RESEARCH OF WHEELIE

MUHAMMAD AMIR BIN RAZALI

(24DTP20F2025)

MUHD ALIF HAKIM BIN MOHD RAHIM

(24DTP20F2020)

MUHAMMAD SYAZWAN BIN ABDUL AZIZ

(24DTP20F2023)

WAN AIMAN ZULKARNAIN BIN WAN SABRI

(24DTP20F2001)

JABATAN KEJURUTERAAN MEKANIKAL

SESSION AUGUST 2022

Author by Syazwan

RESEARCH OF WHEELIE

MUHAMMAD AMIR BIN RAZALI

(24DTP20F2025)

MUHD ALIF HAKIM BIN MOHD RAHIM

(24DTP20F2020)

MUHAMMAD SYAZWAN BIN ABDUL AZIZ

(24DTP20F2023)

WAN AIMAN ZULKARNAIN BIN WAN SABRI

(24DTP20F2001)

This report was submitted to the Mechanical Engineering Department as part of the requirements for the award of the Mechanical Engineering Diploma

Author by Syazwan

JABATAN KEJURUTERAAN MEKANIKAL

SESI 1 2022/2023

STATEMENT OF AUTHENTICITY AND PROPRIETARY RIGHTS

RESEARCH OF WHEELIE

TITLE : WHEELIE

SESSION : AUGUST 2022

1.We is a final year student of Diploma in Engineering Mechanical Mnufacturing, Department of Mechanical Engineering,Politeknik Banting Selangor, which is located at Persiaran Ilmu, Jalan Sultan Abdul Samad,42700 Banting, Selangor. (Here in after referred to as 'the Polytechnic').

MUHAMMAD AMIR BIN RAZALI

(020813-10-1799)

MUHAMMAD ALIF HAKIM BIN MOHD RAHIM

(020321-10-0829)

MUHAMMAD SYAZWAN BIN ABDUL AZIZ

(020715-07-0087)

WAN AIMAN ZUKARNAIN BIN WAN SABRI

(020103-01-0075)

2.We acknowledge that 'The Project above' and the intellectual property there in is the result of our original creation/ creation without taking or impersonating any intellectual property from the other parties.

3.We agree to release the 'Project' intellectual property to 'The Polytechnic to meet the requirements for awarding the Diploma in Engineering Mechanical Manufacturing to us.

ACKNOWLWEDGEMENT

Alhamdulillah and first of all we would like to thank God , we have succeeded to complete our final year project assignment successfully. Even though many challenges and obstacles we faced while completing the fabrication and paperwork, we managed to overcome them with our own patience , confidence , effort and struggle among the group members . All the problem can be settle down and we were able to adapt properly and wisely .

We would like to express we gratitude and appreciation to all those who gave the possibility to complete this project . Special thanks is due to our supervisor En. Zulkarnain whose help, because without his guide our project cannot be done properly like this . He always give us supports and guide us how to do our assignment in purpose to produce a good outcome from research that been studied . His invaluable help of constructive comments and suggestions throughout the coursework to success . We would also like to drop our sincere appreciation to the role of the staff of Mechanical Workshop for giving the permission to use all required machinery .

Sincere thanks to all group members especially for their kindness and moral support throughout doing this project. With the presence of group members ,we have shared ideas in making this project a success .Without your support and encouragement, we would not have been able to perform this task as perfectly .In addition, many thanks also to our colleague who worked hard to produce this work and exchanged ideas to help us complete the course work .

Last but not least, we hope that the work we do will increase our knowledge base and make us more cooperative and responsible .

Thank You .

Author by Syazwan

TABLE OF CONTENT

ABSTRAK

Dalam projek kali ini saya Bersama ahli kumpulan saya akan mencipta dan membina sebuah projek yang dapat jadi kan sebuah platform kepada robotic arm untuk bergerak dari satu tempat ke tempat lain. Di sini kami dapati bahawa sebuah projek yang dicipta iaitu projek robotic arm mempunyai masalah dari segi untuk bergerak dari satu tempat ke tempat lain bagi melakukan sesuatu kerja dengan baik. Hal ini demikian kerana robotic arm tidak diciptakan Bersama roda atau sebaliknya kami satu kumpulan bertanggungjawab untuk mencipta sebuah platfom yang membolehkan robotic arm bergerak dengan mudah. Dengan ini kami mendapat idea untuk membuat sebuah kereta atau platfom untuk robotic arm mudah melakukan kerja. Walau bagaimana pun, kami diberitahu oleh supervisor yang sesuatu produk sudah ada dan dibina khas untuk meletekan apa apa objek dan dapat bergerak dari satu tempat ke tempat lain. Disebalik itu kumpulan kami bercadang akan mencipta projek yang sama Cuma Bahagian roda atau tayar yang sedikit berbeza. Apa yang kami dapati ialah roda yang di platfom sebelum begerak dalam keadaan normal seperti depan, belakang, dan perlu membelok sekiranya untuk menukar arah kiri dan kanan. Dengan menggunakan kaedah baru, iaitu kami akan menggantikan roda yang baru iaitu mecanum wheel yang banyak kelebihan berbanding yang lama kerana, kita dapat lihat yang teknologi mecanum wheel ini memudahkan pergerakkan yang dikatakan boleh bergerak 360 darjah. Mecanum ini diciptakan dengan satu arah sahaja tetapi dapat bergerak lebih bagus dari roda yang lama.

In this project, I and my group of experts will create and build a project that can make a platform for a robotic arm to move from one place to another. Here we find that a project created, namely the robotic arm project, has problems in terms of moving from one place to another to do something well. This is because the robotic arm was not created with wheels or vice versa we are a group responsible for creating a platform that allows the robotic arm to move easily. With this we got the idea to make a cart or platform for the robotic arm to easily do work. However, we were told by the supervisor that a product already exists and is specially built to drop any object and can move from one place to another. On the other hand, our team hopes to create the same project, only the wheels or tires are slightly different. What we found were wheels that were platformed before moving in normal circumstances such as front, rear, and needing to turn just in case to change direction left and right. By using a new method, that is, we will replace the new wheel, namely the mecanum wheel, which has many advantages over the old one because, we can see that the mecanum wheel technology makes it easier to move, which is said to be able to move 360 degrees. This mecanum was created in one direction only but moved better than the old wheel.

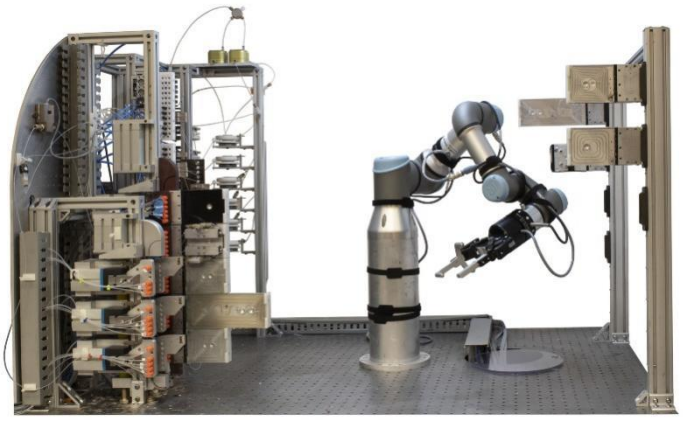
Author by Syazwan

BAB 1 PENGENALAN

1.1 pengenalan

As you can see the diagram above is an old robotics platform where, the project uses wheels in the old method. Therefore the project to be built is a project named WHEELIE which can be used as a platform for another project which is a robot arm. Where the project cannot move from one place to another. Therefore we use a wheel called a mecanum wheel that can move 360 degrees. This is because existing projects cannot move like this and can only move forward, backward, left, and right

1.2 latar belakang projek.



Author by Syazwan

As we know in the industry many use robotic arms to lift heavy or light items. In the robotic arm industry, it should be there to facilitate human work in terms of safety and so on. There are two types of conditions in the industry, heavy and light. And we can see the robotic arm tasked to lift any object does not use technology to move to another place. Therefore, to make our work easier, we should install wheels on the robotic platform so that it can move from one place to another. Mecanum wheel is based on the principle of a central wheel with a number of rollers placed at an angle around the periphery of the wheel. The angled peripheral rollers translate a portion of the force in the rotational direction of the wheel to a force normal to the wheel direction.

1.7 pernyataan masalah

Here there are some problems that the robotic arm goes through when doing work and the problems that exist on the existing platform Among them when doing work lifting goods and so on, we find that the robotic arm cannot move freely to do work from one place to another other This will cause the work process to be slow because human energy is needed to change the position of the robotic arm for a certain place. With this problem occurring, the industry may not be able to reach the target to produce items that will be placed in the robotic arm in the next process. In addition, the existing platform before is not technological enough because it still uses the old wheel technology which is a wheel that can only move forward, backward, and right, left if necessary to turn.

1.4 objektif projek / kajian

i. to produce a platform for a robotic arm using a mecanum wheel.

ii. to facilitate the movement of the robotic arm in the process of lifting goods.

iii. to determine whether the new or the old platform is better.

