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CONCEPT OF AN UGV WITH ARDUINO DEVICE

Abstract

In the first chapter the article provides an overview of the currently used and most popular UGVs in the United States Army driven by battery. In addition, through the UGV's the AGV is presented, too. The subsequent chapter looks at some of the research results about hybrid and electric UGV's. The study presented is an Arduino device and some properties of it. The final chapter contains a brief review of the tools and the number of battery cells. This publication summarizes briefly a prototype UGV concept with Arduino energy management system.

A cikk az első fejezetben áttekintést nyújt a jelenleg legnépszerűbb akkumulátorral működtetett UGV-kről, amelyeket az Egyesült Államok hadserege használ. Az UGV-k mellett bemutatásra kerülnek az AGV-k. Az ezt követő fejezet néhány kutatási eredménybe pillant be hybrid és elektromos UGV-k tekintetében. Bemutatásra került a koncepció kidolgozáshoz használt Arduino néhány tulajdonsága. Az utolsó fejezet rövid ismertetőt tartalmaz a felhasználandó eszközökről és a vizsgált akkumulátor cellák számáról. E publikáció egy Arduinóval támogatott prototípus UGV koncepcióját foglalja össze röviden.

Keywords: UGV, AGV, battery, MATLAB, Arduino ~ UGV, AGV, akkumulátor, MATLAB, Arduino

INTRODUCTION

The mobile robots and autonomous vehicles got a high level evolution in the last few years. We use these robots and machines widely all over the world thanks for the developments.

The role of autonomous vehicles and robots in the battlefield and the industry is unquestionable. Lots of complex research trends works on the develop of air, ground and underwater autonomous vehicles. There is a series of papers from Prof. Szabolcsi deriving requirements for the UAV applications [20, 21, 22], and UAV certification procedures [14, 15]. An effective UAV solution requires indentified models. Szabolcsi derived procedure for the UAV model identification [19]. Using identified UAV models Szabolcsi derived flight control systems of the UAVs [17, 18]. For large UAVs Szabolcsi derived mathematical models consisting of both rigid body and elastic body model components [16].

Tha unmanned ground vehicles (UGV) makes new perspectives in military, space and heavy industry. Thanks for the fast spread we can see many research about the robots energy managemant system and maintenance.

Nowadays the military and industry researhes focus on the energy management and the availability maximizing of the robots and autonomous vehicles.

If UGV's battery life gets longer health in battlefield the soldiers get a better support in the military actions. This option also good for the factories, because their machine can be work more time on the shopfloor.

Oil and other energy crises had shown importance of the new alternative energy sources. One of the most important type of these resources is the electrical energy. Nowadays a lot of hybrid cars, UGVs and AGVs use this type of energy source. Everybody knows the fact that ranges of these vehicles are far away from conventional vehicles. In order to get better efficiency and usability a lot of energy management system developed by military, car and robot industry. Developers try to achive a sustainable results in this topic regarding the rapidly developing electronic systems.

UGV AND AGV

The robots of today are not important their design eg. humanoid robot. Robots are maid in different size and designed for their function. One of the main important things is the robot computer. The robots have controlled partly or wholly by this computer, which is connected to various sensors, motors and actuators. [1] [2]

The robots which are used for tactical purpose are low and relatively small sizes. Expectations for these robots are the followings: they are able to move with high mobility on a different type of terrain. The military robots contain a many sensors. These sensors can be capable for voice and video transmission. Some of these robots installed with chemical detectors, which is important in hazardous conditions. Some of the robots are equipped with weapons. Nowadays these weapons are controlled by soilders. The following will be some type of UGV¹s peresented, they are used by the U.S. Army. [1] [2]

The most widely used military UGV bears the TALON name (Figure 2.). These kind of robot is product of Fosterm-Miller, which is an American company: the UGV manufactured and developed in the United States. [2] [3]

¹ UGV: Unmanned Ground Vehicle



1. figure: TALON [2]

Technical parameters of the robot [2] [3]:

- Height: 27,9 to 150 cm
- Width: 57,2 cm
- Length: 86,4 cm
- Weight: from 34 kg to 54 kg
- Maximum speed: 8,3 km/h

Energy source [2] [3]:

- Nickel metal hybride battery ~3.5 hours battery life (rechargeable)
- Lithium ion battery ~8 hours battery life (rechargeable)
- Alkaline battery ~1 hour battery life (non-rechargeable)

