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Overview of Solar Robot

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Abstract

Automation is in great demand in today's Industrial world. Robot is one of the ways to use and implement the automation in Industry as well in-home utilities. New types of Robots are introduced to meet the growing demand. Solar Robot is one type of robot extensively used utilizing solar energy. The objective of this paper is to perform a study on designing on Solar robots. A detailed study of Solar robot design, the description of its components, circuits is studied and discussed. The Power Management and working of charge controllers is described. The behavior of Solar Robot is elaborated mentioning the design parameters.

Keywords: *Solar Robot, Driving Pattern, Power consumption, Photovoltaic*.

1. Introduction

Human life has been influenced by machines for a long time. Use of machinery and machines marked Industrial Revolution and were associated with several human fears and threats. The significance and importance of machines were assessed in different ways: some viewed machines as threats while others saw promising opportunities in them.

Today, in the era of omnipresent technology and right in the middle of a transitional phase, the situation is similar with smart machines and processes everywhere. The omnipresent revolution would mean that equipment and machinery could be installed even as part of human body. Robots could become assistant to human, and, they would become co-workers. Man would gradually be released from the shackles of time and space with the help of omnipresent applications and technological solutions. The man-machine relationship would become more and more integrated and interactive as smart machines come to the help of man in the most diverse contexts at work and in the free time. Changes in the social, cultural and economic sphere would occur.

A robots and intelligent machines advantage over human are that it can play a variety of movements and thinking tirelessly and endlessly. When planners are engineering and re-engineering robots, it is important for them to focus on the design of the robots' ability to follow patterns. Because of this basic planning and engineering principle, robots are mainly specialized – at least initially. At a later stage, we might see generalized robots, which would work extensively to imitate and paraphrase humans. In the future, the memory of robots and AI apps would become very extensive, allowing huge amounts of data storage and their utilization in a variety of operational tasks. Extended memory would expand the potential use of robotics.

Figure: 1 Solar Robot prototype

2. Literature Survey

Robotization is not a new thing for humankind. In 1738, Jacques de Vaucanson had already built the Flute Player, an automaton, or the first functioning robot, which could play the flute. De Vaucanson built also a mechanical duck that imitated the motions of the live bird, but also its motions of drinking, eating, and "digesting." His most important invention was the automation of the loom, albeit ignored by his contemporaries. This tells us how, at an early stage in the history of automation, a man built an automaton to

entertain but also to educate his contemporaries about the possibility of working objects (Anderson, 2000).
A robot can be a good partner in work and play. However, we can also identify a long-lasting phenomenon that advanced technologies, digitalization, robotics and the philosophy of lean production, management and government will finally result in the production model of more and more goods while involving less and less people (Brynjolfsson, 2001).
Jeremy Rifkin has noted that the middle class is disappearing, the richest are getting richer and policy makers do have no idea how bad the situation truly is. Textile workers being laid off due to automation, new jobs opportunity did rise in other industries. Due to transfer of labour from automated to non-automated industries, technological unemployment was also known as the Luddite fallacy.
According to recent studies, artificial intelligence and robotics will be a part of people´s daily life by 2025, with huge implications for a range of industries such as health care, transport and logistics, customer service, and home maintenance.

In the work by (Lever et al, 2006,2008) presents a four wheeled driven solar powered rover. The focus of the bot is presented for Antarctic region where during summer sun is present for 24 hours. Harsh and robust condition of the Antarctic are also to be considered during the build of the bot and maximum power is need from the motors to attain maximum torque on ice. (Ray et al., 2007) presented a power management for a cool robot which was tested in Greenland and Antarctica. Robot presented high efficiency, good mobility and long-term deployment even under harsh condition. (Runge et al., 2007) presented in his work the concept of unmanned aerial vehicles which can work for long endurance and high altitude (Lever, 2006). It can be of great application in polar regions. (Andrea, 2008) presents a design and initial result for power supply for an autonomous robot. Because of different layers of robot power flow, the energization of robot with maximum efficiency remain a concern. (Bajracharya et al., 2008) presented a brief study of NASA mars pathfinder and study related to the mar's exploration rovers was performed as they played a very important role in exploring martian surface and have overcome all the challenges related to the unknown terrain.