1.5 skop projek

In producing this project, many industries can use this project because it is suitable for use. This is because the robotic arm project uses a platform to move and it makes work easier. It can also be outside the industrial area because of the mecanum wheel's technological abilities.

Refferences

1)Ilon, B.E., “Wheels for a course stable selfpropelling vehicle movable in any desired direction on the ground or some other base”, US Patent and trademarks Office, Patent 3.876.255, 1975.

2)P.Muir and C.Neuman, “Kinematic Modeling of Wheeled Mobile Robots,” 1986.

3)F. Adascalitei and I. Doroftei, “Practical applications for mobile robots based on Mecanum wheels” — a systematic survey, Rom.Rev.Precis.Mech. Opt. Mechatron. 40 (2011) 21–29.

4)V. Kalman, “Omnidirectional wheel simulation” – a practical approach, Acta Tech. Jaurinensis 6 (2) (2013) 73–90

5)Song JB and Byun KS. “Design and control of a four-wheeled Omnidirectional Mobile Robot with Steerable Omnidirectional Wheels”, Journal of Robotic Systems 2004; 24 (4):193–208.

6)Hanzhen Xiao, Dengxiu Yu and C.L. Philip Chen. “Self-triggered-organized Mecanum-wheeled robots consensus system using model predictive based protocol, Information Sciences”, Volume 590,2022,Pages 45-59,ISSN 0020-0255.

7)Gokhan Bayar and Salih Ozturk. “Investigation of The Effects of Contact Forces Acting on Rollers Of a Mecanum Wheeled Robot”, Mechatronics,Volume 72,2020,102467, ISSN 0957-4158.

8)Zhe Sun, Shujie Hu, Defeng He, Wei Zhu, Hao Xie and Jinchuan Zheng “Trajectory-tracking control of Mecanum-wheeled omnidirectional mobile robots using adaptive integral terminal sliding mode,Computers & Electrical Engineering”, Volume 96, Part A,2021,107500, ISSN 0045-7906.

9)Yoon SW, Park SB, Kim JS. And Kalman “filter sensor fusion for mecanum wheeled automated guided vehicle localization”, Journal of Sensors 2015;2015:1–7.

10)Kundu AS, Mazumder O, Lenka PK and Bhaumik S. “Design and performance evaluation of 4 wheeled Omni wheelchair with reduced slip and vibration”, Procedia Computer Science 2017;105 289–95.lization”, Journal of Sensors 2015;2015:1–7

Author by Syazwan

BAB 2: LITERATURE REVIEW

2.1 Introduction

This chapter focuses on the literature review that has been made prior to execution of the project. Literature review is an important process as it provides understanding on certain subjects that is needed to proceed on a project. In my project, knowledge on robotics and driving mechanism or locomotion is important as this will affect the result of my project. Previous studies we have done show that our project can facilitate the movement of a robot to move anywhere.

In robotics terminology, locomotion can be defined as the movement method of the robot. A mobile robot needs certain locomotion mechanism to move around its environment. There are a number of methods can be applied to enable movements of a robot such as using legs and wheels. For a wheeled robot, there are a number of methods of locomotion such as normal steer locomotion, skid steer locomotion and omnidirectional locomotion using non-conventional wheel, notably omnidirectional wheel and Mecanum wheel. for our project, we use a mecanum wheel instead of using a normal wheel. The use of a mecanum wheel can move the robot in many directions.

Abstract: In this paper a literature review concerning practical applications for mobile robotic platforms based on special wheels (in this case, Mecanum wheel) is presented. Mobile robots equipped with four Mecanum wheels have the omnidirectional property, which means, they have the ability to move instantaneously in any direction, from any configuration. Therefore, compared to conventional platforms, these vehicles possess multiple advantages in terms of their mobility in narrow spaces or crowded environments. They have the ability to easily perform certain tasks in congested environments foreseen with static obstacles, dynamic obstacles or narrow areas. Usually, such environments are found in factory workshops, warehouses, hospitals, etc. Hence the resulting needs to create this kind of robotic platforms to satisfy the requirements of various fields, such as: industrial, military, naval, medical and last but not least, the educational field (as the basis for research). The characteristics of the Mecanum wheel, a short comparison between this type of wheel and a conventional wheel, as well as the constructive and design solutions previously developed are described in the first part of this paper. Then, some application fields and the related systems based on Mecanum wheel are presented.

1. Introduction

Omnidirectional wheels have been used in robotics, in industry, and in logistics for many years. By reviewing and analyzing systematically the existing literature concerning this type of wheels, it was revealed that systems based on Mecanum wheels detain omnidirectional capabilities, whereas systems based on conventional wheels do not. Specifically, these capabilities make the vehicle extremely maneuverable, which could be very helpful in different indoor and outdoor applications. Therefore, compared to conventional vehicles, omnidirectional robotic vehicles possess multiple advantages in terms of their mobility in narrow spaces and crowded environments. They have the ability to easily perform certain

tasks in congested environments foreseen with static obstacles, dynamic obstacles or narrow areas. Usually, such environments are found in factory workshops, warehouses, hospitals, etc. Hence the resulting needs to create this kind of robotic platforms to satisfy the requirements of various fields, such as: industrial, military, naval, medical and last but not least, the educational field. Furthermore, to prevent the shortcomings presented by Mecanum wheel, researchers have focused on its optimization, developing new constructive solutions, thus allowing their implementation in new applications, such as planetary explorations, mine operations.

2. Mecanum wheel

2.1. Mecanum wheel characteristics

Mecanum wheel was designed and invented in Sweden, in 1975, by Bengt Ilon, an engineer with the Swedish company Mecanum AB. Mecanum wheel is based on the principle of a central wheel with a number of rollers placed at an angle around the periphery of the wheel. The angle between rollers axis and central wheel axis could have any value, but in the case of conventional Mecanum wheel it is 45°. The rollers are shaped such that the silhouette of the omnidirectional wheel is circular. The angled peripheral rollers translate a portion of the force in the rotational direction of the wheel to a force normal to the wheel direction. Depending on each individual wheel direction and speed, the resulting combination of all these forces produces a total force vector in any desired direction, thus allowing the platform to move freely in direction of the resulting force vector, without changing the direction of the wheel.

A Swedish omnidirectional wheel has 3 DOF's composed of wheel rotation, roller rotation and rotational slip about the vertical axis passing through the point of contact. In the omnidirectional wheel, the wheel velocity can be divided into the components in the active direction and in the passive direction. The active component is directed along the axis of the roller in contact with the ground, while the passive one is perpendicular to the roller axis. When the wheel rotates, a force vector along the wheel and a force vector perpendicular to the wheel are created. By a simple control of each wheel rotation, the vehicle moving direction can be changed instantaneously.

When a Mecanum wheel is rotating, at least one roller (maximum two rollers) is (are) in contact with the ground. Only a small surface (theoretical, one point) of the roller is in contact with the ground. The area of this surface traverses the roller from one side to another, depending on the sense of wheel rotation. The direction of the traction force will be done by

the traversing sense of contact surface. It means, if we look to the wheel from the top side, the traction force will be perpendicular to the roller axis.

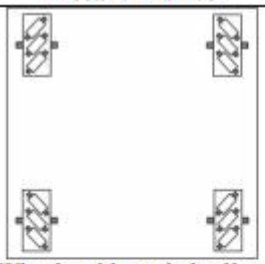
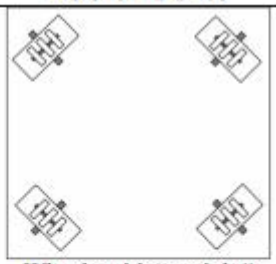
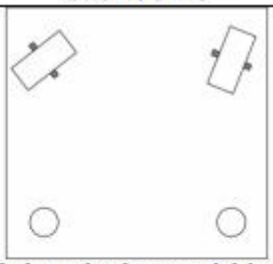
2.2. Mecanum wheel vehicle vs. Conventional wheel vehicle

The benefits of a vehicle with Mecanum wheels relative to one with steered wheels have been presented by [4]. Usually, robotic vehicles are designed to perform planar motion. In a two dimensional space, a body has three degrees of freedom, being capable of translating in both directions and rotating about its centre of gravity. However, most conventional vehicles do not have the ability to control every degree of freedom independently, because conventional wheels are not capable of moving in a direction parallel to their axis. These so called non-holonomic constraints of the wheel prevent vehicles using skid-steering from moving perpendicular to its drive direction. To reach every location and orientation in a two dimensional space it can require complicated maneuvers and complex path-planning. Non-holonomic vehicles can move in some directions (forward and backward) and can describe some curved trajectories, but cannot crab sideways. For example, to realize a parallel parking, a differential drive vehicle should make a number of maneuvers (Figure 3).

Figure 3: Lateral parking of a differential drive mobile robot [6]

A vehicle without non-holonomic constraints it can travel in any direction under any orientation. This capability is widely known as omnidirectional mobility. Omnidirectional vehicles have great advantages over conventional platforms, with carlike Ackerman steering or differential drive system in terms of moving in tight areas [5]. They can crab sideways, turn on the spot and follow complex trajectories. These vehicles are capable of easily performing tasks in environments with static and dynamic obstacles and narrow spaces.