The robot can have some kind of bodywork what depends on the configuration. The robot system is extremely mobile device, what is result of the bodyworks. The UGV can be mounted with firearm, camera and any other sensor or weapon depend on the task. The soldiers are able to deliver the robot on their back due to the relatively low weight (Figure 2.). [2] [3]

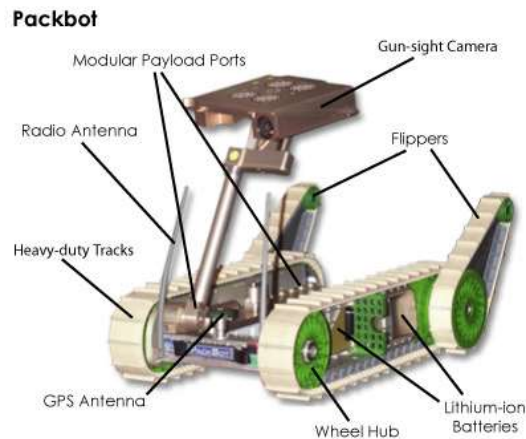


2. figure: TALON backpack [4]

This type of robot family is always controlled by humans with a joystick. The TALON robots excellent usability show in both several war theatre applications and in disaster zone eg.: Iraq, Afghanistan, WTC Ground Zero, Bosnia etc. [2]

PACKBOT robots also used in the U.S. Army. This robot is significantly smaller than the already described above TALON robot family. The design of the robots are aligned to the

standard military backpack (MOLLE²). PACKBOTS use Pentium processors and GPS system, its weight is not more than 400 grams and it can be run at the speed of 13 km/h (Figure 3.). [2]



3. figure: PACKBOT [2]

The PACKBOT is specially designed for reconnaissance purpose, but it also suitable for other operations. Thanks for the design after a band drop or landing, it is able to continue the mission. [2]

The MATILDA (Mesa Associates Tactical Integrated Light Force Deployment Assembly) robot is made and developed by Mesa Robotics company (Figure 4.). [2]



4. figure: MATILDA [2]

The robot has various loads as manipulators, cameras, sensors, or it can work as a transport vehicle. [2]

Technical parameters of MATILDA UGVs [2]:

- Height: 30cm
- Width: 53 cm
- Length: 76 cm
- Weight: 28 kg
- Maximum speed: 3,6 km/h

Energy source [2]:

- DV Nickel metal hybride battery (rechargeable)
- DC Nickel metal hybride battery.

The presented robot type is driven by electricity. There are robots which are bigger then the presented ones, and they are driven by diesel fuel. The energy management systems are necessary for safety and to maximize the robots operation time.

² MOLLE: Modular Lightweight Load Carryin Equipment

These systems have to control and regulation the battery packs or cells. Combat or reconnaissance UGVs can be take a higher level support for the military forces on the battlefield or during any other military actions [2].

The AGV (Figure 5.) is an acronym which is made up of Automated Guided Vehicle. The AGVs same like the UGVs but these systems follow a line or a mark on the floor or an optical signal eg. laser beam. They use this markers for movement orientation. [5] [7] [8]

These robots usually used in industry. The robots transport cargo between warheouse and the workstations. Nowadays these types of robots often can be seen in hospitals, offices or in residential buildings. [5] [7] [8]



5. figure: AGV [6]

The American Society of Safety Engineers (ASSE) had defined the AGV is follows [5] [7] [8]:

- Machines without driver which moves along a pre-programmed way with sensors and navigation tools;
- Vehicles with automatic control system;
- Vehicles without drivers, they pre-programmed to be able to follow a path.

The development of AGVs dating back to 1950. The first development project was made by the Grand Rapids company in Michigan. The same events happened in Europe in the 1970s. [5] [7] [8]

The AGVs nearly operate like the UGVs. They can move point to point to carry out their duties. Most of the UGVs are set to solve difficult and dangerous tasks like disarming bombs. AGV's are used to perform much easier tasks. They moslty used when essentially important the stable and long term operations, eg. factories, office buildings. [5] [7] [8]

The AGV systems include the followings [5] [7] [8]:

- On board controller: it responsible to start and stop functions, to control the speed of the robot (speed up and down, breaking) and conditon monitoring of the vehicle;
- Management system: planning, scheduling and traffic control;
- Communication system: the communication system gets data about the vehicle status and position, and sends it to the central unit and back. This system also monitoring the worphases of the AGV;
- Navigation system: navigate the AGV.

