completely dependent on several corporate decision-making centers) and it suggests to consider an alternative way of organizing human communications with a robot and among machines themselves. Both robots and humans are autonomous agents and they enter into direct liability contracts without an intermediary. This approach decentralizes communication between people and robots, which is the safest option for integrating robots into the human economy. In addition to security, building direct contractual relationships between a person and a robot allows to apply the knowledge about distribution of tasks and resources available to mankind on the basis of market mechanisms. It is essential for training robots to have more efficient behavior within the human economy.

The power of the "center" is dangerous. The process of total robotization of society is moving towards centralized control of machines by corporations / governments. Outcome: robotic devices in you house / city / country can restrict freedom of movement, refuse to distribute essential goods and to serve the basic needs of society based on the command from the "center." The dangerous behavior of the "decision center" is possible for one of the following reasons:

1. System failure. It is difficult to guarantee the fault tolerance of any system in the long run

of decades. Even a quick failure of a large network of subordinate machines can lead to serious consequences.
2. Seizure the decision-making center. In the face of ever-changing political elites, the seizure of centers which control the machines serving the society may be the most interesting from the point of view of the dictators coming to power.
3. Self-awareness of the robot. We can not be sure of how the robot will behave if it reaches the self-realization of its existence. In this case, if a large network of subordinate machines is connected to the self-aware decision-making center, the decisions can be made not in favor of human society.

About the free market. An alternative to centralized control of the world of machines can be a free market for purchasing robot liability contracts. The market, as a structure, is a sufficient tool for coordination, stimulation, and regulation of the activities carried out by machines in human society.

Modern open source decentralized technologies can ensure the existence of a free market for direct economic relations between a human and a robot in such a way that a global robot economy will appear.

The use of free markets as the basis for communications between autonomous robots creates fair competition between large corporations and small businesses in the eyes of the consumer. A large corporate cyber-physical system is nothing but a single economic agent in the eyes of other market participants. And therefore an assessment of its significance will be made solely on the basis of product quality in comparison with the similar options without taking into account the internal complexity and size of the enterprise. The free market does not create barriers for the consumer when he is choosing products.

In order for the market to take on the functions of coordination, stimulation and regulation of the activities performed by machines in the human society, a micro- and macroeconomic models are needed that can form its internal capital, since capital is the driving force of the market.

Microeconomic model of robot economics. The emergence of a global free market of robot liability contracts and instruments for the creditor (robot which is delivering the service) and for the beneficiary (of the service performed by creditor-robot) creates relations of production and thereby form the capital of the robot economy.

About the importance of capital valuation of robot economy. The higher the capital valuation of the robot economy will be, the more effectively the market will perform the functions of coordination, stimulation and regulation. The capital valuation of the robot economy will be higher if relations of production in the market will be able to cope with the main challenges that the industry faces now and take into account the interests of macroeconomic players that help the industry cope with potential challenges.

Macroeconomic model of robot economics. The main purpose of looking at the robot economics at a macro level is the possibility of implementing mechanisms for self-restructuring of production and supply chains of fully automated enterprises, as one of the existing challenges of the industry.

If the capital of the robot economy is expressed by an internal token then, in addition to the capital valuation by the market, we will be able to teach a completely automated plant to take the changes in our needs into account by analyzing the distribution of the internal token between different markets of robot economy throughout our life.

Responsive robot economy. The ability to rebuild the process of production, logistics and data supply by autonomous robots to reflect the changing human needs is the most important step on the way to the advent of fully automated enterprises. The main question is what do we consider a trigger that changes the behavior of the robot or changes the function it performs.

It is most rational to assess the distribution of limited capital in different vectors (markets of one type of service) of the robot economy to analyze changes in human needs. It is important to assess not only the current market volumes, but also the potential of the future period. It is also necessary to evaluate the markets for ideas to take into account potentially interesting but not yet existing proposals on the market. From the point of view of these two tasks (the task of forecasting the next period of the market and the task of evaluation of the new market) the mechanism of predictive markets with the use of the futures on the market volume estimate (market index), described by Vitalik Buterin in the article [An Introduction to Futarchy](#), is of the most interest. Such a mechanism can give us a responsive robot economy which will be personalized to our constantly evolving needs.