Usually, vehicles based on Mecanum wheel have a square or a rectangular configuration, with two wheels on each side of the chassis. Using four of these wheels provides omnidirectional movement for a vehicle without needing a conventional steering system. When Mecanum wheels are actuated, the angled peripheral rollers translate a portion of the force in the rotational direction of the wheel to a force normal to the wheel direction.

	Mecanum drive	Holonomic drive	Swerve drive
Description	 Wheels with angled rollers	 Wheels with "straight" rollers (omniwheels)	 Independently steered drive modules
Advantages	- compact design - high load capacity - simple to control - less speed and pushing force when moving diagonally	- low weight - compact design - simple to control - less speed and pushing force when moving diagonally	- simple conceptually - simple wheels - continuous wheel contact - high load capacity - robust to floor conditions
Disadvantages	- very complex conceptually - discontinuous wheel contact - high sensitivity to floor irregularities - complex wheel design	- more complex conceptually - discontinuous wheel contact or variable drive-radius - sensitive to floor irregularities - lower traction	- complex mechanical design - heavy and massive design - complex to program and control - high friction and scrubbing while steering

Depending on each individual wheel direction and velocity, the resulting combination of all these forces produce a total force vector in any desired direction thus allowing the platform to move freely in the direction of the resulting force vector, without changing of the wheels themselves. The vehicle is able to translate on any direction, forward/backward but also sideways left/right and turning on the spot, thanks to its special wheels (Figure 4). This is especially helpful when having to maneuver in tight environments [5]. A short comparison between Mecanum drive, holonomic drive and swerve drive is presented in Table 1.

2.3. Mecanum wheel constructive solutions

Omnidirectional wheeled vehicles with Mecanum wheels have some shortcomings. According to [7], a vehicle with Mecanum wheels is susceptible to slippage, and as a result, with the same amount of wheel rotation, lateral travelling distance is different from longitudinal travelling distance. In addition, the ratio of longitudinal travelling distance over lateral travelling distance with the same amount of wheel rotation, changes with ground condition. The second drawback is that the contact point between the wheel and the ground moves along a line parallel to the wheel axis, even though the wheel is always in contact with the ground. The lateral movement produces horizontal vibrations. The last drawback is that its ability to overcome obstacles is not independent of travel direction.

The slippage of the wheels prevents the most popular dead-reckoning method, using rotary shaft encoders [5], [8], from being performed well on a vehicle with Mecanum wheels. In order to solve the problem, visual dead-reckoning was used as a slip resilient sensor [7], [9]. This technique, also used in optical mice, makes use of an on-board video camera continuously capturing frames of the ground beneath and image processing hardware on the robot determining the speed and direction in which the current frame has moved relative to the previous frame thus allowing the speed and direction of that point of reference to be calculated.

A traditional Mecanum wheel with the peripheral rollers held in place from the outside is presented in Figure 1. This design, although having a good load carrying capacity, has the disadvantage that, when encountering an inclined or uneven surface, the rim of the wheel can make contact with the surface, instead of the roller, therefore preventing the wheel from operating correctly (Figure 5.a). A simple alternative design, also proposed by Ilon, which alleviates the problem, consists in having the rollers split in two (or in three) and centrally mounted as shown in Figure 5.b. This design ensures that the rollers are always in contact with the work surface, thus allowing a better performance on uneven surfaces [10].

One disadvantage of the Mecanum design is the inefficient use of the kinetic energy supplied to the wheels by the motors. Due to the rotation of the exterior rollers, only a component of the force at the perimeter of the wheel is applied to the ground and the resulting force only partially contributes to the motion of the vehicle. [11] proposed two designs to improve the Mecanum wheel efficiency. The first design is the Mecanum wheel with lockable rollers illustrated in Figure 6. This design was conceived to overcome the losses of efficiency due to energy lost in a direction normal to that of travel through the peripheral rollers (they bleed off energy as they rotate), when the vehicle is travelling in a straight line (forward/backward). Simple actuators are used to rotate the brake activation disc, therefore to lock and unlock the roller, when the vehicle is moving. When driving in longitudinal motion, the peripheral rollers will be locked and they will act as a heavy thread, but when driving in sideways motion the rollers will be unlocked. This design is effective in reducing any lost forces in the forward direction to zero, but does not improve the losses in any other directions.

The second design is Mecanum wheel with rotatable rollers illustrated in Figure 7. Compared to the first design, this one is more effective, but mechanically more complex. The peripheral rollers are split and centrally mounted on an axle which can be pivoted through 135°. This allows the rollers to be adjusted from a straight position (in which they are locked so the rollers cannot rotate on their axles), thus effectively forming an almost normal treaded tire, to an angle of 45° in which case they act as a traditional Mecanum wheel, or to an angle of 135°, making diagonal travel easier as it overcomes the resistance given by the traditionally immobile wheels. The angle of the rollers on each wheel is controlled through all the roller shafts, which are connected through a bevel gear system in such a way that a rotary actuator on one of the shafts controls all the other simultaneously. [3] proposed a new Mecanum wheel constructive solution in terms of its performance on various surfaces and concluded that the size of the peripheral rollers has a great effect upon this performance (Figure 8.a). The larger the rollers are, the greater the range of surface deviations can be overcome. Also, as the size of rollers increases, the slower they spin, resulting in lower friction losses in the driving of the wheel. In conclusion, when designing a new drive system for a vehicle, there exist a certain number of rollers that makes the ideal compromise between having a small number of large rollers per wheel, and having a large number of small rollers per wheel (Figure 8.b).

Educational field

Uranus (Figure 17) was the first mobile robot with Mecanum wheels, designed and constructed in Carnegie Melon University [28], [29]. It was built to provide a general purpose mobile base to support research in to indoor robot navigation. As a base, it provides full mobility, along with support for a variety of payloads, such as sensors and computers. It had not a suspension system, which is absolutely necessary if the ground is not completely flat.

Figure 17: Uranus omnidirectional mobile robot [28]

Other researchers, such as Braunl from University of South Australia have developed two different Mecanum wheel omnidirectional mobile robots, Omni-1 and Omni-2. Figure 18 shows the structure of Omni-1 and Omni-2. The first design, Omni-1 used the Mecanum wheel design with rims that only leave a small gap/clearance for the roller. The motor and wheel assembly tightly attached to robot's chassis. The Omni-1 can drive very well on hard and flat surface but it loses the omnidirectional capability on soft surface.

Conclusions

In this paper, an overview over the Mecanum wheels and their practical applications is presented. The main advantage of this type of wheel is represented by the omnidirectional property that it provides, allowing extreme maneuverability and mobility in congested environments. Also, some research that was carried out in Mecanum wheel mobile robots in order to improve the wheel design is described. The maneuverability provided by omnidirectional vehicles can be utilized and can be very important in both outdoors applications, such as search and rescue missions, military activities, planetary explorations and mine operations, long loads transportation, and indoor applications, like small goods transportation, powered robotic wheelchairs or shopping carts.

Acknowledgement

This paper was realized with the support of POSDRU CUANTUMDOC "DOCTORAL STUDIES FOR EUROPEAN PERFORMANCES IN RESEARCH AND INOVATION" ID79407 project, funded by the European Social Found and Romanian Government.

. Bibliography

[1] Ilon, B.E., 'Wheels for a course stable self propelling vehicle movable in any desired direction on the ground or some other base", US Patent and Trademarks office, Patent 3.876.255, 1975.

[2] [2] Song, J.B., Byun, K.S., "Design and Control of a Four-Wheeled Omnidirectional Mobile Robot with Steerable Omnidirectional Wheels", Journal of Robotic Systems, 21(4), 2004, pp. 193-208.

[3] [3] Doroftei, I., Stirbu, B., "Design, Modeling and Control of an Omni-directional Mobile Robot", Solid State Phenomena Vols. 166-167, 2010, pp 173-178, Trans Tech Publications, Switzerland. doi:10.4028/www.scientific.net/SSP.166-167.173.

[4] Dickerson, S.L., Lapin, B.D., „Control of an omni-directional robotic vehicle with Mecanum wheels", in National Teleystems Conference Proceedings, p. 323-328, March 26-27, Atlanta, USA, 1991.

[5] Borenstein, J., Everett, H.R., Feng, L., „Navigating Mobile Robots: Sensors and Techniques", A K Peters, Ltd, MA, USA, 1996.

[6] Doroftei, I., Grosu, V., Spinu, V., „Omnidirectional Mobile Robot – Design and Implementation", Bioinspiration and Robotics: Walking and climbing Robots, Book edited

by: Maki K. Habib, ISBN 978-3-902613-15-8, pp. 544, I-Tech, Vienna, Austria, EU, September 2007.

[7] Nagatani, K., Tachibana, S., Sofne, M., Tanaka, Y., „Improvement of odometry for omnidirectional vehicle using optical flow information", IEEE/RSJ International Conference on Intelligent Robots and Systems, 2000.

[8] Everett, H.R., „Sensors for Mobile Robots: Theory and Application", A K Peters, Ltd, MA, USA, 1995.

