IEEE SoutheastCon 2020
Hardware Competition
March 14, 2020 – 03/14 – Pi Day

Rodney Radford, SoutheastCon 2020 Hardware Chair

Pi Day is the annual celebration of the mathematical constant pi (represented by the Greek letter π) on March 14, since the date in month/day format, 3/14, corresponds to the first three digits of pi.

Pi Day was first observed in 1988 and became recognized as National Pi Day in 2009 in the United States. Pi Day is observed around the world in a variety of ways, including discussing the significance of the constant pi, competing to recite the most digits of pi, and even eating pi's delicious homophone, pie.

On March 14, 2020, please join us in Raleigh, NC to celebrate Pi Day by participating in the first ever pi-themed SoutheastCon hardware robotics competition. In this competition, your robot will demonstrate how many digits of pi it can stack, using a series of Lego Duplo bricks, as well as how many digits it can input on a set of 10 pushbuttons, in a three-minute competition.

ARENA LAYOUT

The arena is a single 4'x8' sheet of smooth-sanded ½" (nominal thickness is approximately 15/32") BC grade plywood (B side up) that is surrounded by standard 2"x4" 'stud' lumber (nominal size is approximately 1.5"x3.5") walls that form a frame on top of the plywood sheet (the arena inner dimensions will thus be approximately 93"x45").

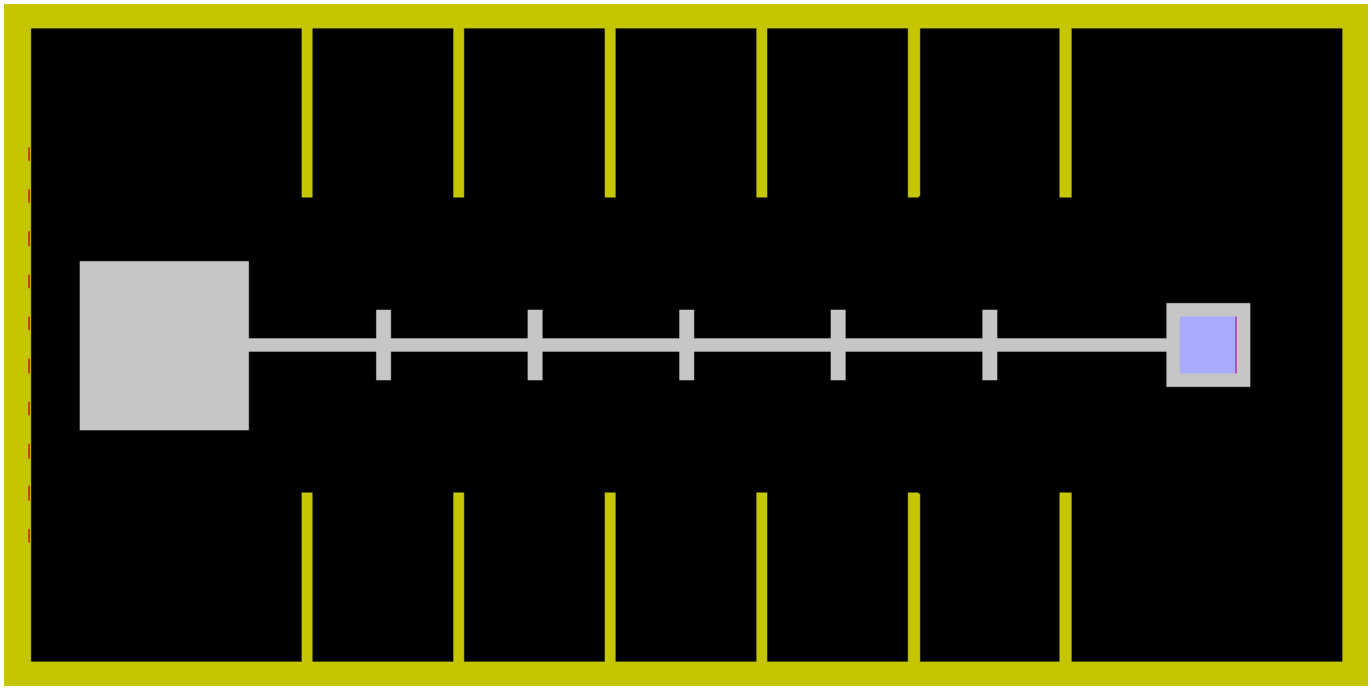
(Note that all ½" plywood referenced in the construction of the arena will have a nominal thickness of approximately 15/32" and all 2"x4" 'stud' lumber will have a nominal size of approximately 1.5"x 3.5", and all 1"x2" lumber will have a nominal size of approximately 0.75"x1.5". Standard building material tolerances are expected).

The arena has a 12"x12" starting square on one end with a 1" navigational line

running down the middle of the arena to a 5"x5" hole in the floor on the other end. Additional 1" navigation lines extend 2" from the edge of the main navigational line toward ten rooms, five on each side of the arena, as well as define the edge of the 5"x5" hole that is open to the conference floor below.

The rooms are separated by a 1"x2" (nominal size 0.75" by 1.5") dividing wall, each 12" long and attached to the 2"x4" walls extending toward the center of the arena. The 1"x2" walls are oriented so that the 2" (1.5") dimension is vertical. The 1"x2" walls are spaced such that there is 10" of space between each wall, giving a room dimension of 10"x12". The first and last dividing wall is located 19.25” from the inside of the 4' walls. There is no wall in front of the bins (as seen from the center line).

Both the starting square and the hole are centered between the two longer 8' sides and 9.5" from the interior wall of the shorter 4' sides of the arena. This puts the starting square edge at 3.5" (9.5 - (12/2)) from the interior side of the 4' wall and the hole at 7.0" (9.5 - (5/2)) from the interior side of the other 4' wall.



Along the 4' wall that is closest to the starting square are ten pushbuttons that

are centered vertically on the wall (center is 1.75" up from the floor) and horizontally spaced 3" apart with a distance of 9" from each 8' wall and the center of the first and last pushbutton.

