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TDPS Notebook by Team 07

Members:

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Primarily on adjusting the communication content of each module and the robot arm, improving the OpenMv pathfinding system, and writing the initial report.

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Submitted third-week progress and discussed methods to integrate the system and finish later modules.

Improve some group's modules Fourth week day-to-day progress

OpenMv camera , ultrasonic detector and chassis design were being implemented. PCB group designed the connection. Mid-term report and notebook might be finished.

Third-week progress reports and midterm assessments Fifth-week group meeting

Sensor, camera, and chassis integrated, together with communication and robotic arm modules were given to PCB team for assembly and field testing. To solve issues, PCB group should also ensure proper integration and group communication.

First week group meeting

Date: Thursday, February 23, 2023, 19:00–20:00 PM

Purpose: Identify group members.

Procedures:

1. During the first week of class, I sat in the Liren Building classroom and listened intently as the teacher outlined the guidelines for this group assignment.
2. Classmates and I spent an hour after class debating and adjusting the team members in each major(including IE, ME, and CE) to form a fair and cohesive team.

Results: We selected our ten members from three majors: four IE majors, four CE majors, and two ME majors.

Conclusion and suggestions for future experiments: After confirming the division of labor, our team members and I should read the tasks and requirements of the project for this semester carefully and confirm the division of labor among members during the next week.

Recorded by: Gu Xingci

Second week group meeting

Date: Tuesday, 28 February 2023, 16: 15 PM-18: 00 PM

Purpose: Determine team members' distribution of labor

Procedures:

1. Firstly, our team members and I clarified the project's goals and timeline. Our aim was to program a robot to carry out a series of operations and complete two patios' activities, each with three tasks.
2. We started with both Patio 1 and Patio 2's tasks, deciding that our team needed to confirm the construction of our rover model system before moving on to the pathfinding process for the initial goal. At this point, everyone started introducing the parts they are good at; for example, Chen Xi said he is suitable for the control module based on the servo principle; Yang Chun said he is suitable for handling the openMV vision processing module; and Yuan Ye said he is good at building the system's framing.
3. After that, we confirmed the initial roles assigned to each member of the group: Sun Linhan, Guo Linhong, and Zou Hanlin were all working on PCB and document integration. In this group, I was in charge of writing the notebook and initial report. Chassis and tires were Sheng Dian's domain. Motor maintenance is within the purview of Chen Xi. Li Chenghao and Liu Cehan were in charge of the communication between modules and adjusting the clock frequency. The OpenMv module was developed by Yuan Ye and Yang Chun.
4. Finally, we identified the timing of the initial project report, notebook, and intermediate evaluation to ensure that the content of these sections was submitted on time.

Results: We confirmed the initial division of labor among the group members and verified that everyone had an appropriate division of labor and was capable of completing the mid-term progress assessment successfully.

Conclusion and suggestions for future experiments: Following a week of clarifying roles and responsibilities, everyone began working on their assigned tasks this week, with a plan to

report and integrate the system at the same time next week.

Recorded by: Gu Xingci

Third week group meeting

Date: Wednesday, March 8, 2023, 13:00 PM–16:15 PM

Purpose: First week's progress reports and system integration

Procedures:

1. To start, Chen Xi gave a detailed briefing on motors, explaining that he had purchased a motor and tweaked its module to better regulate the robotic arm's motion. He also recommended that, once everyone had finished their individual reports, the team's group members should go on to complete their group reports.
2. Following that, the PCB integration team led by Sun Linhan, Guo Linhong, and Zou Hanlin stated that they would try to convert the Arduino code to STM32 to meet the course requirement. As the two chips' designs and programming languages were different, they needed to make some adjustments to guarantee the code's correctness and stability.
3. Li Chenghao and Liu Cehan, who were in charge of communication, said that two key parts of their current effort were fixing RTCs and transferring data via HC12. Among these was real-time clock debugging, in which they were trying to utilize a Nucleo-L432KC chip to retrieve the time over the I2C protocol.
4. Yuan Ye and Yang Chun, who were in charge of the OpenMv module, said that they first conducted a field trip to the pavement conditions of our school's East Lake, and Sheng Dian also went to confirm the terrain conditions to ensure that the chassis and wheels of the rover he designed could maintain a smooth progress on gravel ground and flat stone pavement.
5. After all group members were debriefed, everyone focused on the problem of how to identify road signs in Task 2.1. There are currently two schemes to achieve the recognition of arrows through machine learning algorithms; the other is to directly identify triangles and rectangles. The final result of the discussion was the former. It was decided to ensure the basic functions of the rover to complete the task of midterm display. Secondly, every team member was concerned with finishing Task 2.2, which entailed throwing small balls, using the motor to operate the robotic arm, and also had a requirement for the 3D printer arm. The current discussion was led by Chen Xi to finish the content of the servo, while Sun Cehan and others were responsible for assisting with the modeling and finishing the task of 3D printing the robotic arm. Finally, I wrote everyone's report in detail on the electronic notebook in order to find everyone's corresponding progress and make timely adjustments.

Results: Modules have been developed for the project, and our team has discussed system integration. Everyone on the team knew what he needed to do to move his part of the project forward.

Conclusion and suggestions for future experiments: The robot's system was taking shape. This week, team members should continue developing the partially assembled modules they were accountable for and talk to each other about the coordination and communication issues that have arisen between the modules.

Recorded by: Gu Xingci

Third week day-to-day progress:

Purpose: Improve some group's modules

Date: Friday, 10 March 2023.

Purpose: Adjust the communication content of each module by communication team members, including Li Chenghao and Liu Cehan.

Procedures:

1. To lessen the burden on the main control's memory and boost the stability of time communication, they've settled on a communication system with a different design in which the main control and communication module were split.
2. In the end, they settled on the DS3231 as their RTC after considering other options. By using an external crystal oscillator, Beijing time can be pre-programmed into the system. The module then functions as an independent clock, enabling time processing even during a blackout.
3. They decided to jump into the coding. Their proposed starting procedure framework is as follows: The HC12 receives an enable signal from the main control STM32 (H7 series) when the tram reaches the predetermined location. The signal is received by the HC12, and then the L432kc receives data via the UART protocol from the stm32L432kc linked to the HC12. The L432kc then uses the time read from the RTC's (DS3231) crystal oscillator module as a buffer after receiving the command. After that, the PC receives the group's name and time through USB and displays them.

Results: The planning of the communication system has already taken shape, and on top of this, it was ensured that the programming of the communication module was partially completed before the next group meeting.

Recorded by: Gu Xingci

Date: Saturday, 11 March 2023.

Purpose: Improve the OpenMv pathfinding system by OpenMv programming team members, including Yuan Ye and Yang Chun.

Procedures:

1. Based on observations made during field trips Their team established that the OpenMv camera might perform the duty of road surface patrol: the surface used for the patrol line with a sparse gravel pavement, while the surrounding pavement with a flat stone pavement. And the camera was required to send a signal to the rover, which might determine the direction of the current small car based on the signal's intensity.
2. They chose to use the CANNY operator for edge detection of the pavement. While the edge of the standard pavement was sparse, and the edge of the patrol line surface was thick and complex. The next step involved detecting as many edges as possible. Hence, a higher resolution was needed.
3. After a heated discussion They finally chose to use the mean operator to lighten the load on the subsequent computations, involving adaptive binary and image filtering.

The next step was to apply mean pooling to grayscale photos to identify pavement in areas where there were many edges.

Results: OpenMv Camera's path detection has been provisionally implemented. Thus, the team moved on to discussing how to establish communication with Sheng Dian's Rover chassis in preparation for their next group meeting.

Recorded by: Gu Xingci

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Date: Sunday, 12 March 2023.

