

# Line follower robot

[Science](#), [Computer Science](#)



UNIVERSITY OF BIRMINGHAM| EE2G - Design Report| THE GREAT EGG RACE| |  
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Conclusion28 References29 Appendix The Group Contract As a group, EGM  
had one target, to bring life to ICKI. This would not happen but with  
cooperation andhard work. By signing this contract you declare: \* EGM will  
do the tasks they are responsible for by the internal deadline decided. \* If  
EGM had any problems fulfilling any of their responsibilities they should  
inform the group leader in advance. EGM should back up all their group  
mates in unexpected and hard situations. \* EGM should trust their group

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mates for their capability of doing their own responsibilities however this does not mean that they cannot say their opinion and ideas. \* As the work break down has been decided when the entire group have been together, EGM is not allowed to complain about the inconsistency in the work division among the members of the group. \* In any case when all the group members cannot get to agree on one subject they will have to count votes.

If they tie they will have to ask a person's opinion every group member trusts. (Or they can flip a coin alternatively. ) \* If EGM wants to change any of the plans, they should discuss it with the rest of the group first. They are not allowed to accept doing something and do it in their own way without a group agreement. \* EGM is responsible for attending all the group meetings unless they have a convincing reason not doing so. If any of the group members disobeys any of the statements above, the rest of the group has the right to reduce their mark upon agreement.

Delaram SharifiZhanar Samayeva Hedieh Ekhlasi Xun Liu Introduction The purpose of this initial report is to survey the created plan made in order to accomplish the given Robot Project. This project is given to entire second year and the purpose of the project is to design and construct an autonomous robot that should follow the dark line track on a light background. First there is an overview on the line follower robots in literature review , The aims, objectives and requirements will follow the review.

### Literature Review

The line-following robots are classified under the “ Mobile Robots”. Mobile Robots are the robots which do not have a fixed base; they can move around and do not physically stand at one location. These kinds of robots are fairly

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important as it is stated in this part of the article from Wikipedia's Mobile robot is stated below: " Mobile robots are the focus of a great deal of current research and almost every major university has one or more labs that focus on mobile robot research. Mobile robots are also found in industry, military and security environments.

They also appear as consumer products, for entertainment or to perform certain tasks like vacuum, gardening and some other common household tasks. " History of mobile robots: The first mobile robots were built during the World War II with the main purpose of producing flying bombs and radars. The next generations would follow a light source, determine if there are any obstacles and plug in themselves when their battery was low and according to the needs they would have different functions and made huge improvements in the progress so that they cover a very wide range of features.

Line-following robots which are the main subject of this project are classified as " Land or Home Wheeled" robots. It is necessary to be said that the technology is far more advanced now that the robots with human like or animal like legs to provide mobility rather than legs exist. The technology has gone as far as making intelligent human-like robot (Androids), with a variety of capabilities such as speaking, voice recognition, face recognition, human like movements, dancing and singing.

The purposes behind these projects are coming from a variety of backgrounds as well such as: Household robot which can undertake any of a household maid's duties and sciencefiction movie productions. The pioneer countries in Android are Japan, Korea, the US, the UK and Iran. The <https://assignbuster.com/line-follower-robot/>

information above are to show how advance the technology has gone in mobile robots but since the aims set for this project require very much lower level of understanding the mobile robots, this subject will not be discussed further. The history of the line-following robots:

The designs of the first line-follower robot in 1960 was basically built for the purpose of getting controlled from earth while it is on the moon using a camera on it for processing images and video which has been unsuccessful. At 1970 the robot ended up following a high contrast white line under controlled lighting conditions at a speed of about 0.8 mph which is pretty different to this robot projectsince we have more advanced programming equipment and processors, the robot of ours uses sensors rather than the video cameras to use less process. The main aim is thoroughly different too.