The plywood floor is painted flat black. The navigation stripes are gloss white. The exterior and room walls are gloss yellow. We will not be providing exact paint vendor names and manufacturing codes for these paints, so your robot should be able to discern between the flat black and gloss white on the floors without looking for an exact match.

(Note: As past competitors have discovered, colors do not look the same under different lighting conditions, so it is never advisable to look for exact colors in a competition. Thus we chose this high-contrast paint scheme as a benefit to you, not as an additional challenge.)

The arena external lighting environment is not specified, nor is it controlled by the contest coordinators, so wide variances in lighting arrangements (intensity, hue, direction of light, shadows, etc) are to be expected by the teams. In addition, no restriction will be placed on the spectators and those present during the competition for use of their cameras and cellphones. As a result, flash photography and infrared range finders on cameras will be permitted and could cause accidental interference of robot range sensors. Intentional interference with the operation of the robots is not allowed and will result in sanctions.

Care will be taken in building of the arenas so they meet the specifications as accurately as possible. However, since building the arenas is a manual process, there is expected to be some minor variances from arena to arena. The physical size of the arena and the wall lengths will vary no more than +/- 0.25” from the specified size, and each buttons will be placed no more than +/- 0.25” up/down/left/right from the specified absolute center location and no more than +/- 0.125” from the specified depth. The white line may vary as much as +/- 0.1” in width and +/- 0.25” in length from the specified 1.0” width and specified lengths. Robots should be prepared to handle these minor variances.

ROBOT

The robot must be completely autonomous and must fit completely within a 12"x12"x12" cube at the start of each match. The robot must at all times be wholly contained within the playing surface, but may reach a maximum of 1" beyond the outside edge of any arena walls, and a maximum of 1/2” down the

backside of the arena walls. There is no weight restriction on the robot. Aerial or flying robots are not allowed.

The robot may expand beyond the initial size to any size. It may split into multiple independent robots during the competition. If multiple independent robots are used, they must all start within the same 12"x12"x12" starting space and split after the competition begins.

You may not tether or externally control the robot in any way, including wired or wireless tethers, with either two-way or one-way data transmission to or from the robot.

For the safety of other robots running at the same time and to avoid interference, any communication between the robots must communicate over wired links. Wireless communication among and between robots is not allowed. This restriction includes any communication by radio, light, sound, or any other non-wired communication channel, with a single exception for the initial start of the robot as explained below.

While multiple switches can exist on the robot for powering up and controlling the various subsystems on the robot, there must be a single, clearly visible, labeled start switch. This switch can be either a pushbutton or a toggle switch and will be actuated by the robot team once the judge indicates the start of the match. All other switches must be configured prior to the start of the match, and only the single start switch is allowed to be activated once the judge indicates the match is ready to begin. Any interaction with the robot after the start button has been activated could result in disqualification.

If the robot consists of multiple sub-robots, there must be a single start button that starts all the sub-robots at the same time (not one start button per sub-robot). It is possible to use one or more visible LEDs on the robot containing the start button to signal to the other sub-robots that they are to start, but this communication is only for starting and may not be used for any other communication.

It is recommended that the robot have an easily reachable emergency cutoff switch to allow the robot team to disable the robot if necessary (this is to avoid

damage to both the robot and the arena in case a sudden stop is required). It is advisable that if the robot splits into multiple independent robots, the single emergency cutoff switch should stop motion of all the robots, but this is not a requirement. It is recommended that robots automatically stop at the three-minute mark to avoid teams having to manually reach over to stop the robots and accidentally interfering with the stack.

The robot cannot contain any explosive, pyrotechnic, toxic or corrosive materials. Flammable liquids or gases are also prohibited. Compressed gas is allowed on the robot as long as the pressure is limited to no more than 30 pounds per square inch at any time. Gases other than air are permitted as long as they do not pose a safety threat if accidentally released.

The robot shall not present any danger to the judges, spectators, playing arena, or area surrounding the arena. If at any time the judges deem the robot is causing or is likely to cause harm, the judge may terminate the match immediately. The judge will have the discretion of whether any points are awarded for that match and if the robot is allowed to complete in any remaining matches.

Sonar and LIDAR sensors are allowed on the robot. Teams should be aware that other teams may be using similar sensors, so teams are required to handle any accidental interference from other robots or other noise sources with either shielding or software filtering of false data. However, while it is the team's responsibility to handle accidental interference, any intentional interference by another robot or team will not be tolerated and can result in sanctions.

It is encouraged that the robot display a flag on the robot representing the school flag or logo, state, territory, or national flag, but the flag must fit within the initial size constraints of the robot. The flag can be static, or can be raised automatically at any time once the match begins.

COMPETITION

The competition is composed of two challenges that may be executed in any order or in parallel if multiple sub-robots are used. It is permissible for a robot to only do one of the two challenges and skip the remaining challenge.

The two challenges are described in the two sections below.

Stacking Pi Digits

In this challenge, the robot's goal is to stack as many digits of pi as possible within the competition match time. Points are awarded both for the total height of the stack and for how many digits of pi that are in the correct order. Correct order is defined as starting with the first digit, '3', on the bottom of the stack and counting up (it is not allowed to have the stack reversed with the first digit, '3', on the top of the stack).

Each digit of pi is represented by a single 2x2 Duplo brick (Lego part number #3437), with the color of the brick specifying the digit number using the standard resistor code as shown in the chart below.

Digit	Resistor color	Official Lego color
0	Black	Black
1	Brown	Tan
2	Red	Red
3	Orange	Orange
4	Yellow	Yellow
5	Green	Bright Green
6	Blue	Blue
7	Violet	Lavender
8	Gray	Dark Bluish Gray
9	White	White

For example, for the first 8 digits of pi (3.1415926), the colors for the stack counting up from the floor are: orange=3, brown=1, yellow=4, brown=1, green=5, white=9, red=2, and blue=6. Note that the stack uses only the resistor code for the digits and does not make use of the multiplier or tolerance bands of a resistor code.

The digits must be stacked within the 5"x5" hole at the end opposite the robot's starting position. Teams may stack the bricks directly on the conference hotel floor under the arena, but this is ***not*** recommended, as we cannot control the surface area of the floor beneath the arena. Instead, teams are encouraged to provide their own bases.