[9] Giachetti, A., Campani, M., Torre, V., „The use of optical flow for road navigation", IEEE Transactions on Robotics and Automation, Vol.14, No.1, pp. 34-48, 1998.

[10] Doroftei, I., Grosu, V., Spinu, V., "Design aspects of omnidirectional wheels and mobile platforms", Proceedings of he 4th International Conference on Robotics, Buletin of the Transivania University of Brasov, Vol. 15(50), Series A, Special Issue, ISSN 1223-9631, 2008.

[11] Diegel, O., Badve, A., Bright, G., Potgieter, J., Tlale, S., „Improved Mecanum Wheel Design for Omni-directional Robots", Proc. Australasian Conference on Robotics and Automation, Auckland, November 27-29, pp. 117-121, 2002.

[12] Ramirez-Serrano, A., Kuzyk, R., „Modified Mecanum Wheels for Traversing Rough Terrain", 6 the International Conference on Autonomic and Autonomous Systems, IEEE Computer Society, 2010, doi: 10.1109/ICAS.2010.35

[13] Lippit, T.C., Jones, W.C., „OmniBot Mobile Base", KSC Re-search and Technology Report, NASA, USA, 1998.

[14]http://rtreport.ksc.nasa.gov/techreports/98report/09-ar/ar06.html

[15] http://www.robotics.com/robomenu/odv.html

[16] http://www.architectureandvision.com

[17] Ransom, S., Krömer, O., Lückemeier, M.., "Planetary rovers with Mecanum wheels", 16th ISTVS Intl Conf, Nov 25-28, 2008, Torino, Italy.

[18] http://www.lomag-man.org/nouveautes/20vehicules/ airtrax_omnidirextional.pdf

[19] Tuck-Voon How, „Development of an AntiCollision and Navigation System for Powered Wheelchairs", 2010

[20] Schulze, L., Behling, S., Buhrs, S., „Development of a Micro Drive-Under Tractor - Research and Application", Proceedings of the International MultiConference of Engineers and Computer Scientists, Vol. II, March 16-18, 2011, Hong-Kong.

[21] Furmans, K., Schleyer, M., Schönung, F., "A Case for Material Handling Systems, Specialized on Handling Small Quantities", in Proc. of 10th International Material Handling Research Colloquium, Dortmund, Germany, 2008, pp. 185-197.

[22] Schulze, L., Behling, S., Buhrs, S., “Automated Guided Vehicle Systems: a Driver for Increased Business Performance”, in Proc. of International Multi Conference of Engineers and Computer Scientists 2008, Hong Kong, pp. 1275-1280.

[23] Brandt, A., Iwarsson, S., Stahle, A., "Older people's use of powered wheelchairs for activity and participation", J. Rehabil. Med., no. 36, pp. 70-77, 2004.

[24] Evans, R., "The effect of electrically powered indoor/outdoor wheelchairs on occupation: a study of users' views", British Journal of Occupational Therapy, vol. 63, no. 11, pp. 547-553, 2000.

[25] Hardy, P., "Powered wheelchair mobility: An occupational performance evaluation perspective", Australian Occupational Therapy Journal, no. 51, pp. 34-42, 2004.

[26] Hoyer, H., Borgolte, U., Jochheim, A., "The OMNI-Wheelchair - State of the art," in Center on Diabilities, Technology and Persons with Disabilities Conference, Northridge, CA, 1999.

[27] Po-Er Hsu, Yeh-Liang Hsu, Jun-Ming Lu, Jerry, J.-H. Tsai, Yi-Shin Chen, „iRW: An Intelligent Robotic Wheelchair Integrated with Advanced Robotic and Telehealth Solutions”, in „1st Asia Pacific eCare and TeleCare Congress,” June 16-19, 2011, Hong Kong, China.

[28] Muir, P. F., Neuman, C.P., „Kinematic Modeling for Feedback Control of an Omnidirectional Wheeled Mobile Robot”, IEEE Intenational Conference on Robotics and Automation, 1987.

[29] Muir, P. F., Neuman, C. P., „Kinematic Modeling of Wheeled Mobile Robots”, Journal of Robotic Systems, No. 4(2), pp. 281-340, 1987.

[30] Braunl, T., „Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems”, First Edition. Springer-Verlag, Berlin, 2003.

[31] http://robotics.ee.uwa.edu./eyebot/omni.html

[32] Goller, M., Kerscher, T., Ziegenmeyer, M., Ronnau, A., Zollner, J. M., Dillmann, R., „Haptic

Control for the Interactive Behavior Operated shopping Trolley InBOT”, in New Frontiers in Human-Robot Interaction symposium at the Artificial Intelligence and Simulation of Behaviour (AISB) 2009 Convention, 2009.

[33] Goller, M., Kerscher, T., Zollner, J.M., Dillmann, R., Devy, M., Germa, T., Lerasle, F., „Setup and Control Architecture for an Interactive Shopping Cart in Human All Day Environments”, In Proceeding of the Int. Conf. on Advanced Robotics (ICAR'09), pp. 1-6, 2009.

3.0 PROJECT METHODOLOGY

3.1 DEFINE SPECIFIC RESEARCH AND METHOD USED

The many procedures and research methodologies that are often employed are examined in this chapter. This phrase is used by information system researchers. The technique used in this study, along with the research strategy and conclusions, are recognized and described. The chapter opens with a general overview of research. The investigation's approach and research techniques used in information systems are then thoroughly detailed. A lot of work has gone into defining and separating different research approaches and procedures. In our literature review for this study, we discovered that many researchers were using research methods and Robotic Arm research techniques interchangeably. In order to address research approaches independently, there are sections on research methodology.A section that compares and contrasts the two is included after the section on research methodology. The two main forms of research methodology—qualitative research methodology and quantitative research methodology—as well as the many varieties of research technique are then described. The qualitative research approach is given. This study's research methodology is examined, along with the reasoning for the particular research strategy's selection. The research methodology, or the actual process of gathering and analyzing data, is next covered. A justification for the particular research methodology chosen is also given.The case study research technique is used with the grounded theory research strategy for document analysis of archive material downloaded from the Internet. Descriptive techniques were used to assess the advantages and disadvantages of cloud computing with mobile phones in developing nations.

Mecanum wheel

Figure 1:mecanum wheel

Designed in 1975 in Sweden by Bengt Ilon, the Mecanum wheel is a type of non-conventional wheel that has attached rollers around its circumference, aligned 45° to the axle

of the wheel. This wheel configuration, as shown in Figure 1 allows the robot to move in 2-dimensional plane without the need of conventional steering mechanism [2]. On top of that, robots using this wheel configuration are able to strafe sideways and diagonally without changing the wheel direction itself [4]. Figure 2 shows the allowed movements when these wheels are used:

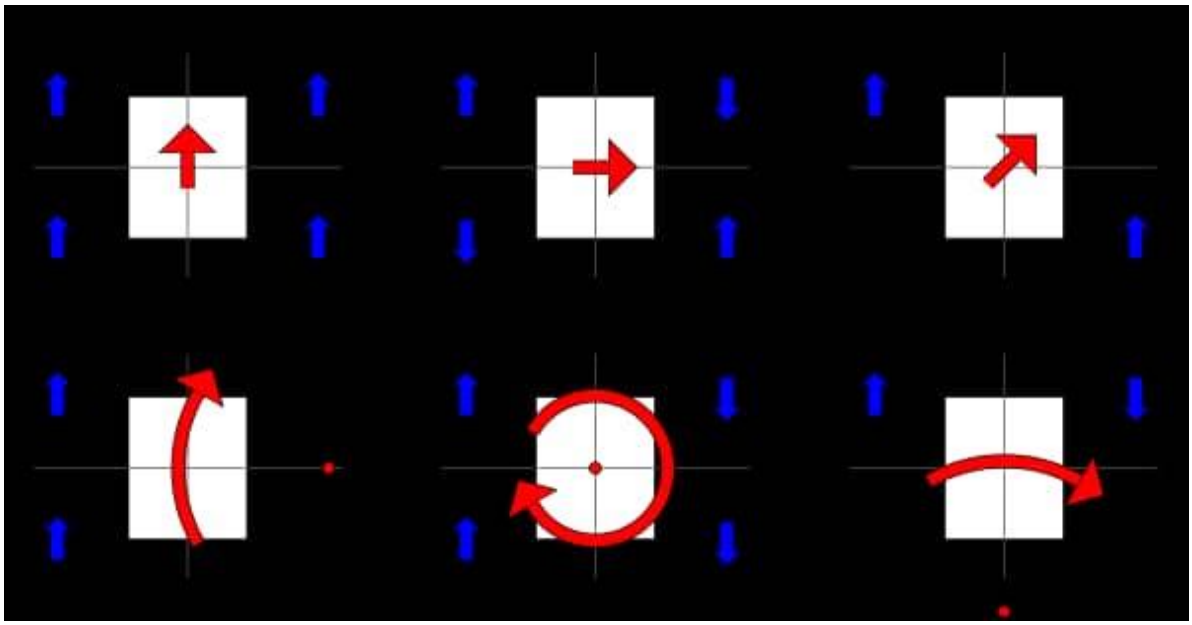


Figure 2:movement of mecanum wheels

In order to achieve these movements, the Mecanum wheels are attached to its independent drivetrain i.e. Brushless DC motors. Each motor will drive a wheel and the total force exerted by the wheels will determine the movement of the whole robot. The resultant force vector when each wheel is in motion. The mathematical equation for voltage output of each motor when it is controlled purely by supply voltages for each axis of control.