Purpose: Adjust servo and robotic arm modules by Chen Xi

Procedures:

1. After a heated discussion at the third week group meeting, Chen Xi carefully evaluated the design of the robotic arm and the selection of servos.
2. The original concept for the control module he was tasked with was as follows: when the rover was in front of the trash can, the master (STM32) sent a PWM signal to the robotic arm, which then rotated 180 degrees and dropped the ball into the opening at the bottom of the frame. For the ball to be successfully deposited into the frame, the trolley's servo and robotic arm would be elevated above the frame via a platform.
3. For three reasons, he settled on this basic structure. One, it was easy to build (requiring only a single servo), and two, it was lightweight and took up little room. Inherent in its bridge-type construction, the PLC material was surprisingly lightweight. Using this layout, you could save some space. The third was personalization. We were able to adjust the drive rod's length, thickness, and interface type thanks to the 3D model. Also, you can alter the appearance of several objects, including the tennis ball used in the mission.

Results: He had a rough plan for his robotic arm's control system and hoped to have some of the programming parts and some of the parts 3D-modeled and printed by the time of the next group meeting next week.

Recorded by: Gu Xingci

Date: Sunday, 12 March 2023.

Purpose: Write an initial report based on the progress they reported to me.

Procedures:

1. I listened to some of the group's day-to-day development and wrote down my observations in the digital version of the notebook.
2. Then I drafted the initial report's abstract, introduction, and task content introduction. based on the partially formed system framework.

Results: The notebook was half filled with entries by the due date. and a draft of the initial report has been created.

Recorded by: myself

Conclusion and suggestions for future experiments: The focus was mainly on adjusting the communication content of each module and the robot arm, improving the OpenMv pathfinding system, and writing the initial report. It was also intended to report the progress and handover of modules in the next group meeting.

Fourth week group meeting

Date: Tuesday, March 8, 2023, 14:00 PM-16: 05 PM

Purpose: Second week's progress reports and system integration

Procedures:

1. First, Sheng Dian carefully reported the chassis he was now correcting. After receiving the progress of the OpenMv camera under the charge of Yang Chun and Yuan Ye. He was picking modules, first deciding that the chassis wheels should utilize the Mecanum wheel, which allowed wheels to synthesize force in any direction. Then it was determined that the main control OpenMv and the chassis motor to carry out UART communication. Through the calculation, the motor gets the corresponding speed assigned to each Mecanum wheel.
2. After the basic work on Sheng Dian's chassis was finished, the following groups with day-to-day weekly progress last week was reported separately. The OpenMv camera team, including what Yang Chun and Yuan Ye reported last week on the rover's basic pathfinding, progress and discussed the code operation. They would next finish Patio 2's machine learning-based OpenMv camera to identify garbage can and recognize an arrow icon.
3. At the same time. Chen Xi, the robotic arm's in-charge designer, displayed his 3D-modeled portion of the arm. pointing out that the component frame can reserve a 3mm border for the pitch to prevent the ball from getting stuck in the custom 3D printing. But that the original model is simple and needs to be iterated and raised to achieve the process of throwing into the trash.
4. The members of the communication team, including Li Chenghao and Liu Cehan, said that they should accelerate the programming part of the communication module content. As elapsed time was pre-injected via the external crystal oscillator module, they used the DS3231 as RTC. Nucleo-L432KC used the time read from the DS3231 crystal, Osilltoarl. module after receiving the signal to perform buffring. The time and the group's name were then sent to the computer via USB and shown there."
5. I reported that I had completed the first half of the notebook content.and also indicated that I would continue to draft the report's initial version.
6. Yang Chun and Yuan Ye gave chassis designer Sheng Dian OpenMV's orders and signals during module handover. Chen Xi, who is in charge of the robotic arm exports the 3D modeling diagram to the students in charge of the document for writing report part, and Li Chenghao and Liu Cehan also hand over their communication module to Sun Linhan. Guo Linhong. and Zou Hanlin, who were all working on PCBs and document integration, let their group be responsible for drawing the schematic and system-design writing.
7. The students who were in charge of the prior phase would make enhancements to the system next week. while the students who would be in charge of the phase after that would create the matching modules in the fourth week following the handover of the prior phase, I meticulously recorded everyone's reports in the digital notebook so that could track down their individual improvements and make necessary

adjustments.