The purpose of the base is to allow a vibration insulation between the floors and walls of the arena and the stacking area, so it is recommended that there be a gap between the base and the arena, but it is up to each student team to design the base that best suits their robot design. The base should not interfere with the judge's view of the stack at the end of the match.

The bases can either be placed within the hole before the match begins during the pre-match setup time, or can start out within the starting square and placed autonomously by the robot during the 3 minute match time.

There is no limitation on the design of the base or the base composition material (plastic, wood, metal, combination, etc.), or weight of the base.

If the base is placed in advanced, it cannot extend more than 2" beyond the top of the floor surface, or beyond the outer edge of the 1" white line surrounding the 5"x5" hole. The base can include indentations, alignment pins, Lego bricks/plates or any other alignment aid. Any Lego bricks that are part of the base will not be counted as part of the scoring stack.

In addition, if the base is placed in advance, it may not include any processor, motors, beacons, LEDs, switches, or any other active device as this would be considered part of the robot, which must begin the match within the starting square. Active bases can be used, but they must start within the starting square and be positioned in place by the robot after the match begins. It is possible to include non-motorized moving parts (hinges, sliding or rotating pieces, etc) and

not be considered an active base as long as no motors are included in the base at the time of the match start.

The stack is not required to physically touch the base, but can be held by the robot over the hole, but the bottom of the stack must be contained within the 5x5 opening. If the stack leans, the top of the stack can extend outside the 5x5 area. This is to allow some leaning, but stacks must be within +/- 15 degrees of vertical.

Teams may provide supports for the stack, including the robot holding on and supporting the stack, as long as there is a clear view of the stack (from any position) at the time of judging at the end of the match. If a robot obscures the view of the stack, it may not be possible to judge the stack correctly. Partially obscuring the stack, or a brick, is allowed. However if any brick in the stack can't be seen, it will not be counted as a correctly sequenced brick and only the number of bricks above it will be counted as non-sequenced bricks at that point. It is the responsibility of the team to design the robot and stack placement to allow visibility of the stack. If a judge determines that the stack cannot be judged, teams can choose to either accept the reduced score, or attempt to manually move any part of the robot that is obscuring the stack. If the stack falls over during this time, the final score will be based on what is left standing, which could be a lower score than the reduced score with the partially obscured stack.

Teams are responsible for stocking the ten bins during the pre-match setup time before each match and can choose to put any color Duplo brick within any bin, but only a single color can exist within a single bin (i.e., don't put a blue Duplo brick and a red Duplo brick in the same bin). The bricks within a bin can be placed in any configuration, including placed in a grid, stacked, on their side, or arranged in any pattern on the bin floor, but they cannot extend out beyond the edge of the bin rooms as defined by the bin walls (but they can exceed the height of the bin walls). Teams may use an alignment tool or stencil for each bin to help in placing the bricks in a precise location before the competition, but any alignment tools must be removed before the competition begins.

Teams may choose how many (or how few) of the Lego bricks of each color they choose to place within each of the bins. They may choose to place differing amounts of each color within the different bins. Each arena will have a minimum of 15x of every color, but if a team needs additional bricks, they should communicate that request to the judge during setup and additional bricks will be made available.

The judging of the brick stack occurs only at the end of the match, once the robots have stopped moving, and the score is based on what is left standing at that time. Note that if a team accidentally knocks over their stack while stopping their robot, or moving the robot out of the way to allow viewing the stack, the judge will score the stack based on how many bricks are left standing at that time. Thus teams should take every measure possible to safely stop their robot at the three-minute mark and automatically positioning it out of the way, to avoid accidentally knocking over the brick stack.

Bricks must be oriented with the Lego studs on top to count as being in a stack, but it is not required that the bricks be snapped together to count. If more than one stack exists within the 5"x5" stacking area, the stack that has the highest points value will be used. If more than one stack of the same height exists, the stack that yields the most points for the team will be used.

(Note: It is not recommended that teams have more than one stack within the 5”x5” stacking area. The preceding information about multiple stacks is designed to give maximum points possible to a team if a stack falls over, breaks into multiple pieces, and multiple stacks are left standing within the stack area.)

Legos can be used in the construction of the robot and the base, but it must be clear which Lego bricks were placed by the robot from the bins for the competition. In addition, non-counting bricks can be used on top of the stack for support and in the base, but it must be very clear they are not to be counted. It is recommended that the bricks be of a different color than those used in the competition and/or have a different marking on them. Teams are encouraged to explain to the arena judge prior to the match of the use of the non-counting bricks to avoid any misunderstanding in judging.

Pressing Buttons

In this challenge, the robot's goal is to enter as many digits of pi as possible on the 10 pushbuttons within the competition match time. Points are awarded both for the total number of distinct button presses, as well as how many digits of pi are entered in the correct order.

The pushbuttons are 1" diameter white arcade buttons centered vertically 1.75" from the arena floor (in the center of the 3.5" high wall). Each pushbutton is inset so that the button top is 0.125" behind the surface of the wall.

The buttons are Adafruit #3491, (https://www.adafruit.com/product/3491), which include a builtin LED. The buttons and LEDs are controlled by an Arduino Mega 2560, and full source code for the Arduino is available on the github site (see FAQ at the end of the rules).

Buttons are centered on the wall at a spacing of 3" between buttons (27" between the '0' and the '9' digit and 9" from the center of the first and last pushbuttons to the nearest 8' long side).

The '0' digit is located on the farthest left position, with the '9' digit in the farthest right position, as viewed from the starting square looking toward the pushbuttons.

At the start of the competition, the '3' pushbutton will illuminate, indicating it is the first button to press. Once it is pressed, the '1' will illuminate, with each digit being lit in succession in order of the digits of pi (excluding the decimal point as a character). If an invalid digit is pressed, all the buttons will flash at the same time and will continue to all flash on each subsequent button press.

A button press is counted when 25ms of continuous on time is sensed, and a release is counted when 25ms of continuous off time is sensed. Teams are responsible for determining how much time should be used for on and off to guarantee button debounce has completed, and realize that this may vary from button to button, so teams are urged to be cautious when determining how fast to press and release each button.