$$V_{m1} = V_x + V_y + V_z$$

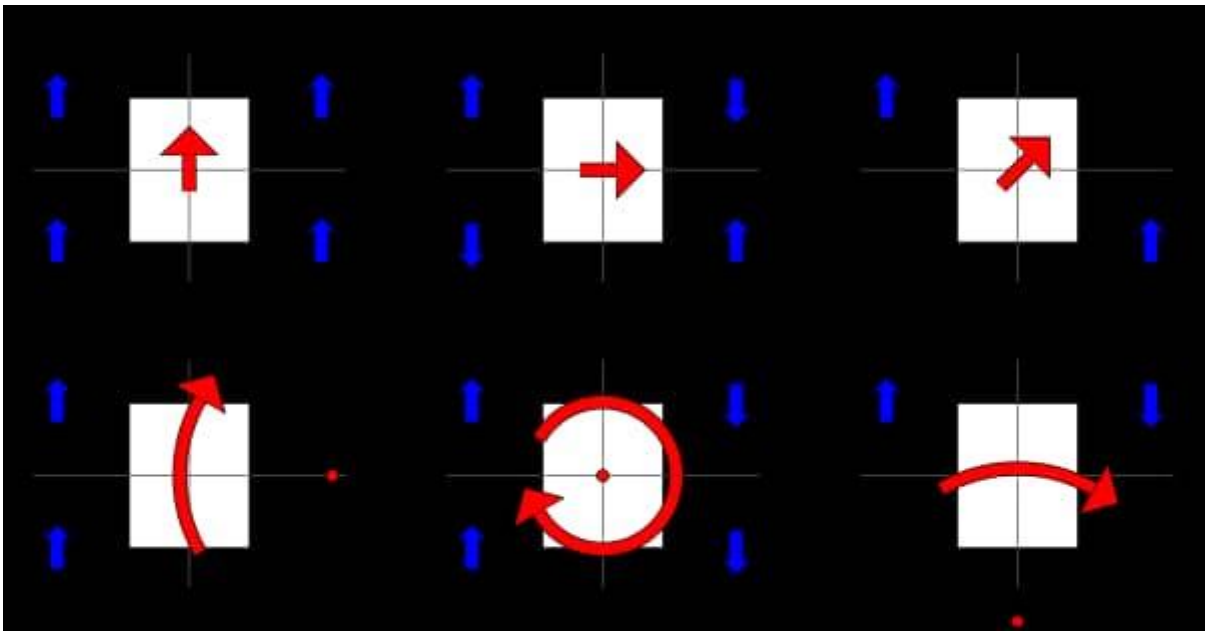
$$V_{m2} = -V_x + V_y - V_z$$

$$V_{m3} = V_x + V_y - V_z$$

$$V_{m4} = -V_x + V_y + V_z$$

In the above equation, Vx, Vy and Vz are the voltage applied to the motor from the controller, where Vx, is for x-axis control, Vy is for y-axis control and Vz is for rotational control. When the receiver receives the signal, the micro controller will analyze the signals and assign the values accordingly and then it is manipulated to ensure that the output is not exceeding the maximum limit. As each wheel is independently-controlled, a specific control system needs to be used as conventional control system implemented in earlier robots cannot be applied in this drive system.

2.2 Mecanum drive control system



As Mecanum wheel locomotion is different to conventional wheel locomotion such as normal steer mechanism which used servos to steer the front wheel and skid steer locomotion using differential method, a new control circuit needs to be applied to control each wheel, allowing it to perform the maneuvers smoothly.

There are several ways to control a Mecanum-wheeled drive system and one of it is by using a microcontroller [2]. In the paper by Cooney (2004), the microcontroller is used to receive, analyze the input and maneuver accordingly. The input of the microcontroller comes from two optical mouse sensors and based from the input analysis, the microcontroller sends out 8 different output signals, which are the Pulse-width modulation signal for motor speed control and the direction of motor rotation signal. As for this project, I will be using a radio control as input to the system instead of pre-program the route into the microprocessor. The microprocessor will mix the radio control receiver's signals and sends out the outputs to the DC motor driver circuit. Radio control-based input system for Mecanum drive has been studied and applied in several works [5][6]. From the studies, the radio control unit can be interfaced with the microcontroller to control the robot.

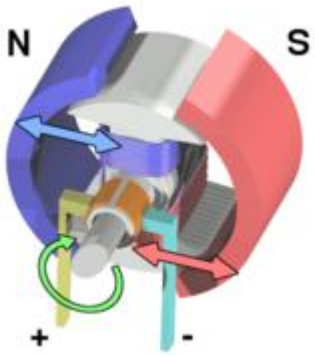
Motor Drive

Another consideration in developing the robot is to select the motor drive for the wheels. For a small robot, DC motor drive is favorable due to small size compared to AC motors. For DC motor, it can be separated into 2 types, which are brushed, and brushless.

DC Motor

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

DC motors were the first form of motors widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor, a lightweight brushed motor used for portable power tools and appliances can operate on direct current and alternating current. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.



Workings of a brushed electric motor with a two-pole rotor (armature) and permanent magnet stator. "N" and "S" designate polarities on the inside axis faces of the magnets; the outside faces have opposite polarities. The + and - signs show where the DC current is applied to the commutator which supplies current to the armature coils.

Arduino uno R3

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010.[2][3] The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It is similar to the Arduino Nano and Leonardo.[5][6] The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark a major redesign of the Arduino hardware and software.[7] The Uno board was the successor of the Duemilanove release and was the 9th version in a series of USB-based Arduino boards.[8] Version 1.0 of the Arduino IDE for the Arduino Uno board has now evolved to newer releases.[4] The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.[3]

While the Uno communicates using the original STK500 protocol,[1] it differs from all preceding boards in that it does not use a FTDI USB-to-UART serial chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.[9]

The Arduino project started at the Interaction Design Institute Ivrea (IDII) in Ivrea, Italy. At that time, the students used a BASIC Stamp microcontroller, at a cost that was a considerable expense for many students. In 2003, Hernando Barragán created the development platform Wiring as a Master's thesis project at IDII, under the supervision of Massimo Banzi and Casey Reas, who are known for work on the Processing language. The project goal was to create simple, low-cost tools for creating digital projects by non-engineers. The Wiring platform consisted of a printed circuit board (PCB) with an ATmega168 microcontroller, an IDE based on Processing, and library functions to easily program the microcontroller.[10] In 2003, Massimo Banzi, with David Mellis, another IDII student, and David Cuartielles, added support for the cheaper ATmega8 microcontroller to Wiring. But instead of continuing the work on Wiring, they forked the project and renamed it Arduino. Early arduino boards used the FTDI USB-to-UART serial chip and an ATmega168.[10] The Uno differed from all preceding boards by featuring the ATmega328P microcontroller and an ATmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Technical specifications

- Microcontroller:

IC: Microchip ATmega328P[9]

Clock Speed: 16 MHz on Uno board, though IC is capable of 20MHz maximum at 5 Volts

Flash Memory: 32 KB, of which 0.5 KB used by the bootloader

SRAM: 2 KB

EEPROM: 1 KB

UART peripherals: 1

I2C peripherals: 1

SPI peripherals: 1

Operating Voltage: 5 Volts

- Digital I/O Pins: 14
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)[11]
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Length: 68.6 mm
- Width: 53.4 mm

- Weight: 25 g
- ICSP Header: Yes
- Power Sources:

USB connector. USB bus has a voltage range of 4.75 to 5.25 volts. The official Uno boards have a USB-B connector, but 3rd party Uno boards may have a miniUSB or microUSB connector.