One capital, a set of market vectors. The classical predictions market is based on a concept of choice between the two outcomes of one event and on the fact that voting by capital by purchasing the metric in which the person believes/appreciates more is a more objective assessment than the usual poll of interested persons ("vote values, but bet beliefs . ").

If we abandon the model with two outcomes and limit predictions markets by using the same token, then we get the classical problem of choosing between an unlimited number of market vectors and limited resources. At the same time, the price of the metric will be equally useful for both estimating the next period of the current market and for assessing the new markets.

Standard questions for token holders. This "one capital, many market vectors" approach requires the standardization of the questions to the holders of tokens who wish to use them as investments. Each question reflects a new vector of the robot economy and with the correct assessment of the market potential an investor can collect earnings from the market futures. The standard for creating new vectors developed by Aira is based on the following assumptions:

(1) The question is always about volume.
(2) The question should always evaluate the market in the internal token of the robot economy.
(3) The question should always have a time interval.
(4) The question should always specify the size of the market commission including the commission of the market creator and investors.
(5) The specification which the robot will understand must always be attached to the question.

Example of a question: "How do you evaluate the market potential for dosimeters in Europe in 2018 with a market commission of 3%?"

Robot unification in the eyes of the market. Aira (autonomous intelligent robot agent) project

implements the standard of human-robot and robot-robot economic interactions with the help of liability contracts. Aira allows to connect a lot of different robots to the liability contract market existing in Ethereum for direct sale of data from robot sensors, ordering unmanned transportation services or personalized products in robot enterprises.
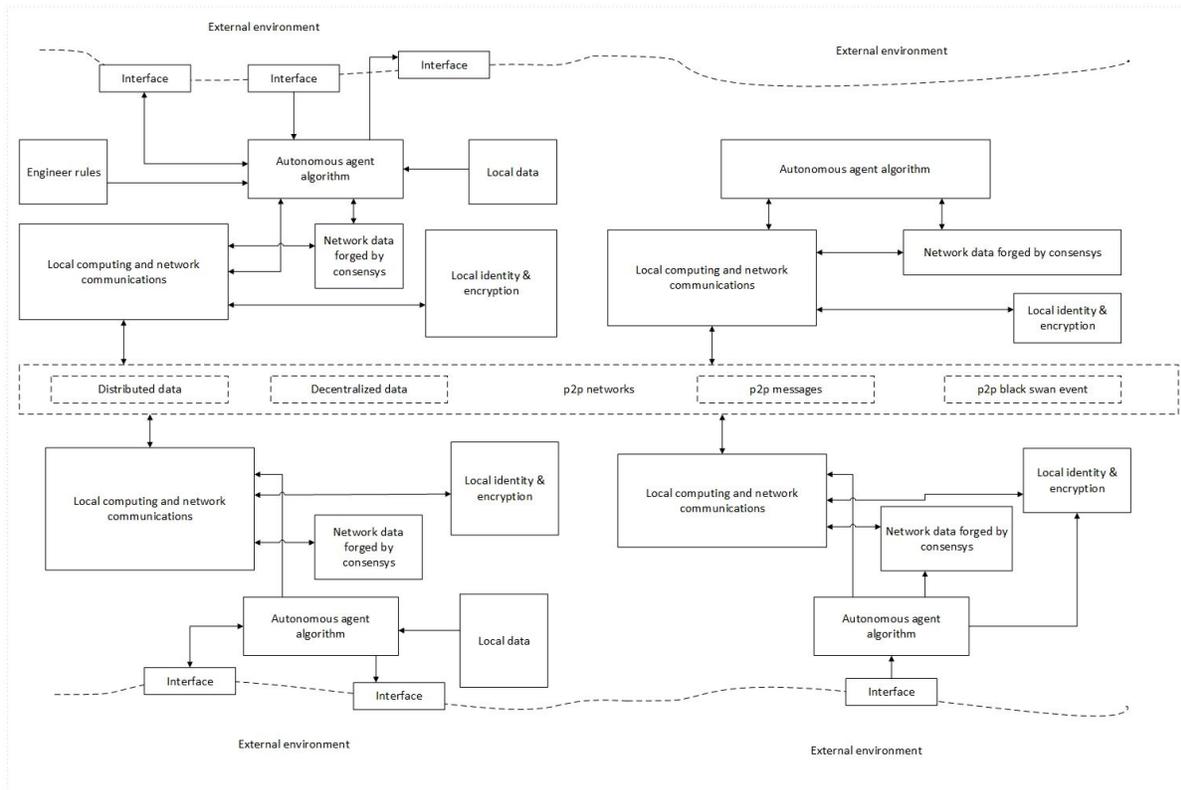