Results: After submitting third-week progress, our team discussed how to integrate the system and finish later modules.

Conclusion and suggestions for future experiments: The students who promoted the early project continue to build and improve the module. The students in charge of the handover must complete the communication interaction with the early progress and develop their later modules.

Recorded by: Gu Xingci

Fourth week day-to-day progress:

Purpose: Improve some group's modules

Date: Friday, 17 March 2023.

Purpose: Improve the OpenMv recognition system by OpenMv programming team members, including Yuan Ye and Yang Chun.

Procedures:

1. To achieve the unity of accuracy and robustness, they planned to use that one ultrasonic detector was placed at the front of the rover and two ultrasonic detectors were placed on the right side, allowing them to realise the second stage of pathfinding and arrow signpost recognition using OpenMV's artificial intelligence image recognition function.
2. In the early stages, they discussed numerous strategies to recognise arrows. But conventional algorithms had trouble recognising the arrow itself from a great distance. Then their team started using a machine learning approach. In order to determine the orientation of the arrows, they wanted to take photographs of acrylic and black standing plates.
3. As the ground's pebbled texture makes stable extraction difficult, they planned to utilise numerous ultrasonic sensors to help the rover navigate safely along the edge of the railing as it searched for trash cans.

Results: The framework for the OpenMv camera's path-finding and icon recognition tasks was taking shape, and the camera would be fully programmed before the next group meeting.

Recorded by: Gu Xingci

Date: Friday, 17 March 2023,

Purpose: Begin working on the PCB design and the top-level system integration by PCB and document integration team members including Sun Linhan, Guo Linhong, and Zou Hanlin.

Procedures:

1. They decided in the beginning. The PCB acts as a reliable connector between components of the system, such as the microcontroller, servo, motor drivers, and communication module. Other components of the system include the battery. They said that they had brought the initial components and designed the preliminary PCB board. After the system had been put through its paces in terms of testing, the precise design of the PCB would be completed.
2. They also incorporated the communication team's module into the previously

discussed system solution, drew and described the high-level design of our initial report in detail, and broke the process down into detection phases in which the sensors are in charge of gathering data, and the STM32 MCU is in charge of processing and analysing that data. Once the draught report section was complete, it was sent to the execution section, where the robot arm and Chassis' motor controlled the movement. And these were delivered to me to complete the draft initial report part.

Results: The preliminary materials and design of the PCB board had prepared, and they had made a simple layout of the main control part and the integration of other parts, which was used to designed the top-level system design and included it in the writing portion of the initial report.

Recorded by: Gu Xingci

Date: Saturday, 18 March 2023,

Purpose: Design and Adjust rover's chassis modules by Sheng Dian

Procedures:

1. After determining the choice of Mecanum wheels, he finally settled on the PID algorithm, a linear controller with a simple concept, strong robustness, and a broad practical range that guaranteed the real speed of the wheel was identical to the desired speed and considerably improves the precision with wheels moving. His programming part started by measuring the wheels' real and rotational speeds with the use of a rising-edge interruption, then work to bring the two speeds closer together until they are equal.
2. Specifically, he decided to use a PWM output to regulate the motor's speed and direction by adjusting the duty cycle, and a pair of digital pins to alter the output's potential level.
3. Finally, with regards to communication, he chose to use UART serial communication. Once OpenMV published information with front and rear speed and its direction, left and right speed and its direction, these information would go through calculation to obtain the corresponding speed assigned to chassis motor then to each wheel, resulting in matching the control of the speed and direction of the four wheels.

Results: Sheng Dian's modified PID algorithm moved wheels perfectly. PWM output, digital pins, and UART connection enhanced chassis motor and wheel precision to complete rover chassis components.