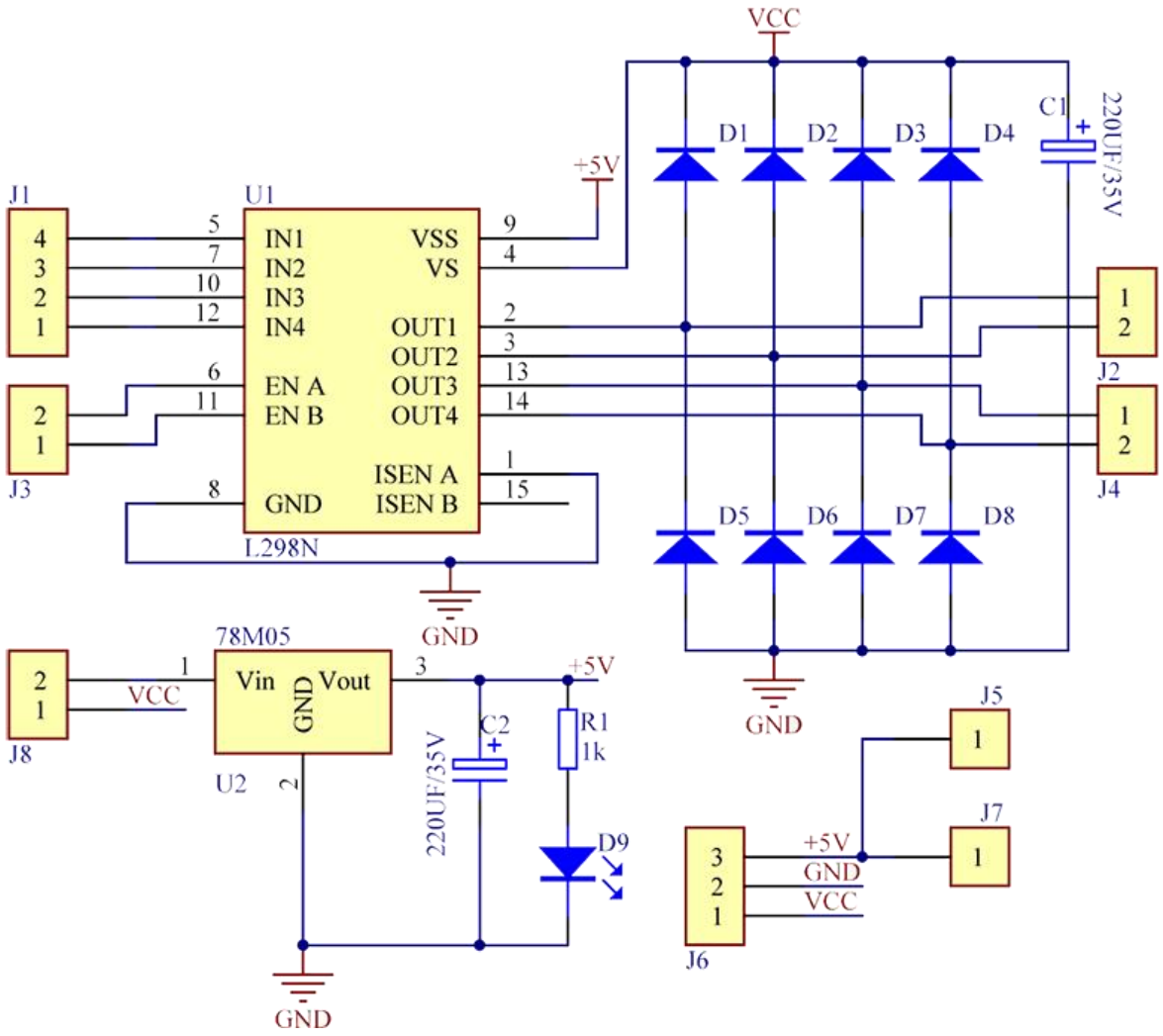
5.5mm/2.1mm barrel jack connector. Official Uno boards support 6 to 20 volts, though 7 to 12 volts is recommended. The maximum voltage for 3rd party Uno boards varies between board manufactures because various voltage regulators are used, each having a different maximum input rating. Power into this connector is routed through a series diode before connecting to VIN to protect against accidental reverse voltage situations.

VIN pin on shield header. It has a similar voltage range of the barrel jack. Since this pin doesn't have reverse voltage protection, power can be injected or pulled from this pin. When supplying power into VIN pin, an external series diode is required in case barrel jack is used. When board is powered by barrel jack, power can be pulled out of this pin.

Driver motor L298n

The L298N is an integrated monolithic circuit in a 15- lead Multiwatt and PowerSO20 packages. It is a high voltage , high current dual full-bridge driver de-signed to accept standard TTL logic level sand drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the in-put signals .The emitters of the lower transistors of each bridge are connected together rand the corresponding external terminal can be used for the connection of an external sensing resistor. An additional Supply input is provided so that the logic works at a lower voltage.

Its schematic diagram is as shown in figure (a):



a) Schematic diagram for motor drive module

Bluetooth module HC-05

HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard, and many more consumer applications.

It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.

It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.

It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

HC-05 bluetooth module pin diagram

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

1. Key/EN: It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

1. Data mode: Exchange of data between devices.
2. Command mode: It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.

2. VCC: Connect 5 V or 3.3 V to this Pin.

3. GND: Ground Pin of module.

4. TXD: Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)

5. RXD: Receive data serially (received data will be transmitted wirelessly by Bluetooth module).

6. State: It tells whether module is connected or not.

HC-05 module Information

HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.

This module works on 3.3V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator.

As HC-05 Bluetooth module has 3.3V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

The data transfer rate of HC-05 module can vary up to 1Mbps is in the range of 10 meters.

Specification of HC-05 Bluetooth Module

- Bluetooth version: 2.0 + EDR (Enhanced Data Rate)
- Frequency: 2.4 GHz ISM band
- Modulation: GFSK (Gaussian Frequency Shift Keying)
- Transmit power: Class 2 (up to 4 dBm)
- Sensitivity: -80 dBm typical
- Range: approximately 10 meters (or 33 feet) in open air
- Profiles supported: SPP (Serial Port Profile), HID (Human Interface Device) and others
- Operating voltage: 3.3V to 5V DC
- Operating current: less than 50mA
- Standby current: less than 2.5mA
- Sleep current: less than 1mA
- Interface: UART (Universal Asynchronous Receiver/Transmitter)
- Baud rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, and 460800
- Operating temperature: -20°C to 75°C (-4°F to 167°F)

Jumper wire

A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

Battery rechargeable

Specifications

- SKU: 00664R
- Weight(grams): 200
- Dimension: 6 cm (Length) x 4 cm (Width) x 2 cm (Height)
- Type: 6800 mAh
- Voltage: 3.7V
- Technology: Lithium-Ion
- Size: 18650

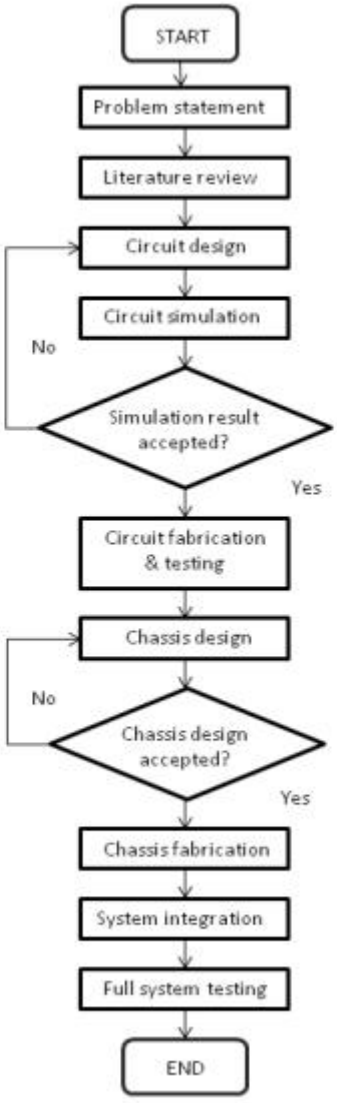
https://en.wikipedia.org/wiki/DC_motor

https://en.wikipedia.org/wiki/Arduino_Uno#cite_ref-Makerspace_1-0

http://wiki.sunfounder.cc/index.php?title=Motor_Driver_Module-L298N

https://www.electronicwings.com/sensors-modules/bluetooth-module-hc-05-

https://en.wikipedia.org/wiki/Jump_wire



Flowchart

4 : PROJECT IMPLEMENTATION

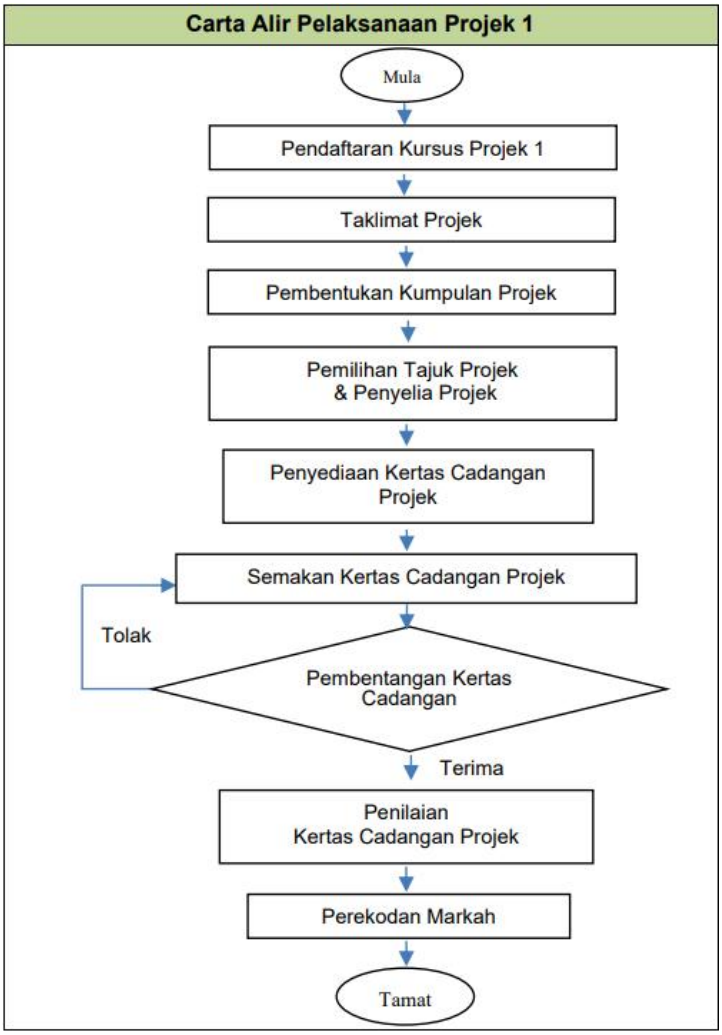
4.1 Project Implementation Flow Chart

(a) In order to make this project a success, we must follow procedures and processes so that it runs smoothly and successfully. However, in order to make our project successful there are some defects that occur during the process of completing the project and we will try our best to fix the defects that occur.