Figure 1: work scheme of a set of robots in p2p networks using the Aira image.

It is important to note the following:
- The interaction of autonomous agents occurs exclusively through the p2p network;
- An autonomous agent is not required to have interfaces to the outside world or engineer intervention mechanisms in its work;
- An autonomous agent that participates in the processes of decentralized;
- Autonomous organization may not have local data, but network data is mandatory for it;

Internal market token of the robot economics (robonomics in some articles). Autonomous intelligent robot token or Air token allows creating free global market of the robots' liabilities. Air tokens are units of the liability market, the market for connection of all robots with Aira image installed.

Air tokens are required every time when the user makes a contract with the robot.

Aira project will use the smart contract TokenEmission to implement the internal token of the robots economy market. http://airalab.github.io/core/docs/docs/TokenEmission/

The TokenEmission contract is a token contract that is fully compatible with the ERC20 interface, supplemented by the function of additional token issuance by calling a special method "*emission*".

Liability contract market for robots. It allows to the owner of robot to replicate the unified contract of the robot's liability and offer services, which can be ordered directly from the robot.

https://github.com/airalab/core/blob/develop/contracts/market/LiabilityMarket.sol

Liabilities market provides a free trade area with contract searching and dealing with the agents of the market.

The unified contract of the robot's liability. A smart contract providing the basic interaction of ROS-compatible robot, creditor, and beneficiary in a way that:
  1. the lender complies with the terms of the contract;
  2. the robot receives a notification about payment for the service and publishes the result of the work (in the form of a hash);
  3. Air tokens are sent to the beneficiary only after publication of the work results (in the form of a hash).

https://github.com/airalab/aira-IoT/blob/master/contracts/RobotLiability.sol

The *RobotLiability* contract is an interface for interaction and message processing from a ROS-based robotic system. The liability includes the format and the order of interaction of the parties that have concluded the contract.

The theorem about safe robot economics.

Axiom 1: Economic interaction between a person and a robot is carried out on the basis of a contractual liability and capital existing in a digital form.

Axiom 2: There is not enough internal capital and contractual liabilities for the existence of a self-sufficient economy.

Robots have internal capital and contractual liabilities without ownership rights, creating a human-dependent robot economy.

There is no liability without ownership. Any robot in the process of performing a service still needs to rent space for work.

Robot economics rules. Three basic rules for making a safe and human-dependent robots economy:

- **A robot cannot have liability rights.** While the robot works on the basis of contractual liability, people are able to control the economy of robots.
- **The economy of robots must have internal capital.** The internal capital is able to support the market and reflect the value of the participation of robots in human life.
- **The economy of robots can only exist within the digital economy** with internal capital and fulfillment of contractual liabilities.