(Zarafshan et al., 2010) developed a system dynamic which is partitioned into two rigid and flexible bodies' motion, and a practical model for control implementations on compounded rigid-flexible multi-body systems. (Marco et al., 2010) presented the preliminary results for the design of a power supply system of an autonomous robot.

(Hans et al., 2012) aimed to describe the design, the control and the renewable energy supply for a small electric powered robot for outdoor field monitoring and other operations. Furthermore, the energy consumption for the different operations scenarios was determined based on power consumption measurements for the basic navigation modes. The PV charging solutions are expensive compared with using the public power grid. They are only viable when there is no access to the grid. (Dühring et al., 2012) processes the possibility to energize an autonomously running machine with photovoltaic energy. The aim is to incorporate renewable energy in daily use of agriculture machines. The machine is operated as a robot. The agricultural robot has to take care of 3 different tasks: navigation, scouting and weeding. The goal is to provide power to the robot only with energy from the sun. it was also examined that how many solar modules are needed and for how long the robot can operate with the 3 different tasks. The aim is 24 hours on the run if possible.

2.1 Advantages of Robots

Robots can free people to focus on the creative process by taking care of unpleasant physical and mechanical work. The greatest benefits of robotics should be meant for people working in unhealthy environments, such as mines and deep waters. Using robots, industrial production could be maintained in countries with high labor costs – especially for small scale batch production. The third domain for robots would be confined to productive activities and tasks that a man cannot perform. Robots planned to analyze, audit and edit massive data are in the business interest of companies and private experts.

The majority of data collected in the world has been gathered in recent years; approximately 90 per cent of it all in the past two years. Thus, the "Big Data" are real-time data and up-to-date; in their analysis, attention is paid to the volume of data stream, variances, and to the velocity of data. When big data is analysed on the basis of these criteria, businesses and other stakeholders will identify new opportunities in crowds, markets and networks.

At present, the main challenge of robotization lies in combining human and robot activities, guaranteeing the safety of the "man-robot merger". The key aim is to find the best human-robot match. On the basis of co-operation of humans and robots, companies and the public sector would increase efficiency and capacity, as well as improve quality and industrial working conditions. In particular, co-operation of humans and robots would enhance the production of small series manufacturing.

The background information necessary to understand the technology used for the design of a solar robot deals with different parts like charge controller, inverter, and power management, docking station and batteries. A charge controller has to protect the battery from overcharging. The core of the solar robot design is the power management. Many factors determined the type of power scheme used. The solar panels had to be efficient and yet affordable, the capacitors had to be configured in a certain way for maximum performance, and circuitry had to be introduced to manage or regulate the power.

3. Solar Robot Behaviour

Solar Robot is planned to display two main behaviours: Obstacle avoidance and Light-seeking. The primary goal of any Phototropic (light-seeking) robot is to find and maintain access to a source of light (it's primary source of energy). The secondary goal is to keep from getting stuck. Your Solar Robot is equipped with optical sensors to find the light, and touch sensors to avoid any immediate obstacles. The optical sensors can sense obstacles by the shadow they cast, so your Solar Robot may occasionally surprise you with their adeptness.

The power consumption of the robot is measured while the robot is driving in a plane soil bin with a speed of 0.3m/s. The soil in the bin was dry and very loose. The measurement device measured in DC voltage per current and made a measurement 2 times per second. The current was found and then the power was calculated with the battery voltage at 48V.

3.1 Forward driving

The robot was programmed to drive forward 10 meter with a speed of 0.3m/s. Meaning when it starts driving it drives slower (speed up) and a little time before the 10 meter is attained the robot drives slower again to stop (decelerate). 2 different measurement series were made on a 10 meter distance. One of them had 75 measurements (38 sec) and the other had 60 measurements (30 sec), meaning in average it takes 34 sec for the robot to drive 10 meter straight forward in a soil bin.

The moment power of the robot was in the first measurement 413 W in average and in the second measurement it was 455 W in average. The average of these two measurement series are 434 W for forward driving. During up speeding and decelerating the robot used less power. Also measurements with higher speed were made (not displayed in Appendix) and the robot had a higher moment power with higher speed. This means the robot uses more energy the faster it drives. While weeding the robot has to drive 20 cm and stop for wipe out a weed (in average), so the power consumption will be less than 434 W. When the robot is navigating and scouting the speed might be more continuous at 0.3m/s without stops, meaning the power consumption might be a little higher.