The fist line-following robot was followed by more commercial used robots for which could do vacuuming and cleaning the floor. They used sensors to get the objects out of their way which is the method in which this project's robot will determine its track, using sensors. Ongoing a most advanced projects on line-following robots or line-following based robots: The most advanced of the line followers according to the Wikipedia, DARPA website, Kiva systems and spec -minder website are : “ DARPA Urban Grand Challenge, with six vehicles autonomously completing a complex course involving manned vehicles and obstacles. “ Kiva Systems clever robots proliferate in distribution operations; these smart shelving units sort themselves according to the popularity of their contents. The Tug becomes a popular means for hospitals to move large cabinets of stock from place to place. ” “ The Speci-Minder with Motivity begins carrying blood and other

patient samples from nurses' stations to various labs. “ “ Seekur, the first widely available, non-military outdoor service robot, pulls a 3-ton vehicle across a parking lot , drives autonomously indoors and begins learning how to navigate itself outside. “ Boston Dynamics released video footage of a new generation BigDog able to walk on icy terrain and recover its balance when kicked from the side. ” The mentioned robots are very advanced using not only basic reflective switch sensors but also cameras to detect whatever their purpose is. Since this project requires simple solution to make the robot built fast and work fast these could not very much help in the process of building the robot. According to the websites and also reports available on the internet, every university which does computer science or electrical engineering has got some kind of robot project and mainly line followers.

The specific specifications are moderately different but in all projects the main purpose is practicing an actual project in real life and knowing how to use simple and quick circuit design, program and implementation. The MINI Line follower robot for example has the most similar specifications to this project. The robot needs to follow a line powering up by a battery with size limitations. Kerman, Judith B. (1991). Retrofitting Blade Runner: Issues in Ridley Scott's Blade Runner and Philip K. Dick's Do Androids Dream of Electric Sheep?

Bowling Green, OH: Bowling Green State University Popular Press. ISBN 0-87972-509-5. Perkowitz, Sidney (2004). Digital People: From Bionic Humans to Androids. Joseph Henry Press. ISBN 0-309-09619-7. Shelde, Per (1993). Androids, Humanoids, and Other Science Fiction Monsters: Science and Soul in Science Fiction Films. New York: New York University Press. ISBN 0-8147-

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7930-1. <http://www.stanford.edu/~learnest/cart.htm> <http://www.richardvannoy.info/building-a-line-following-robot.pdf> [http://ikalogic.com/proj\\_mini\\_line\\_follower.php](http://ikalogic.com/proj_mini_line_follower.php) [http://online.physics.uiuc.edu/courses/phys405/P405\\_Projects/Fall2005/Robot\\_project\\_jaseung\\_.pdf](http://online.physics.uiuc.edu/courses/phys405/P405_Projects/Fall2005/Robot_project_jaseung_.pdf) [http://nereus.mech.ntua.gr/pdf\\_ps/aim11.pdf](http://nereus.mech.ntua.gr/pdf_ps/aim11.pdf)

Aims: \* To design and construct an autonomous robot \* The robot to be completed on time \* To build the robot with its maximum speed \* Build the robot with all the possibilities to win the race

Objectives: \* To come up with the ideas \* To work as a team. Review and practice the skills of teamwork \* To get experience of systems engineering \* Improve electronic and mechanical practical design skills

Requirements: \* The robot must follow the line

- The line is 50mm wide
- The line is 10m long
- The line is black on white background
- The line has maximum corners of 90°
- The line is horizontal

\* The robot must move forward \* The robot must carry an egg

- The mass of egg is 25gr (approx. )
- The size of egg is 5cm x 3cm (approx. )

System Decomposition System is an organized, purposeful structure regarded as a whole and consisting of interrelated and interdependent elements such as components, entities, factors, members, or parts.

According to the Robot Project, the robot itself is the system, as it consists of different subsystems, while the subsystems made of the components. Being more related to the Robot, it can be explained as the Mechanical, Electronic and Software Designs are the main subsystems, while the elements of each subsystem is defined as the components. The figure below shows the Robot system decomposition for better explanation: Figure [ 1 ]-

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The System Decomposition for the robot Group Management Structure During the meetings the work allocations between group members were discussed.