There is no limit on the number of correctly sequenced buttons that may be

pressed (except for the physical timing requirements of meeting the on and off times), until the match is over.

In addition, teams receive a smaller number of points for any button presses beyond the last valid button press. Thus a team will continue to score points for incorrect digit button presses; however, it will be a reduced score. There is a maximum limit of 100 incorrect button presses that will be scored.

RUNNING THE COMPETITION

There is no limit on team size for the participating team, but each team member should be a member of the same local student branch, and they must all be IEEE Region 3 student members. Only one team per student branch is allowed in the Main competition. Teams that do not fit this qualification (additional teams in the student branch beyond the one allowed in Main, teams including students from other regions, hobby groups, or non-students, or the robots are not associated with the local student branch) may compete in the Open category, but all team members must be IEEE members. If more than one robot is submitted from a student branch, the student branch must designate which robot will be in the Main category at the time of onsite robot rules qualification at the conference (all teams must be qualified before the captain's meeting, so this means any designation of Main or Open must be made before the captain's meeting). There will be more details on the qualification process and deadlines in the #team-captains Discord channel.

The competition will consist of two preliminary runs, with the scoring of the preliminary rounds based on the highest score of the two preliminary rounds.

The top four highest scoring teams in the preliminary runs will then compete in the final run that will be held during the awards banquet. The final competition placement of the four teams will be determined solely on the points in the final run and does not include any points earned in the preliminary runs.

Each match will last for a maximum of three minutes. The robot team can stop their robot at any time before the three-minute period and signal to the judge

that they are finished with their match. The judge may stop the match at any time if the robot is acting in a manner that may cause injury to anyone nearby or damage to the arena or itself. If the judge does force a stop in a match, it is the judge's discretion whether the points in that match are counted, and if the robot is allowed to run in the next match.

At the start of each run, the judges will require that all robots be sequestered in a special staging area. Once in the staging area, the robots must remain turned off and cannot be touched by students until they are called for their match to begin. The robots cannot be charging during the sequestration period. For each match, the judges will call the names of the teams to run in that match. Once called, teams will have two minutes to retrieve their robot from the sequestration area and move it to a pre-match staging area near the arenas. In this area, teams can perform final checks to the robot, make any last-minute adjustments, swap in a new set of batteries, and power it on. This time will overlap with the time another set of teams is competing. Once the current set of teams has completed their matches and cleanup, the judge will call the teams from the pre-match staging area to the arena to begin their setup.

Once teams have been called from the pre-match staging area to the match, they will have an additional two minutes to get their robots and their arenas ready for the match. During this time, teams should place their robots in the starting area, arrange the Lego Duplo bricks in the ten bins, and optionally place their build plate within the hole in the arena floor. The Lego Duplo bricks will be sorted by color into ten buckets near the arena to make it easy for the teams to collect the colors and quantities that they need. While every effort will be made to have consistency in the quality of the bricks, teams are encouraged to inspect the bricks as they are placed within the arena. If any brick is defective, or damaged, it should be shown to the judge and a replacement will be made available.

There is no limit on the number of students allowed in the arena area during setup as long as they can do so without disturbing other nearby arenas. Once the team is ready, all team members but the one designated to initiate the robot start must step away from the arena. That team member then indicates the

readiness of the robot to the judge, and the judge begins the match countdown. Once the countdown is complete, the last team member will activate the designated start switch on their robot and back away from the arena. Any other interaction with the robot (additional buttons, touching or adjusting of the robot, etc.) during this time could lead to disqualification.

Once the match is over and the robots have stopped moving, the judge records the number of button presses from the arena Arduino controller, and will count the number of correctly sequenced bricks (counting from the floor up) and the number of additional non-sequenced bricks. Teams are encouraged to document their stack with their own cameras in case there is any dispute on scoring. Once the judging is complete, the team will be signaled that it is okay to remove their robot and to collect any Lego Duplo bricks in the arena. Teams are responsible for returning the bricks to the buckets in preparation for the next team.

The robot is then returned to the sequestration area until all the robots have completed their matches. At that time, teams will be instructed to retrieve their robots. Teams will be guaranteed at least 60 minutes between the end of the sequestration for the first match and the start of the final match for any necessary changes to the robot.

To avoid teams having to manually stop their robots at the end of the three-minute period and risking knocking over the stack, it is advisable that teams automatically stop their robots at the three-minute mark. This is not a requirement, but any team that chooses not to do so and then accidentally knocks over their stack will be awarded whatever points (bricks) are left standing when the judge scoring begins. Scoring will not begin until all robots in the arena have been stopped. The robots shall remain in the arena until the judge scoring is complete.

The judges will work with the teams to make sure each of the steps in the match is run as quickly and as smoothly as possible, including setting up the robots in the sequestration area, preparing the robots in the pre-match arena area, instructing the teams where to get the Lego Duplo bricks for their arena setup, running the match, scoring, and verifying that the arenas are cleaned and

ready for the next match. It is the teams' responsibility to follow the judge as quickly as possible so we have time to run both matches during the day.

If a team believes their robot was scored incorrectly, the team captain should first bring it up with the judge immediately upon the end of the match. If the matter cannot be quickly resolved, the judge and team captain will summarize the issue to the arena appeals judge, who will make the final decision about any scoring issues.

When addressing judges with questions, teams are expected to act within the IEEE code of conduct. Any team that acts in an inappropriate manner toward a judge, or other contestant, can result in sanctions against the team. Note that teams should use caution in filing appeals as unnecessary, unsuccessful appeals could result in loss of 10% of the current match score.

Scoring

Points will be awarded per match for:

- the total number of Lego Duplo bricks that are stacked and sequenced in the correct Pi order, starting with the first brick on the floor (base)
- any additional stacked bricks that are out of order
- the total number of button presses sequenced in the correct Pi order
- any additional button presses out of order, with a maximum of 100x out of order button presses counted

The points awarded per category are:

Description	Number of points
Total stack sequenced correctly	20 * N * N
Additional stack not sequenced correctly	N * N
Total button presses sequenced correctly	10 * N
Additional button presses not sequenced correctly	N (max of 100 counted)

There is no maximum to stacking height (correct or incorrect). There is no

maximum correct button presses scored, but there is a max of 100 incorrect button presses counted.