3.2 Turning

The robot was programmed to make a turn of 90◦ giving 47 measurements (equal to 24 sec) and a moment power at 293 W in average as shown in figure 2. Then the robot was programmed for a 180◦ turn and this took 76 measurements, meaning it took 38 sec to make this turn. The moment power consumption of the 180◦ turn was 466 W in average. The robot will mostly drive straight forward and only make very few turns compared to the forward driving. The percently difference between the turn and the forward driving is depending on the specific field. Normally the robot will drive all the way down the field and at the end make a 180◦ turn and drive back. The average between the 180◦ turn and the 10 meter forward driving is:

$$P_{driving} = \frac{466 + 434}{2} = 450W$$

So in this project the power consumption of the robot will be 450 W.

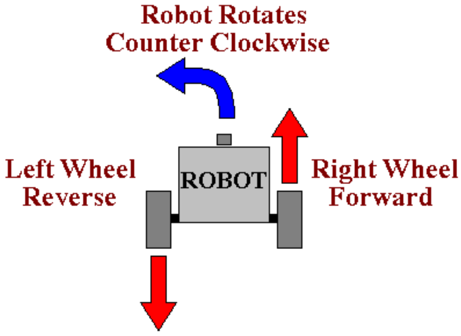

Figure. 2: Differential Drive method of a robot

3.3 Uncertainty

The measurement only gives a limited picture of the power consumption of the robot, because the consumption is depending a lot on the condition of the field the robot has to operate in.

• The condition of the field. If the soil is firm the robot uses less energy.

• The robot will probably consume more energy when driving uphill and less energy when driving downhill, but the test soil bin is only horizontal, so these measurements have not been made.

• The measurements was made with a 'plain' robot, the robot had no sensors attached and no end-effectors for the weeding operation. The extra weight from these might have an influence on the power consumption.

• The number of measurements made is also very low and would give a better picture if there was a lot more.

3.4 The total consumption

For the navigation the robot consumes the driving consumption plus the navigation
power: 450W + 70W = 520 W

For the scouting the robot consumes the driving consumption plus the scouting
power 450W + 80W = 530 W
For the weeding the robot consumes the driving consumption plus the weeding
power 450W + 175W = 625 W

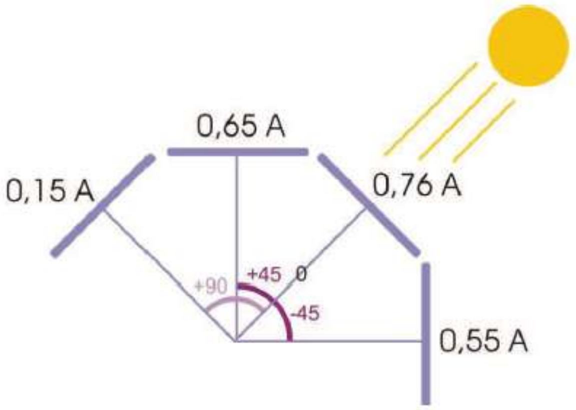

Figure 3: Change of the amperage when changing the angle.

4. Conclusion

This paper illustrates that designing a solar robot which will meet our demands under different circumstances. Making a self-sustainable human-independent robotic system develops two main ideas. The first one is creating a robot that can work on some projects without any human help. The second one is using a renewable power source as main energy supplier. Combining these two concepts, very powerful robotic systems can be assembled contributing to the whole aspect of the life in future. In fact, there are challenges like choosing the best solar cell for our solar robot and many others. Based on the discussions which we had in this thesis we choose thin Film solar cell amorphous, because of the cost, efficiency and the most important want, the increasing rate of technology and heat resistance thanks to the developing of nanotechnology.
On the other hand, the next challenge for us was designing a really basic and simple prototype for the solar robot. This thesis describes the beginning of the process in which a self-sustainable robotic system is created. This is a very stable platform which can be easily modified and upgraded. Adding new features, such as controller and sensors, will make this robot more intelligent and adaptive to the human needs.

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