The works as mechanical, electronic, programming, report, DVD film and logbook were divided between each in the group. To give one work division per group member means to put a big responsibility on him, as every part has a big amount of not easy work to be done, and it can cause the difficulty in understanding the job that will lead to uncertainty. So every part has two members to work on it, and every group member has 3 jobs to be done by the end of the project and the work allocations are as followings: \* Team Leader : Delaram Sharifi \* Mechanical: Zhanar ; Hedieh Electronic: Xun ; Delaram \* Programming: Delaram ; Hedieh \* Reports: Zhanar ; Hedieh \* DVD Film: Xun ; Zhanar \* Logbook: Delaram ; Xun Name of the Robot The first thing was done by group is creating the name for the future robot. This process made the group to be more opened, close-knit, and creative, as well as the process helped to improve the team working. A lot of options we considered, but the main aim of giving the name was to create something that can reflect all of the group members in one name. So the final choice made by the group is the name ICKI.

It stands by the countries of the each group member which are Iran, China, Kazakhstan, and Iran again. Mechanical Design Mechanical design for the robot presents many challenges and its main idea is to make it simple and affordable. The mechanical design of autonomous robot is including: \* Robot's Wheels. They are one of the most important assemblies of the mechanical platform. \* Robot's Frame. This frame is mechanical platform of



robot and due to the frame all the parts are hold together \* Motors. To control the speed and direction of the robot. \* Sensors. To detect the direction.

Technical Options, Critical Review and Final Design Choice During one of the meetings there are two options of mechanical design were discussed. Two group members responsible for the design presented their ideas to the group with all the aspects, advantages and disadvantages. The option as followings: Option 1 The first option was presented as the robot with the round shape. Then the robot would have 2 wheels by the left and right sides, 2 motors, line with 5 sensors in the front and the frame of HDPE (High Density Poly Ethylene), i. e. plastic. Figure 2-Round Shape Option 2

The second option is to make more traditional, the rectangular one. The rectangular robot with the frame and base of Aluminum or HDPE, with 2 wheels on the sides and with the “ V” shape line sensors and the skid on the front. The skid will help to control the balance. Figure 3-Rectangular Shape After presenting the options of the mechanical design for the robot some advantages and disadvantages were written for each of the option that helped the group to choose the right one. During the discussion of the design, three things were considered: capacity, light weight and low to the ground.

As long as two motors are used for the construction of the robot and each motor can take one wheel, the neediness in wheels is just for two. So two wheels connected to the motors at the back of the robot is enough to control the rout and the skid connected to the sensor board in the front can help the autonomous robot control the balance. The robot’s size is to be about 12cm

to 14 cm and 4 cm is for the wheels. Review of the Frame The frame is the basic structure to which everything should be attached and Aluminum and HDPE were considered as the frame.

First of all, Aluminum is strong, light, and easy to cut and drill while HDPE is the same light, strong, easy to shape and cut but also the cheap one. In comparison, HDPE has a very low thermal conductivity, and a higher strength to weight ratio than Aluminum. Review of the Wheels All the group members agreed that the large diameter wheels give the robot low torque but high velocity and if the motors strong enough then the wheels with larger diameter better to use. The speed of the robot depends on the size of the wheels and it is good to have them between 1cm and 2 cm.

Here are some advantages and disadvantages of the first and second options that were made during the discussions on the meetings: | First Option The Round Shape| Second Option The Rectangular Shape| Advantages| \* Beautiful, unusual design \* HDPE frame | \* HDPE frame \* The front skid \* “ V” shape line sensors \* Compact| Disadvantages| \* Distance between wheels and sensors is not enough to make turns right after the sensor is detected \* Not enough of space for circuit board, 2 motors and sensors, that makes the design not compact| \* Usual Design| Table [ 1 ] Advantages and Disadvantages for the design options

Final Design Taking into account all the reviews made and the table of advantages and disadvantages the decision was made is to choose the second option of the mechanical design, and to change some nuances as to use HDPE for the frame together with the “ V” shape line sensors (also see Software Design) and add a spoon in the middle between the wheels that is <https://assignbuster.com/line-follower-robot/>

the best position to keep the balance for an egg. So the final result would look like: Figure 4-Final Design Electronic Design The Circuit is consisted of 5 units. Sensors are acting as the input. The control unit controls every component in the circuit.