Some example robot stacking scores:

- 31415926 = 20*8*8 = 1280
- 3141555555555 = 20*5*5 + 8*8 = 564
- 11111111111 = 11*11 = 121

Some example robot button press scores:

- 31415926 = 10*8 = 80
- 3141555555555 = 10*5 + 8 = 58
- 11111111111 = 11

Obviously, if a robot competes in both challenges, completing stacking and button presses, the independent scores for each will be added together to obtain the total points for that match.

IMPORTANT DATES

The dates below are the best estimates of the various milestones leading up to the competition. The plan is to meet or exceed those dates, but if any delay occurs, it will be reported in the 2020 SoutheastCon #hardware Discord channel.

April 14, 2019

Release of the first set of rules at SoutheastCon 2019. The "IEEE SoutheastCon 2020" Discord server will begin allowing teams to join. The rules and arena OpenSCAD design will be posted to the #hw-links-uploads channel.

June 1, 2019

Next release of the software rules to clarify or fix any issues found by the teams after the initial April 14 release.

August 1, 2019

First official release of the arena electronics for verifying the proper pressing of the pi digit pushbuttons. The code will continue to change and improve after this date, but this version should be sufficient for teams that plan to build their own copies of the arena electronics. The code will be posted to github so that teams can see the code, understand how it works, and leave any comments on issues found.

November 1, 2019

Rules will be officially frozen, with no major changes allowed after this date. Any questions will be answered in a separate FAQ document. Note that if any glaring issues are found after this date, they will be addressed as quickly as possible.

March 7, 2020

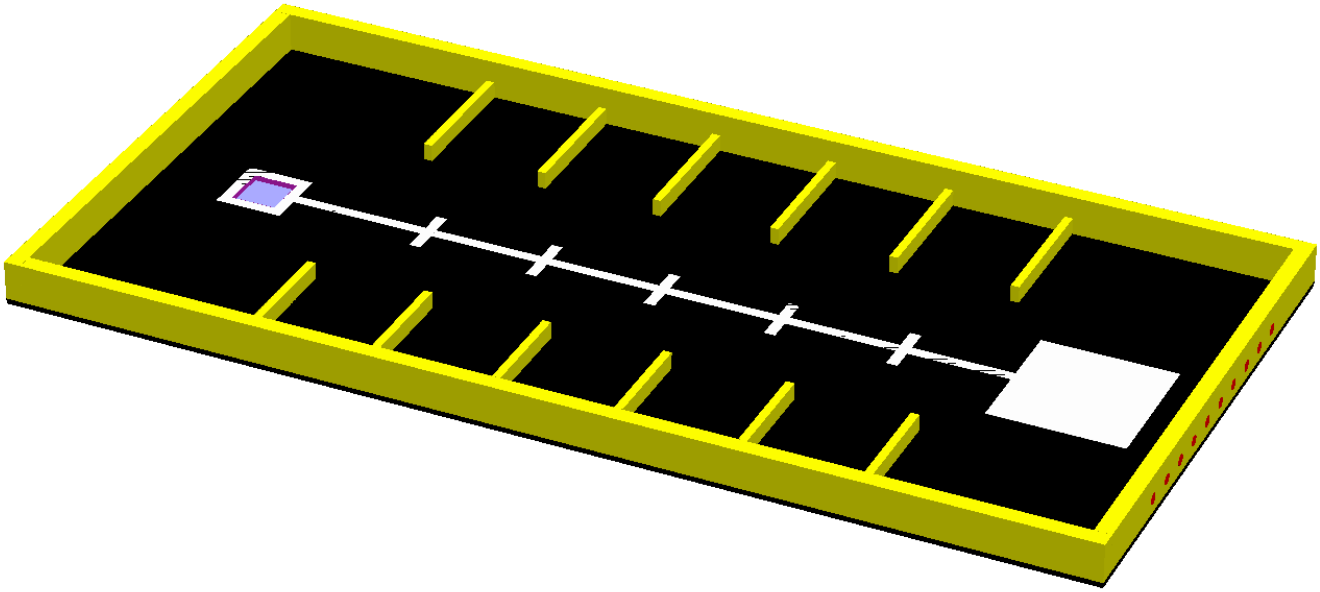
This is the deadline for registering your team to compete in the 2020 IEEE hardware competition. This will allow the contest organizers know how many teams to expect for the competition. The list of registered teams will be posted regularly to Discord in the #team-captains channel as we get closer to this date to allow teams to know whether they have correctly competed the steps of the registration process.