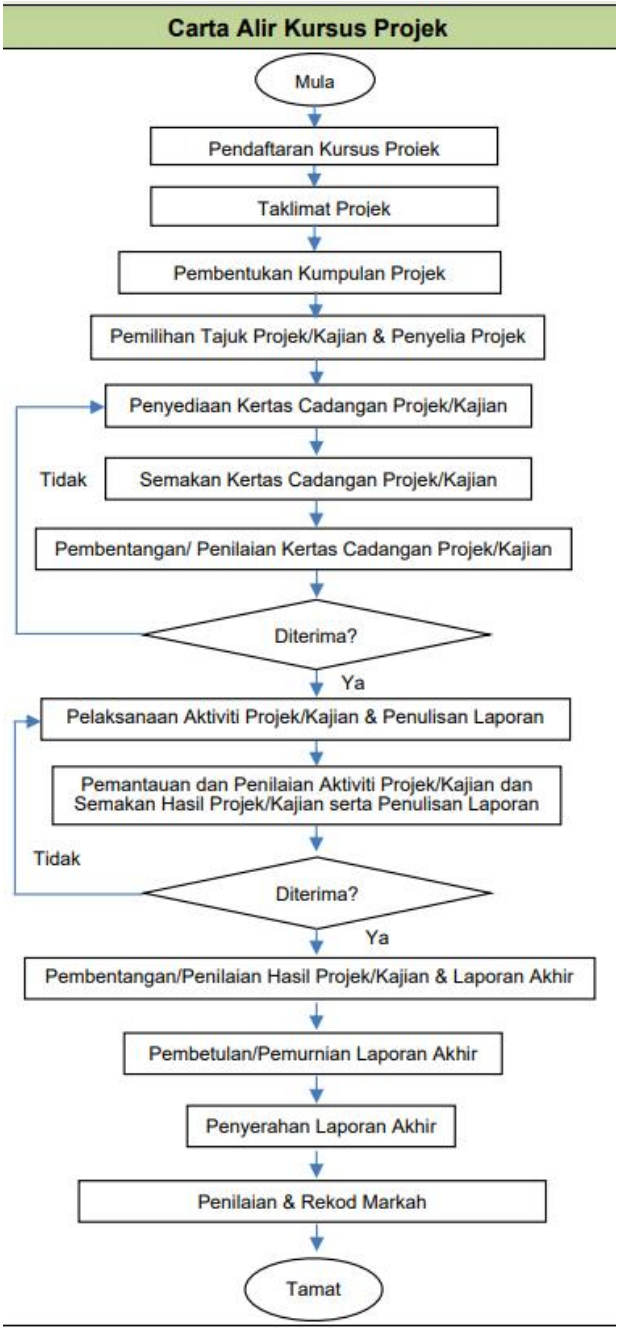
(I) (b) Project courses conducted over a period of two (2) semesters

(II) Flow chart of project 1:

(III)



(ii) flow chart of project 2 :



4.1.1 project course registration

Pada pelajar semester 4 dan 5 hendaklah mendaftar kursus ini yang ditetapkan oleh politeknik.

4.1.2 Briefing

a) The department's student project coordinator/project course coordinator has delivered or briefed the students related to the project during the first week of lectures. This information is given to ensure that all parties involved can be given clear and coherent information on their respective duties and responsibilities towards the production of quality, innovative and commercial student projects. The content of the proposed briefing is as follows:

b) Course Outline (CLO, PLO, AST).

c) Project implementation activities according to the project implementation activity planning calendar/calendar.

d) Types of projects based on the needs of each program.

e) Themes, titles and project ideas in the field.

f) Student distribution according to the project supervisor.

g) Project title registration approved by the Project Supervisor or Project Course Coordinator..

h) Writing proposal papers and Gant charts

i) Assessment of presentations and paper proposals.

j) Student log book.

k) Implementation of student projects.

l) Distribution of marks based on the curriculum document of the study program.

m) Reporting, presentation and Final Project Report.

n) Project financing.

o) Ownership of the project: and

p) The Polytechnic student project implementation guidebook (Diploma Program) that is currently in force and must be adhered to.

4.1.3 Formation of the project group

Projects/Studies can be carried out individually or in groups (not exceeding four (4) students) according to the type of project to be carried out. For group projects, the scope of tasks for each group member should be clearly stated and detailed. Proposal papers and Final Project Reports can be produced by group but the writing must follow the scope of the assignment. However, the formation of project groups can be added or changed according to the respective programs.

4.1.4 Project/Study Title Selection

Students need to complete the registration form for the selection of project/study title and submit the form to the project supervisor no later than the 3rd week of the lecture session. Departmental student project coordinators/project course coordinators/project supervisors are encouraged to set themes to help students generate ideas and determine the scope of the course according to their respective study programs. Project ideas come from students themselves, supervisors, local communities or industry collaborations.

4.1.5 Preparation of project/study proposal papers

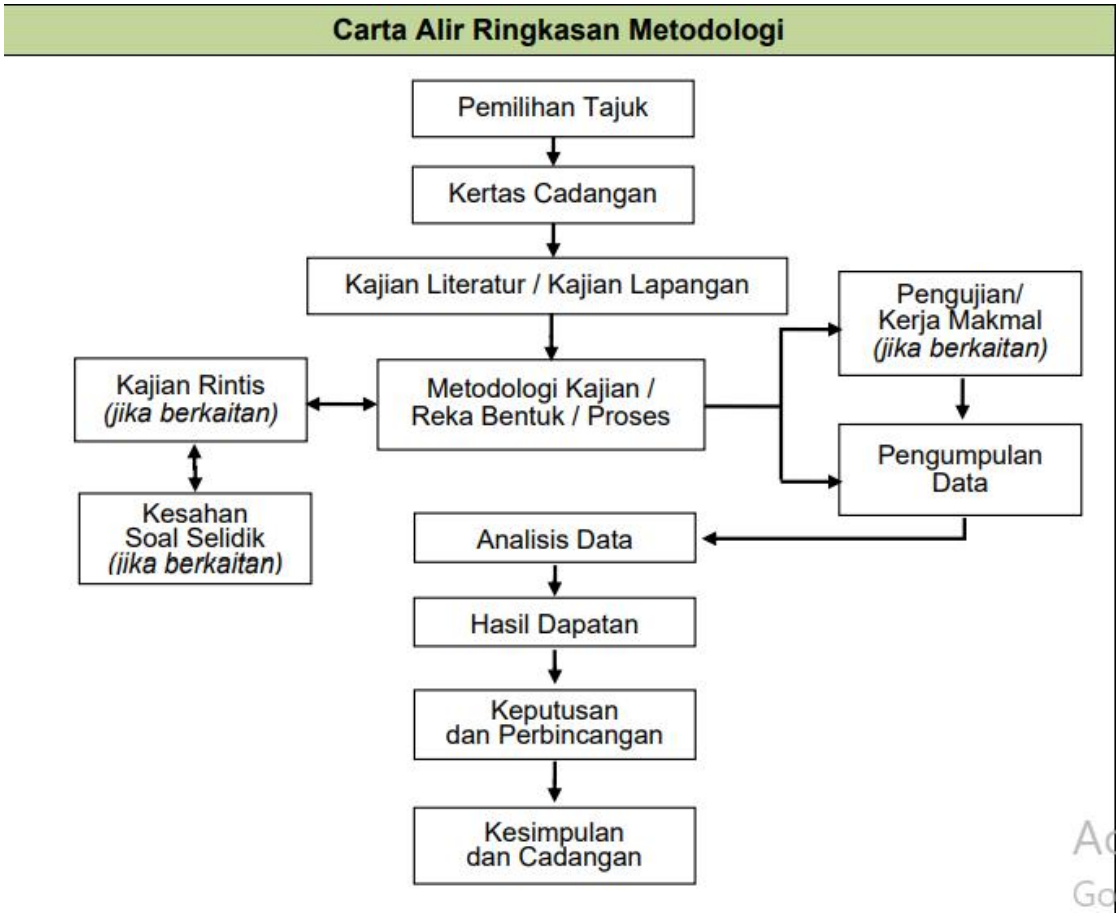
The preparation of a project/study proposal paper depends on the requirements of the course or study program. Proposal paper writing can be done in Bahasa Malaysia or English according to the student's project management at the respective polytechnic.