The driver provides enough power for the stepper motor to move the robot. The Power supply powers up the whole circuit. Sensors Control Unit Driver Stepper Motors Power Supply Figure 5-Block Diagram Technical Options, Critical Review and Final Design Choice The Control Unit: AVR/PIC/8051 8051: an old but very popular controller. The older 8051s are kind of slow: 12 clocks per instruction. Newer 8051s have 6 clocks per instruction up to 1 clock per instruction. The selection of low pin count devices is a bit limited. Most 8051s have an external memory bus that makes it easy to add memory and peripherals.

CISC has free C compiler. PIC: Slightly less old than the 8051. PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability. AVR: The newest architecture by about 20 years. Designed for a pipeline, so has a very good clocks/instruction. Good range of devices: small and cheap with fairly high performance. It is very C friendly because of the RISC. Comparison:

Selections: AVR= PIC; 8051; Price: AVR= 8051; PIC; For beginners: 8051; PIC; AVR; C language: AVR= PIC; 8051; Anti-interference: AVR= PIC; 8051; Final Choice We have used PIC in a few experiments, so we are familiar with it. Moreover, in university we just have equipment for program the PIC, so we <https://assignbuster.com/line-follower-robot/>

decided to use the PIC. The chosen microcontroller and the reasons: PIC16F648 The PIC16F84 was chosen for its small size, easy reprogrammability and interrupts it is clocked at 4 MHz by a ceramic resonator and it can be even powered by 4 AA rechargeable batteries (Very low consumption).

These same batteries power the motors. This is usually not recommended since surges in motor current can affect the processor's operation, but with decoupling caps in place and the watchdog timer being used in the software no problems were experienced. The watchdog could reset the processor if it went stupid before you could ever see it act up. After all, we considered the number of inputs and outputs. The inputs are number of sensors we have which is 7, and outputs are motors. So PIC16F648 which we have used several times has enough bit (8-bit PORTA, 8-bit PORTB). Stepper Motors Unit:

Servo motor/Stepper motor Servo motor: A servomotor (servo) is an electromechanical device in which an electrical input determines the position of the armature of a motor. Servos are used extensively in robotics and radio-controlled cars, airplanes, and boats. Stepper motor: A stepper motor (or step motor) is a brushless DC electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely without any feedback mechanism (an open-loop controller), as long as the motor is carefully sized to the application. Comparison:

Both types of motors offer similar opportunities for precise positioning, but they differ in a number of ways. Servomotors require analogue feedback control systems of some type. Typically, this involves a potentiometer to provide feedback about the rotor position, and some mix of circuitry to drive

a current through the motor inversely proportional to the difference between the desired position and the current position Final Choice: Servo motor needs complex analogue feedback circuits. And we have used stepper motor before. However stepper motor will be given to us, so we chose stepper motor. The Driver Unit

L298&L297/L293D A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. [1] A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. Three ways to drive a stepper motor: Use a transistor to drive each coil. But It was a little awkward to wire up the circuit - board space. Also, it requires 4 pins on the PIC to drive the motor.

Use a driver array packaged in an IC. Don't forget to wire in the protection diodes! (i. e. SAA1027, L298, L293D) Use a specialized stepper motor driver chip. It would save on board space, and pin usage. As the price of stepper motor drive chip is very expensive and 4 transistors to drive each coil may make the board a mass. So we choose stepper motor driver IC. L298 has current capacity of 2A compared to 0.6 A of a L293D. L293D's package is not suitable for attaching a good heat sink; practically you can't use it above 16V without frying it. L298 on the other hand works happily at 16V without a heat sink, so we choose L298.

And in the datasheet we find out that it's better to combine L298 with L297.

\* It needs to be considered that regarding to the temperature power supply

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is going to add to the circuit a heat sink needs to be included in the board otherwise it would melt. Software Design Technical Options, Critical Review and Final Design Choice The software to be used in order to program the pic CCS C Compiler, as it is the well-known software for the group. This software was used to do experiment laboratories for EE2A course and to use CCS C Compiler to program the robot will be more than adequate and helpful.