If these robots get failure the companies can lost millions. The AGVs also need an energy management system to avoid this problem. [5] [7] [8]

INTELLIGENT ENERGY MANAGEMENT

The study from Bugár M., Stanák V., Ferencey V. describe a hybrid powered UGV, which is powered with a 2000 cc diesel engine and electric motors. They explain the importance of loud and soft or stealth modes importance in tactical applications. It is an important property in military systems. One of the most important property is the silent mode. They explain this mode when importance of the mission is maximized. There are a lot of opportunities to develop combat robots if the stealth mode has better quality. [9]

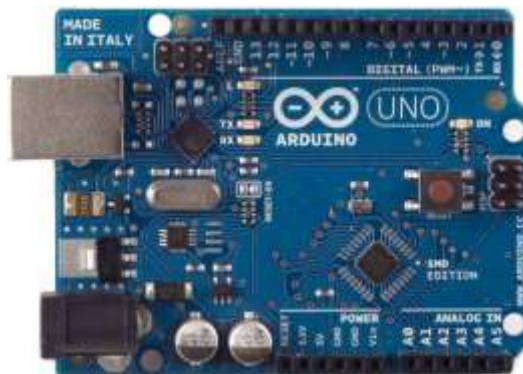
In the summary can be read the forces which affect on the UGV like eg: gravity, aerodynamics etc. The article contains a description about a different type of ground/soil condition, speed and engine power relations. They also mentioned that fuel cell and electric hybrid systems for new developing is a promising way. [9]

Hiemaa M. and Tamra M.'s main research topic is the Li-ion batteries recharge strategies and how can they use better the batteries when the vehicle is enroute. They separated other batteries for electrical systems and others for the drive system. They presented more ways of electrical connections about the batteries like: Limp Home mode and Primary and Secondary Chain. Theirs study mentioned different type of loads. In some cases the system takes voltage from all batteries and sometimes only from the most charged. The solar panel referred to a secondary source. [10]

The study devoted a special attention to PNR³. All UGV need to know where is the point where they can not turn back to the start point. [10] A study made at The Ohio University study also contains a description about an ideal regulation of charge control. The researches of the university used Fuzzy logic to determine the ideal values. [11]

ARDUINO

The Arduino is an open source development platform which is based on Atmel AVR microcontroller. The equipment is relatively widespread thanks to the simple programming and configuration. [12]



6. figure: Arduino UNO [12]

The programs can be prepared in a virtual development environment (IDE), which can be loaded and tested on computer, and, it is easy to download to the controller on an USB port. [12]

The IDE is a cross platform which is written in JAVA. The device can be programmed by C and C++. [12]

³ PNR: Point of No Return

The Arduino is supplemented by various shields [12]:

- Ethernet Shield
- Wifi Shield
- Proto Shield
- GSM Shield
- Motor Shield

These features can give more functions to the basic device. [12]

A CONCEPT OF A NEW UGV – BASIC TERMS

The purpose and future work of the author is to draw a brand-new concept of a the UGV designed and constructed by the author. This preliminary study is the basic one allowing to find new areas of applications both in military and non-military fields.

The most of the UGVs are driven by Li-batteries, this fact is also proven in the literature research. The next problem being investigated and solved by the author is the conceptual design of the optimal energy management system applied on-board of a new UGV/AGV. The energy management control described above is to use an Arduino UNO hardware. The data which measured by Arduino will be processed using MATLAB and the regulation is also will be solved with MATLAB Control System Toolbox software and leaning on Szabolcsi's textbook of [13].

The Arduino oversees 4 LiPo battery cells to simulate a variety of connections, emergency processes. Other parts of the UGV which also need electric supply get power from another battery pack. The UGV drive by 2 electric engines. The UGV has rubber track.

The UGV includes 6 ultrasonic sensor for the measure of orientation and emergency stop simulation. The UGV will be made of aluminium and steel.

CONCLUSION

This paper describes the most popular battery powered UGVs in the United States Army. The study contains a description about their size, type of energy sources and fields of applications.

The article also describes the so-called AGV which are resemble to the UGVs because their main properties are the same. We can see that the proper use of the battery cells is an important research area.

The paper provides a glimpse into another energy management studies and their main research directions. The researches addressed more strategy depending on the end use. Also disclosed an Arduino controller with main properties and shields.

The author writes from a preliminary concept about a prototype UGV and its associated equipments and software which provides a possibility to energy management measuring.

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