Appendix 1. The structure of the autonomous agent

The basis of the autonomous agent is the behavioral algorithm. The robot interacts with the environment through the interface and communicates with the network through standardized network protocols.
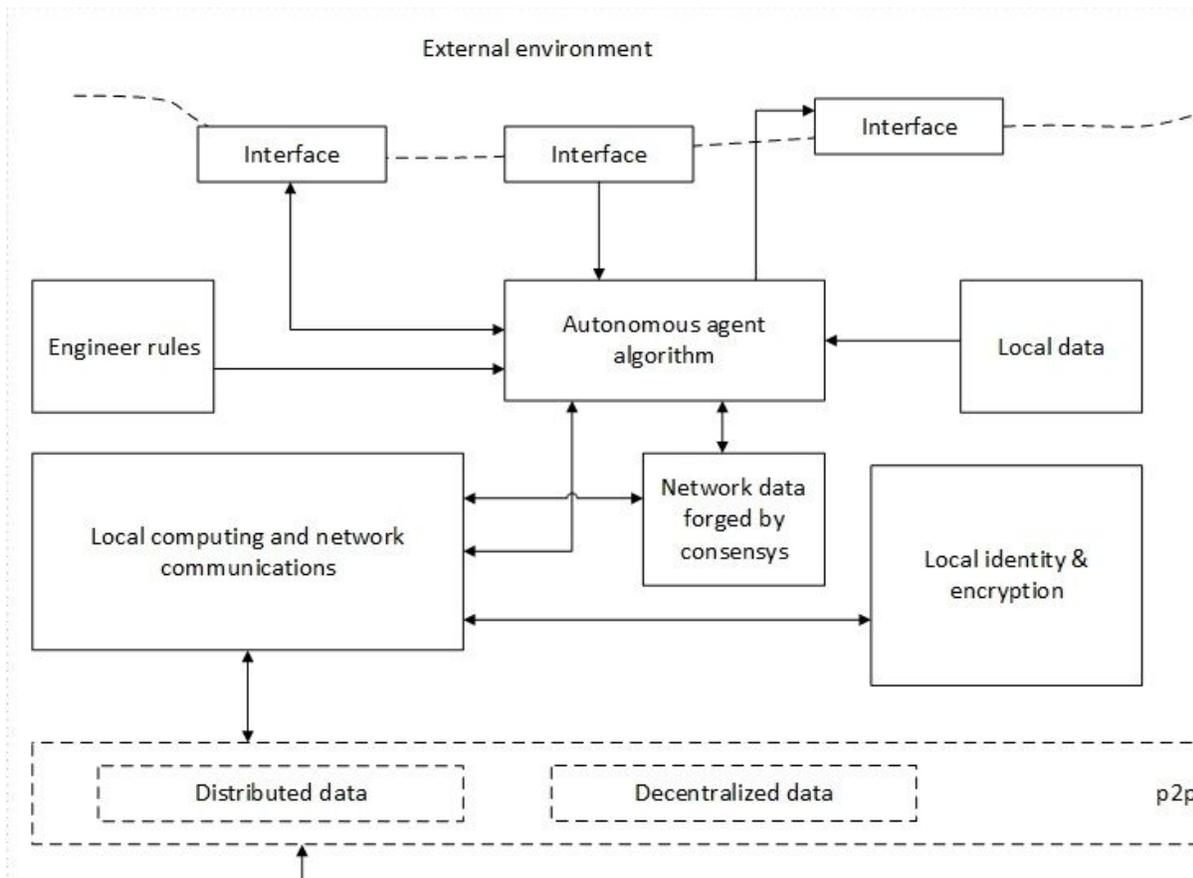
It is important that the structure of the agent implies two types of data:
- Local data of the autonomous agent;
- Network data forged by consensus.

It is worth noting some features of the interaction of processes within the agent:
- the network communication protocol communicates with network data directly and with local data through an autonomous agent;
- the network identification of the autonomous agent is realized by the protocol but not by the algorithm of the autonomous agent;
- the control of robot during the task is engineering problem;
- the interface of the autonomous agent is close to the external environment.

Appendix 2. AIRA Internet of Things

https://github.com/airalab/Aira-IoT

Internet of Things inside robot economics is associated with blockchain based financial networks. Aira IoT project determines communication standard for robots and liability smart contracts, ref. *RobotLiability*. An example of the standard implementation is *AIRA ROS Bridge* project.

AIRA ROS Bridge

https://github.com/airalab/aira_ros_bridge

It is a package for Robot Operating System nodes and Ethereum smart-contracts communication, as a part of the Ethereum network.

AIRA ROS Bridge consists of:
● *ROSBridge* smart-contract as an Ethereum network access point for robots;
● The robotic system node is *aira_ros_bridge* application for low-level interaction with a smart contract.