Odd or even number of sensors Both odd and even numbers are possible to use, the group has chosen the odd to increase the accuracy and make the code more understandable and clear. As it will be explained how the program works, it will be clear how they both can be used. The Number of Sensors \* 3: The program would work, but not accurate enough. All turns, no matter large or small will be reacted the same. \* 7: Again, the program will work, but needs far too much extra effort, increases the time of processing the data and makes the code very complicated. 5: Is a perfectly fine number, will give the opportunity to detect the turns in two different stages so that the robot can make the turns soon enough and with more accuracy. The shape in which the sensors are put together \* An upside down V: Where the middle sensor is in the front, followed by two sensors, wider from each other in the back and followed by another two sensors, wider at the very back. This will not work because the turn is detected by the wider sensors later than the right time for to move to be taken from the robot. This method may be accurate but would not help the robot being fast. line: Where all the sensors are at the same level. This method is better than the latter but still will not make the robot to detect the larger turns sooner in order to make the reaction at the right time. \* V: The middle sensor is at the very back corner,

two sensors with a wider distance comes next and the last two, again wider at the front. This method makes the robot understand the large angles sooner with the outer sensors, so that the robot will start turning sooner than the smaller angles which are detected by the middle sensors. The angle of the V

The angle should not be too small, because the robot will start the turns too early, and it should not be very wide because then it would not make any difference from the flat shape. This is to be experienced during the testing process but the decided angle at this time is 120 degrees. How does the program work? As it has been explained before, there are 5 sensors to be used in the robot. The recognition of the turns has been explained in 4 figures below. The green circles represent the sensors which have detected the black line and the red circles represent the sensors which have detected the white surface.

The green circle is the logic “ 1” and the red is the logic “ 0”. Normal positions of the sensors In this situation, when only the middle sensor detects the black line, the robot moves straight forward without any turns. The logic is “ 00100” 2. 5 cm Figure 4- The normal position of the sensors More than 50° turns including the 90° : When the turn is more than 50 degrees, the outer sensor feels the turn sooner than the middle sensor, so that the robot will start turning earlier, or if decided faster as well. The logic is “ 00101”. Figure 5-The more than 50° turns.

It also needs to be said that if the large turns are happening for a very little while (for less than 4. 5 cm), the middle sensor will sense the turn first so that the robot would not change the direction to fast and get out of control.

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Less than 50° turn: When the turn is more than 50° , the middle sensor feels the turn first, so that the robot starts turning at a reasonable time to manage the turn. The logic is “ 00110” Figure 6-The less than 50° turns

Approximately 50 degrees turns: At this situation, both middle and outer sensor feel the turn at the same time.

The logic is “ 00111”. Figure 7- ? 50 ? Time Management plan Due to EE2G1 module, students have learnt how to manage their time in given projects using the graphs, charts and tables. Here is the Gantt chart that consists of two tables. The first one helps to analyze what tasks has to be done, when it has to be started and what amount of time is given and also gives the information about each task, if it is sequential or parallel. Task| Earliest Start (week)| Length (week)| Type| Dependent on...| A. High Level analysis| Week 0| 1 week| Sequential| | B.

Selection of Mechanical Design and Components| Week 1| 1 week| Sequential| A| C. Detailed Analysis of Electronics for Robot| Week 1| 1 week| Sequential| A| D. Mechanical Design| Week 2| 2 weeks| Sequential| B| E. Circuit Design| Week 2| 2 weeks| Sequential| C| F. Build Mechanics| Week 4| 2 weeks| Sequential| D| G. Build Circuit| Week 4| 1 weeks| Sequential| E| H. Construction| Week 6| 1 week| Sequential| F, G| I. Programming| Week 3| 3-4 weeks| Parallel| D, E, F, G, H, | J. Testing| Week 7| 4 weeks| Sequential| H, I| K. Demonstration| Week 11| -| Sequential| J|

Table 1 – Gantt Table Summarizing the first table, information should be transferred to the chart. The chart helps visualize all the given tasks and the time given to accomplish them. Week| 0| 1| 2| 3| 4| 5| 6| 7| 8| 9| 10| 11| (1)



A. High Level Analysis| (1) B. Selection Of Mechanical Design and Components| (1) C. Detailed Analysis of Electronics for Robot| (2) D.