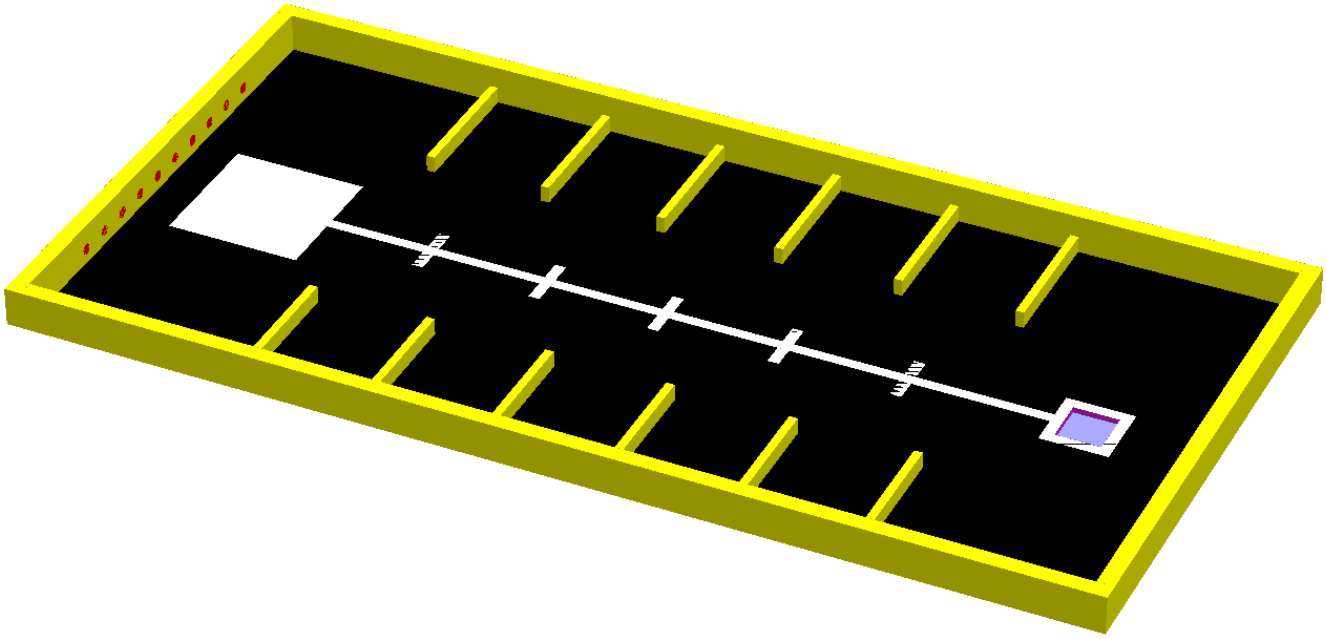
March 14, 2020

Pi Day! It would be *irrational* for you to miss this chance to celebrate with us and bring your robot to the competition. We hope to see you in Raleigh, NC!

ARENA 3D DIAGRAM VIEWS

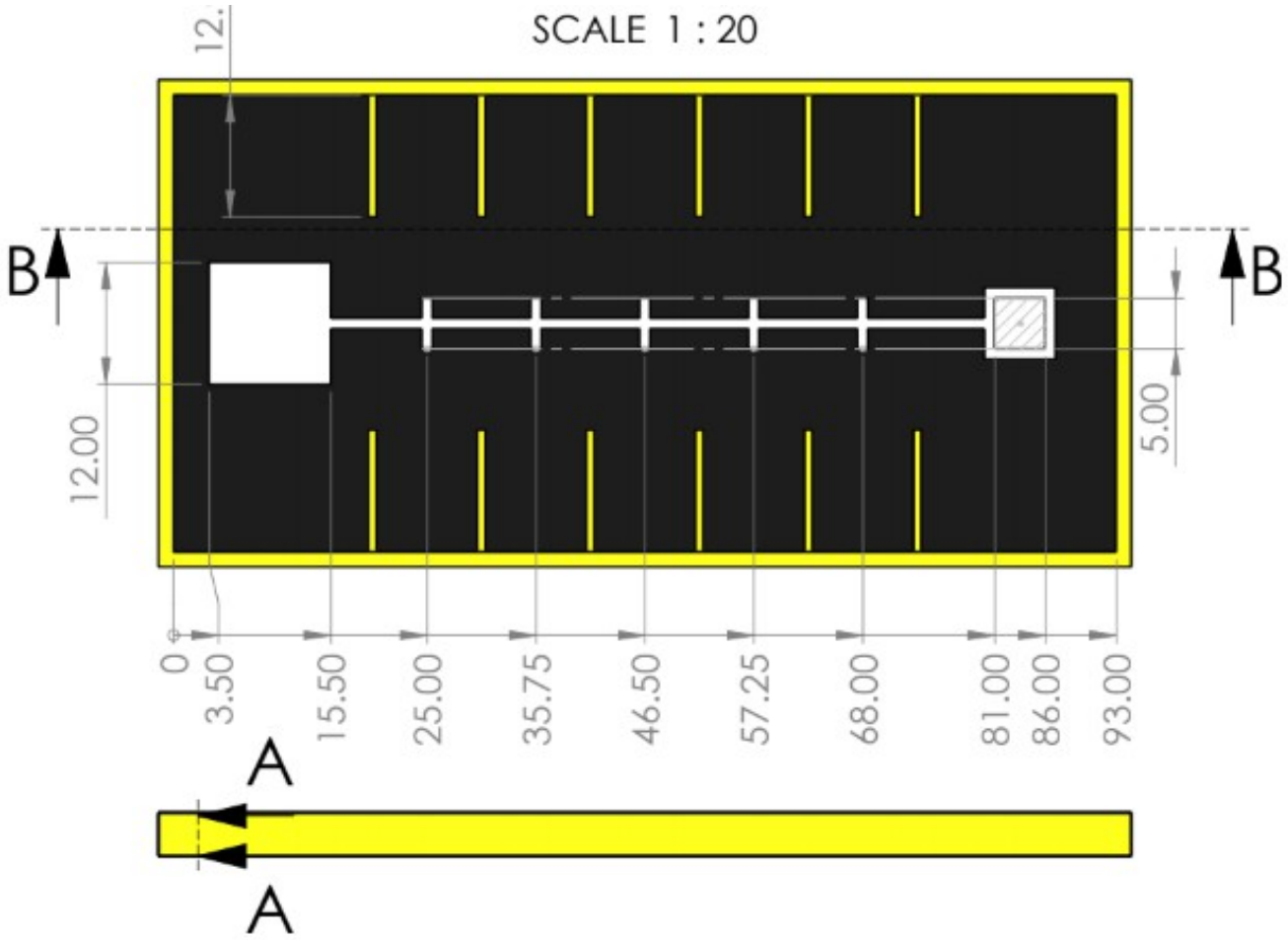
The pushbuttons in the diagram views below are shown in *red* so they are more visible in the drawing, but in the competition they will be *white*.

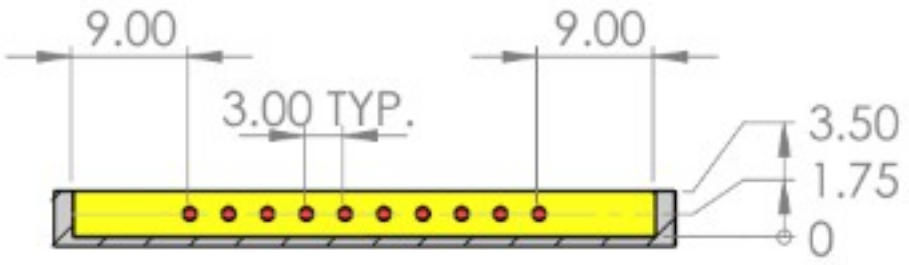




ARENA MEASURED DRAWING

The measured field drawing on this page and the next were created by Discord user '@Will | Clemson', so special thanks to him for his work. The drawings were done in Solidworks 2019, and the 3D file is available in the Discord #hw-uploads channel.