Recorded by: Gu Xingci

Date: Saturday, 18 March 2023,

Purpose: Design and Adjust ultrasonic detectors modules by Li Chenghao

Procedures:

1. After our group meeting, Yang Chun and Yuan Ye decided to assign ultrasonic detectors module to Li Chenghao, who was in charge of communications and the ultrasonic module needs to cooperate with the person in charge of the main control. He accepted, and expected the rover's three ultrasonic sensors' data transmission capability to be activated by the main control board when the vehicle neared the

site's edge.

2. He planned to design two of the three ultrasonic sensors installed 10 cm apart, parallel to the right side of the rover, at the height level of the railing column. The rover could go to the field's edge, made turns, and performed other movements by programming its two ultrasonic sensors to keep a distance of roughly 10 centimetres from the right railing column. And he promised that the programming part would have done before the next group meeting.
3. At last, he proposed that the garbage can symbol in front of the rover would be recognised by the ultrasonic sensors put there. In order to make it possible for the rover to automatically alter the rate of each wheel based on the received data, he decided to build PID regulation specific to the ultrasonic sensor data format.

Results: Li Chenghao promised to finish the programming before the next group meeting and proposed to build a PID regulation specific to the ultrasonic sensor data format for automatic wheel rate adjustment.

Recorded by: Gu Xingci

Date: Sunday, 19 March 2023.

Purpose: Write digital notebook and almost finished initial report based on the progress they reported to me.

Procedures:

1. I hosted some of the group's day-to-day progress online meeting rooms and made notes in the electronic version of the notebook on what I heard.
2. After receiving the top-level design flowchart and each team member described his work part. I wrote the rest of our initial report.

Results: By the due date, the notebook was nearly full of entries. Also, the first report draught might be completed before the next scheduled group meeting.

Recorded by: myself

Conclusion and suggestions for future experiments: The OpenMv camera's pathfinding and identification detection functions were operational, and the ultrasonic detector module was being improved for cooperating with the camera. Chassis design and rover communication are also at the implementation stage. The PCB group had designed the main connection method and top-level system flowchart. I got more information, and a comprehensive mid-term notebook and initial report were able to be submitted before the deadline.

Fifth week group meeting

Date: Wednesday, 23 March 2023, 15:00 PM-18: 05 PM

Purpose: Third week progress reports and midterm assessments

Procedures:

1. First of all, the group responsible for OpenMv camera, Yang Chun and Yuan Ye, had completed their report this week, detailing how they've begun to implement the project's goals of path-finding and arrow and trash can identification. Sheng Dian and Li Chenghao, members in charge of the sensor module and chassis that interacted with the camera, had begun to run the wheels in accordance with the data sent by

OpenMv, with adjustments made by ultrasonic detector. After integrating these components, rover proved capable of implementing the Patio1 tasks, which completed initial part of the mid-term assessment, They said that they had uploaded the code and its explanation together with description on github for other members to view and understand their modules.

2. At the same time, Chen Xi confirmed the ball-throwing robot arm by continuously modifying it, and Li Chenghao and Liu Cehan added their communication module to the running state of the rover for testing and field investigation and demonstration to ensure that the tasks of Patio2 could be completed on the basis. However, the module was not installed on the trolley, so Li Chenghao and Liu Cehan decided to hand over their module to the group in charge of PCB for final assembly and testing.
3. Finally, we talked about the writing of the initial report. I used the version of Word to typeset and record the text content. But in order to facilitate the modification of the format, we settled on using LaTeX so that everyone on the team could view and edit it; and we agreed that the final report would also be typeset in LaTeX so that everyone could easily make changes to the format and share it with one another.

Results: The sensor, camera, and chassis parts had been integrated and installed, and the team in charge of communication, the robot arm, and my notebook and initial report were handed over to the PCB team for assembly and field testing.

Conclusion and suggestions for future experiments: The PCB group should continue to test and integrate all modules to ensure they worked well together. Regular communication and progress updated between groups might help maintain consistency and solve problems.

Recorded by: GuXingci