Mechanical Design| (2) E. Circuit Design| (2) F. Build Mechanics| (1) G. Build Circuit| (1) H.

Construction| (3-4) I. Programming| (4-5) J. Testing| DEMONSTRATION| Chart 1 – Gantt Chart Risk Assessment As everything else, this project has its own risks and possibility of troubles. We cannot stop the problems from happening, but we can consider the ways we would manage if they have happened.

There are different types of problems which may occur, some with large possibility but manageable damage, some with very little possibility but disastrous damages. The group has come with some ideas about these risks and how to manage them which are as follows: Very possible, low cost and manageable risks Burning the electrical components such as the PIC or the power sources: 1. Keeping good care of the more expensive components, putting them in a position which brings the possibility of the damage to the least possible. 2.

Having alternatives for each component, more for the cheap and more burnable ones, less for the more expensive and least burnable ones. Losing the documents, programs or components: 1. Taking good care of where the materials are saved or put, possibly write the places down or share with other group mates in case for memory loss. 2. Having a photo of each page of the written documents, copies of the electronic stuff on different places, and having a list for the components we have to pack every time. The A

plan's failure: 1. Having a plan Bs and Plan Cs for all the Plan As. . Plan Bs can be for a change in the A plan, but plan Cs are completely different methods in case the whole plan has been a whole of a lot of rubbish. 3. Having the responsible person ready for the plans when the failure comes so that the change can be quick and easy. Running out of time: 1. Having someone responsible for the plans to go as it has been decided in the time management plan, taking care of even slight late results to prevent the sum of smalls becoming a huge delay. 2. Stopping panic attacks or they will cause more delay. 3.

Keeping everything simple and tidy in order to make the trouble shooting faster and easier. The plans we have specifically come up with for the Robot project 1. Taking good care of the PIC, having alternatives for all the components. 2. Saving the programs on memory sticks, computer and email. 3. Keeping pictures of the critical pages of the log book. 4. Having an alternative way of programming for the line detecting bits. 5. Having some options for the components available in case the robot doesn't work out with them. 6. Having a map of the circuit with all the explanations about wiring and connections. . Keeping the actual circuit nice and tidy, the wires low and the colors right. Components Wish List According to the design decisions, the list of components needed for the project can be made. There are some basic components required in order to accomplish the mechanical, electrical and software design of the robot, such as: \* HDPE for the frame and chassis \* 2 wheels \* 1 skid \* 2 DC stepper motors \* Sensors \* Circuit board \* Capacitors, resistors, Diodes, Transistors (referring to the main components) \* Microcontroller \* LED's Every group is provided with 40 ? n order to buy the

components needed. The table below shows the approximate price estimations: Wheels| ? 2-3| PIC16F648 (2)| ? 4| Sensors (5)| ? 5| HDPE plastic| ? 10| LED's| ? 5| Screw Box| ? 2| Resistors| ? 2| Capacitors| ? 2| Skid| ? 2-3| Heat Sink| ? 3| Conclusion This project is not only for making line follower race robot but it is also a great and realistic practice for group work and project management. This is a hard challenge and is only possible to manage with co-operation, hard work, motivation and enthusiasm. Each individual member learns how to cope with different opinions and ideas.

They learn to be tolerant and do not let anything personal get involved in the work since this may ruin the friendly environment among the group members. By doing this project a lot of skills will be developed such as: \* Group work \* Time management and working by deadlines \* Work break down in equal amount among group members \* Decision making \* Risk management \* Budget management \* Working with time limit and in stressful conditions \* Starting a project from scratch, developing ideas and making improvements \* Undertaking risks and responsibilities \* Keeping good and reliable documentation Keeping motivation and encouragement among the group live or dead By the end of this project we will have done a complete project management plan and implementation. We will know how to face troubles and problems and hopefully this is going to be a great memory of how we learnt to manage a real project in practice. References Online Documents: \* BASIC ROBOT MECHANICS TUTORIALS, (2005-1012). Society of Robots. Retrieved from <http://www.societyofrobots.com/mechanicsbasics.shtml> \* Priyank Patil Department of Information Technology S. W. Nawawi, M. N. Ahmad, J. H.

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