SECTION A-A

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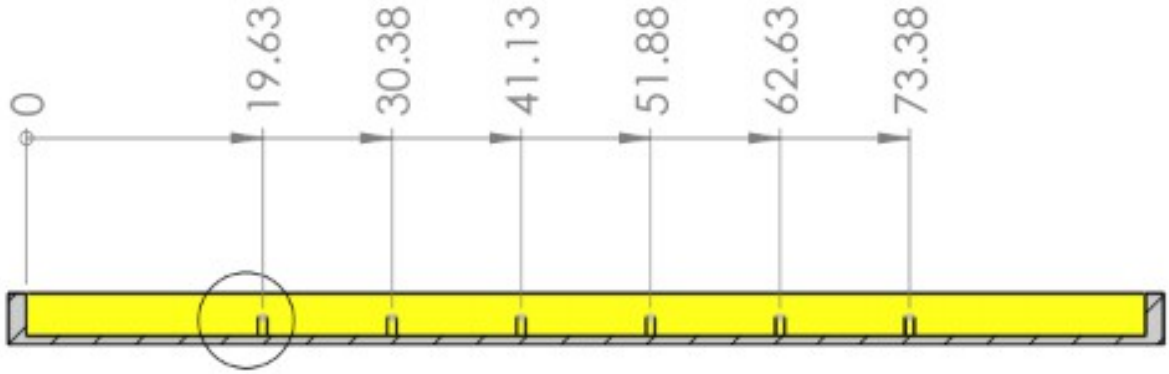

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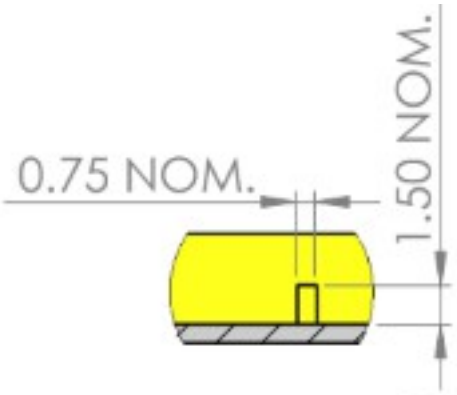


DETAIL C

SCALE 1 : 10

FAQ

- Where do I find out more about IEEE SoutheastCon 2020?

https://attend.ieee.org/southeastcon-2020/

- Where is the SoutheastCon 2020 Discord server and how do I access it?

The Discord server can be found at https://discord.gg/f3VXE74. The Discord server can be accessed directly at that weblink or you can download a client to your computer or smart phone. You will need to create a Discord account to access the server and you can do that within the client, or directly on the Discord website.

Note: Every team is required to have at least one active team member in the Discord server to receive notifications of important rule changes, deadlines, robot qualification requirements, and team captain meetings.

- Where do I find the latest official copy of the rules?

The latest (and only official copy) will always be posted to the following location:

https://attend.ieee.org/southeastcon-2020/student-program

This actually points to a github account that includes the rules, 3D drawings of the arena, description of the Arduino 2560 controller used in the buttons and the Arduino source code. The github account is:

https://github.com/ncgadgetry/southeastcon2020

- In addition, the rules will be posted (sometimes with discussion) to the #hw-uploads channel of the SoutheastCon 2020 Discord server.

- I see the terms “match,” “run,” and “competition” – what does each mean?

A **match** refers to a single robot running a single time, with the result of a single score. There is one match per run per robot.

A **run** is the collection of matches for all teams to run once. The first two runs

are called preliminary runs. The purpose of the preliminary runs is to find the top four teams to compete in the final run. The final run will occur during the awards banquet on Saturday night. During the final run, the only points used to define the final competition placement of the top four teams are the scores from the match in the single final run – no points from the preliminary runs are carried forward.

- How do I post any questions I have about the competition?

The quickest way for an answer is to post it in the "IEEE SoutheastCon 2020" #hardware Discord channel, and someone should be able to help you with it quickly. However, all official answers must be answered by the SoutheastCon 2020 hardware rules document posted in the official location listed above and not via a comment on a Discord channel. The Discord channels are maintained for students to exchange ideas and information and as a way to quickly distribute information to the students about official changes and clarification of the rules. If any discussion warrants a change or clarification in the rules, the rules will be modified (or the FAQ modified), posted, and then an announcement made to the Discord #hardware channel. If a discrepancy exists between what is stated in the Discord channels and the official website, the official page and rules will be deemed the arbiter. This is to avoid any confusion with multiple threads in Discord leading to wrong or confusing interpretations of the rules.

- If I have a question I would like to ask privately, how do I contact you?

The preferred method is by sending a private message directly to Discord user gadgetry (Rodney Radford) in the SoutheastCon 2020 Discord server. This is preferred to contact via email so there is a single location of all communication with the teams and team members.

- Where can I get a 3D drawing of the field?

The field drawings are available as an OpenSCAD program used for creating the 3D diagrams in this document, and a SolidWorks 2019 file used in creating the "Arena Measured Drawing" diagrams. These files can be downloaded from the Discord #hw-uploads channel.

● Where can I obtain the Duplo bricks for the competition?

The Duplo bricks can be obtained in bulk from a number of online sites, including Lego (always a good choice, but probably the highest cost), Bricklink (cheapest per brick, but shipping could be high) or eBay (probably the cheapest option overall, but limited color options). While the official competition will have each of the colors available at each arena, teams could just buy a single color for their practice rounds and write the number on the side of the brick. This would be cheaper than looking for bricks of the exact color specified, and should be sufficient unless teams are using a vision based method of handling the bricks (not recommended due to variations in lighting, and possibly variations in the bricks).