4.1.6 Review of Project/Study Proposal Papers

The project supervisor should review the Project Proposal Paper prepared by the student to determine the appropriateness of the project/study. If the proposal paper fails to meet the specified features/criteria and non-conformity, the student should make corrections to the proposal paper with the guidance of the project supervisor..

4.1.7 Implementation of Project Activities/Research and Evaluation

Approval to continue the project/study is dependent on the evaluation panel that makes an assessment of the student's project/study based on criteria and scope, Students need to carry out the planned project/study activities and produce a Final Report of the project/study. Project/study implementation must follow the project course implementation activity planning schedule and student project/study implementation gantt chart.



4.1.8 Presentation/Project Evaluation/Final study and Final Report

The student must present the results of the project to the evaluation panel for the purpose of evaluation and correcting the mistakes that have been made by the student to complete the project/study. Students must make corrections, resubmit the Final Report of the project and make a re-presentation

4.1.9Final Report Corrections/Refinements

Based on the recommendations of the evaluation panel, students are required to make appropriate corrections with the guidance of the Project Supervisor and send back the refined Project Final Report.

4.1.10 Submission of Project Results and Final Report

Students are required to submit:

(a) The bound Project Final Report that has been verified by the Project Supervisor and Project Course Coordinator in the form of a digital copy (PDF); and

(b) Declaration of Authenticity and Ownership Rights Form (refer to APPENDIX I: DECLARATION OF AUTHENTICITY AND OWNERSHIP RIGHTS) to the Project Supervisor/Project Course Coordinator for record keeping.

5: PROJECT INTELLECTUAL PROPERTY

Intellectual Property is an exclusive right granted by law for a certain period of time to the creator of a work to control the use of their work. Copyright protection in Malaysia is based on the Copyright Act 1987. Therefore, the Malaysian Intellectual Property Corporation (MyIPO) which is a body established by the government has been responsible for managing the protection of various forms of intellectual property such as trademarks, copyrights (copyright), patents and industrial designs, geographical indications and integrated circuit layout designs (IC layout designs)

5.1 Intellectual Property Regulations and Acts

(a) utility patents and innovations as defined in the Patents Act 1983;

(b) copyright and protection granted based on the Copyright Act 1987;

(c) trademarks and their protection given based on the Trademarks Act 1976 and under common law for passing off;

(d) industrial designs and their protection granted under the Industrial Designs Act 1996;

(e) protection of confidential information and business/trade secrets;

(f) geographical indications given based on the Geographical Indications Act 2000; and

(g) integrated circuit layout design provided in the Integrated Circuit Layout Design Act 2000.

5.2 Intellectual property

Intellectual property is all types of things that are protected under the acts and laws stated in point 5.1. It consists of human thoughts, such as ideas, inventions, designs, sketches, drawings, writing and music. Its definition includes computer programs, integrated circuit layout design and databases

5.3 Copyright

(a) The Copyright Act 1987 gives protection to the creator of the work to control the use of the work produced. Based on the breakdown of work categories such as literature, art, music, film, sound, broadcasting and publication;

(b) Students can register copyrights as exclusive rights protection for the products they create;

(c) MyIPO suggests that the protection of project work can be divided into two categories, namely (i) Literature (protecting manuals and writings about student products) and (ii) Art (protecting graphics found in the produced product). However, it depends on the suitability of the work produced; and

(d) The term of protection is perpetual, does not need to be renewed, but can expire after 50 years of the owner's death.

MYGTC 2022

CERTIFICATE

OF APPRECIATION

THE FOLLOWING AWARD IS GIVEN TO

Muhammad Alif Hakim Mohd Rahim

for participating in the Malaysian Youth Green Technology Challenge (MyGTC) 2022
held on 3rd October 2022 to 31st January 2023 | Universiti Putra Malaysia

Assoc. Prof. Gs. Ts.Dr. Sharifah Norkhadijah Syed Ismail
Project Leader

MYGTC 2022

CERTIFICATE

OF APPRECIATION

THE FOLLOWING AWARD IS GIVEN TO

Muhd Syazwan Wan Aziz

for participating in the Malaysian Youth Green Technology Challenge (MyGTC) 2022
held on 3rd October 2022 to 31st January 2023 | Universiti Putra Malaysia

Assoc. Prof. Gs. Ts.Dr. Sharifah Norkhadijah Syed Ismail
Project Leader

MYGTC 2022

CERTIFICATE

OF APPRECIATION

THE FOLLOWING AWARD IS GIVEN TO

Muhammad Amir Razali

for participating in the Malaysian Youth Green Technology Challenge (MyGTC) 2022
held on 3rd October 2022 to 31st January 2023 | Universiti Putra Malaysia

Assoc. Prof. Gs. Ts.Dr. Sharifah Norkhadijah Syed Ismail
Project Leader

MYGTC 2022

CERTIFICATE

OF APPRECIATION

THE FOLLOWING AWARD IS GIVEN TO

Wan Aiman Zulkarnain

for participating in the Malaysian Youth Green Technology Challenge (MyGTC) 2022
held on 3rd October 2022 to 31st January 2023 | Universiti Putra Malaysia

Assoc. Prof. Gs. Ts.Dr. Sharifah Norkhadijah Syed Ismail
Project Leader

Ketua Kampung,
Kampung Seri Jugra,
Lot 264, Kampung Khatong,
42700 Banting Selangor.

En Zulkarnain Bin Jamak,
Pensyarah Jabatan Kejuruteraan Mekanikal,
Politeknik Banting Selangor,
Persiaran Ilmu,
Jalan Sultan Abdul Samad,
42700 Banting Selangor.

25 April 2023

Tuan,

PENGESAHAN PENGIKTIRAFAN WHEELIE BASE CONTROL

Merujuk perkara di atas, kami pihak Ketua Kg dengan sukacitanya telah meneliti wheelie base control yang dibuat oleh pelajar Jabatan Kejuruteraan Mekanikal Politeknik Banting Selangor (JKM PBS) dan mendapati produk ini dapat meningkatkan kreativiti dikalangan anak muda dalam menginovasikan sesuatu produk.

2. Projek kami dapat dijadikan mainan dan menjadi pendedahan kepada anak-anak tentang teknologi terkini yang serba canggih serta dapat menarik minat anak-anak muda dalam menceburi bidang kejuruteraan mekanikal.

3. Pihak kami berharap produk inovasi ini dapat diperkembangkan dan dimanfaatkan kepada anak-anak untuk menyuntik minat dalam bidang ini.

Sekian, Terima Kasih.

.....

Nama: KHUAN BIN NGATINI @ HAJI SIDEK
Jawatan: KETUA KAMPUNG MERANGKAP PENGERUSI MPKK KAMPUNG SERI JUGRA DAERAH KUALA LANGAT

wheelie

by MUHAMMAD ALIF HAKIM MOHD RAHIM

Submission date: 01-Jun-2023 12:11PM (UTC+0800)
Submission ID: 2106481452
File name: report_projek_2023_3.docx (2.5M)
Word count: 8797
Character count: 47875

wheelie

ORIGINALITY REPORT

32%	32%	28%	40%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.incdmtm.ro Internet Source	2%
2	en.wikipedia.org Internet Source	1%
3	pdxscholar.library.pdx.edu Internet Source	1%
4	utpedia.utp.edu.my Internet Source	1%
5	www.mypolycc.edu.my Internet Source	1%
6	www.nielit.gov.in Internet Source	1%
7	www.tj.kyushu-u.ac.jp Internet Source	1%
8	zombiedoc.com Internet Source	1%
9	www.coursehero.com Internet Source	1%

10	wiki.sunfounder.cc Internet Source	1%
11	csjournals.com Internet Source	1%
12	tmi.tolani.edu Internet Source	1%
13	Submitted to Universiti Teknologi MARA Student Paper	1%
14	www.irjmets.com Internet Source	1%
15	docplayer.net Internet Source	1%
16	Submitted to Jabatan Pendidikan Politeknik Dan Kolej Komuniti Student Paper	1%
17	Submitted to RMIT University Student Paper	1%
18	umpir.ump.edu.my Internet Source	<1%
19	Submitted to Institute of Technology Carlow Student Paper	<1%
20	Submitted to Liverpool John Moores University Student Paper	<1%

21	Submitted to East Durham College Student Paper	<1%
22	dspace.daffodilvarsity.edu.bd:8080 Internet Source	<1%
23	garuda.ristekbrin.go.id Internet Source	<1%
24	Submitted to Universiteit van Amsterdam Student Paper	<1%
25	archive.org Internet Source	<1%
26	autoscuolemontagna.it Internet Source	<1%
27	courses.jamesmpoe.com Internet Source	<1%
28	www.inetnetworks.co.uk Internet Source	<1%
29	hdl.handle.net Internet Source	<1%
30	blogpintarolahragapendidikan.blogspot.com Internet Source	<1%
31	"Advances in Service and Industrial Robotics", Springer Science and Business Media LLC, 2019 Publication	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		