● Trivia question: What is significant about the digit sequence at position 18,900,827? This question was included in the original Arduino source, and it was correctly answered by Ben Wiegand [BigBenMOG], of the Bob Jones University team. The answer is that the sequence 0-3-1-4-2-0-2-0 is found starting at this position, which corresponds to the date of the Pi Day challenge during SoutheastCon 2020 (03/14/2020).

Rule updates from October 21 to November 4 release:

The following were the rule changes and clarifications to the rules in this release of the rules (November 4) as compared to the previous release (October 21). This is the FINAL release of the rules, and any further updates or clarifications of the rules will be made in a separate FAQ document.

- Correct the distance of the starting square as 3.5”, not 2.5” from the inside of the nearest 4' wall.
- Added comment that the white line width may vary +/- 0.1” in width, and 0.25” in length from the required 1.0” width and specified lengths.

Rule updates from June 1 to October 21 release:

The following were the rule changes and clarifications to the rules in this release of the rules (October 21) as compared to the previous release (June 1).

- Multiple minor wording changes that do not impact the spirit of the rules, but teams are urged to closely read the new rules to make sure they are fully aware of the requirements [rodney]
- Updates to the "important dates" section [rodney]
- Corrected distance of the starting square and hole as measured from the 2x4" and clarified that the measurement was from the interior side of the 2x4. The distance to the center of the starting square and hole did not change, but the previous incorrect values were due to a calculation error [rodney]
- Clarified there is no wall in front of the rooms (as seen from the center of the arena) [rodney]
- Arena code posted – provide link to github site [rodney]
- Robot can extend 1" in either direction beyond the wall, and no more than 1/2" down below the back side of the wall [rodney]
- If the robot splits into multiple robots, they are not required to be tethered if no communication between them is needed. However, you must have a way to stop the robots at the end of the competition – it is recommended they stop automatically at 3 minutes [private]
- Legos can be used in the construction of the robot, but if used in the robot or the base, it must be clear which were placed by the robot from the bins for the competition. In addition, non counting bricks can be used on top of the stack for support and in the base, but it must be very clear they are not to be counted. Different color, marking, and explain to the judge before the competition begins so there is no misunderstanding [rodney]
- Lidar and sonar sensors are allowed, but be aware that multiple robot competitions will be run at the same time, and it is possible for interference, so code around it, or shield, or both [oldguy61]

● Shorter switch debounce times – button must see 25ms of uninterrupted ON to count, and 25ms of uninterrupted OFF to reset for the next press. That does not mean 50ms time per button! Button debounce may vary from physical button to button. [rodney]

● Removed the limit of the number of scoring pushbuttons. A real limit will exist in the code, but that limit will be higher than is physically possible given the requirements of on/off cycle time as presented in the rules. [rodney]

● Removed section on Raspberry Pi taking photograph of the stack, and added comment that teams should take their own photographs of the stack in case there is a dispute in scoring [rodney]

● Update colors on Lego bricks - dark gray replaced by dark bluish gray, reddish brown replaced by tan [rodney]

● No limit on number of available bricks of any color. If you do anticipate using more than 15x of any one color, please contact me privately with how many you will need and what color, so I can either order more bricks, or arrange the competition such that bricks can be borrowed from other arenas [rodney]

● Remove requirement that the stack be visible from the button area [oldguy61]

● It is allowed for the robot to partially obscure a part of a stacking brick, but not the complete brick. If the brick cannot be seen, it will not be counted (so sequences stop then). See oldguy61 comments dated Sept 9 [oldguy61]

● The pre-placed base may extend on to of the wooden surface, but should not extend beyond the outer edge of the 1” line [oldguy61]

● The 2” height restriction on the base is only for bases placed in advance of the competition. The only restriction on a base dropped off by the robot is that it be included within the 12”x12”x12” original robot space [UNCC-Matt]

● The stack is not required to physically touch a base, but can be held over the hole, but the bottom must be contained within the 5x5 opening. If the stack leans, the top of the stack can extend outside the 5x5 area. This is to allow some leaning, but stacks must be within +/- 15 degrees of vertical – this is

arbitrarily chosen to prevent teams from building the stack completely on the ground (horizontal) and have one brick over the start hole – yeah that was asked [rodney, private, several]

● Bricks must start with 3 at the bottom – not at the top. This was already stated in the rules, but repeating again as I have had that question asked multiple times [many]

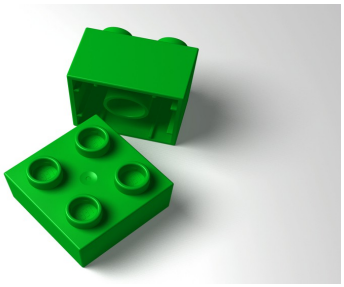
● Quality control of Legos. I will definitely inspect each brick as they arrive for any obvious issues, but teams are encouraged to inspect the bricks as they place them in the arena and can pick and choose which bricks they wish to use (I will have extra) [GT-Isaac]

● Answer to trivia question – thanx! [BigBenMOG]

● Updated table on #Legos of each color to reach a specific height as shown on the github page [rodney]

Duplo Brick Trivia

A Lego Duplo 2x2 brick is 18.2mm high and 31.8mm wide and is twice the size of a standard (non Duplo) Lego brick.



First 250 Digits of Pi

3141592653589793238462643383279502884197169399375105820974944592307816406286208998628034825342117067982148086513282306647093844609550582231725359408128481117450284102701938521105559644622948954930381964428810975665933446128475648233786783165271201909

How many bricks are needed?

The following table shows how high a stack you can build provided a specific number of each Lego Duplo brick. With 15x of each color, it is possible to build a stack that is more than 7' above the top of the base!

If that is not enough, let me know, and more bricks can be provided.

Bricks/ color	Bricks/ stack	Stack height
1	3	2.3”
2	10	7.6”
3	17	12.9”
4	24	18.1”
5	25	18.9”
6	27	20.4”
7	43	32.5”
8	46	34.8”
9	58	43.8”
10	62	46.9”
11	79	59.7”
12	80	60.5”
13	100	75.6”
14	107	80.9”
15	113	85.4”
16	124	93.7”
17	134	101.3”
18	147	111.1”
19	150	113.4”
20	152	114.9”