PoLIDAR: a six wheel-legged mapping robot

E. Gissinger, M. Vermot-Desroches

***Abstract*—In order to make a six wheel-legged mapping robot to remove the human need in mapping, we realized a wooden model of the frame and the wheel ensemble consisting of a 12V motor, a 5V servomotor, wood support pieces, a wheel and a suspension. We also used a LIDAR sensor to scan the area and get a series of point to, later, make the robot autonomous by choosing where he should go according to the series to scan the area.**

***Index*—LIDAR, autonomous, mapping, six-wheeled**

I. Introduction

TO map an area is the process of creating a map using coordinates of the relief in points by scanning an area. Mapping an area can be a complicate task for a human. Indeed, the relief can have rocks, mud, hills, humps, cliffs (mostly for coasts) or just for a post-disaster area 's exploration [1]. Moreover, mapping is a complicate task for a human in general [2].

To ease this task, many mapping robots were made depending on the type of area: on the earth [3], in the air [4], under water [5], in Mars [6].

Our goal was to make a mapping robot that does not require human presence to work properly (with a LIDAR sensor). We chose to make a mapping robot that works on the earth. There are two types of earth mapping robot, those with tracks and those with wheels. We chose to use six wheel-legs for their efficiency [7].

We wanted the robot to be autonomous in its movement, so we used the LIDAR to allow the robot to map and locate itself without human assistance [8].

In this article, we will first speak about the robot's structure, from the frame to the wheel ensemble, from its sketches to the wooden model made as a prototype. In the second part, we will speak about how we manage to scan the area thanks to the LIDAR. Finally, we will conclude on what we have done at the moment.

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II. The Robot's structure

A. The frame

The frame is an important piece of our robot, it will support the microprocessors and the wheel-legs. After looking at different existing robots similar to ours [9] [10], we first decided to go with a T-shaped frame : the top would support everything and the tip would be the fixing point of all the wheel-legs.

However, after counting everything the top would have to support, we switched for a sort of cubic-shaped frame as it is more resistant than a T-shaped one. The wheel ensemble would be fixated on a side of the cube.

B. The wheel ensemble

The wheel ensemble is the centerpiece of our robot, it has to be able to support relief-changes as well as rotating the wheels when needed. We decided to make an ensemble consisting of a wheel, a 5V servomotor, a 12V motor, a suspension and supports pieces. The servomotor will allow the ensemble to rotate, the suspension will make the ensemble able to sustain the relief-changes and the supports pieces will make the link between it and the frame. You can see on figure 1 a sketch of the ensemble.

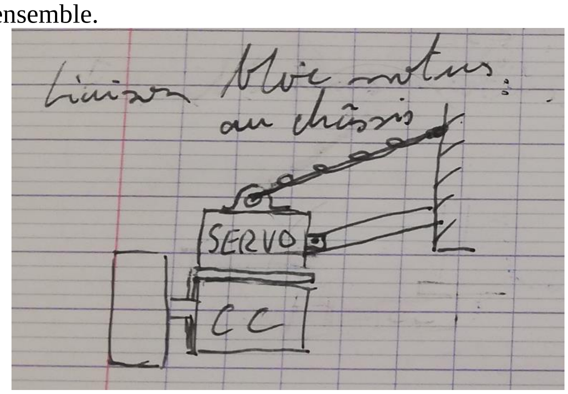

Fig. 1. The wheel ensemble

C. The wooden model

In order to have a prototype of our robot, we decided to make a wooden model, at least one for the frame and for the wheel ensemble. Firstly, we realized CAD models of the supporting pieces (named joints) and plate for the frame. Then, we used the cutting machine to make them with wood. This step created a lot of problem for us, as we didn't know how wide we wanted our model to be (we had a large choice of width, between 3mm and 8mm for example) and ended up making one of 3mm and one of 5mm. The other problem was with the joints, at first, we wanted them to be the same as the

supporting pieces of the wheel ensemble, but in the end we decided to make them different. That slowed the process a lot since we also made the first batch using the wrong width.
In the end, we managed to make the frame and the wheel ensemble (we used two small aluminum bars with the wood). You can see a picture of the wheel ensemble on figure 2.

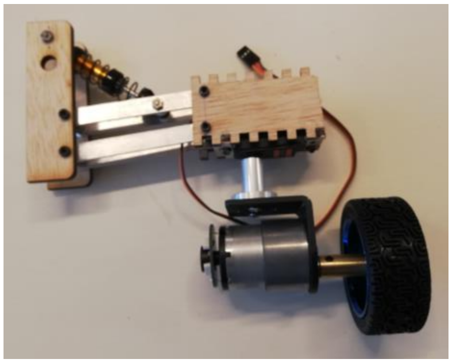

Fig. 2. The first wheel ensemble

D. *The servomotor program*

We wanted the robot to turn when an obstacle is encountered, so we needed to program the servomotors. In order to do this, we used ultrasound sensor to measure the length between the robot and an obstacle to then rotate accordingly.

III. LIDAR

To be able to effectively scan the surrounding environment, we decided to add a LIDAR based module on top of the robot. We chose to use a LIDAR-Lite v3HP as our LIDAR sensor because it is fast (>1000 Hz) and accurate. We also decided to attach the LIDAR sensor and redirect the LASER with a mirror to achieve 3D vision instead of moving the LIDAR to get a more robust and faster robot [11]. We achieve this with a structure that enables the mirror to rotate on the vertical and horizontal axes. To achieve this, we use four pieces that we designed using Fusion 360 and then printed using a Prusa : a rotor, a ring, a synchronizer and the mirror's support. The ring slides around the rotor, while the synchronizer lies on top of the ring and rotate with the rotor while being also attached to the mirror's support as seen in Fig 3. With this basic setup, we can control the mirror's pitch angle by sliding the ring and rotating the rotor. We use two 9g servo-motor on each side of the ring to slide the ring because it is cheap, small, precise and easy to control. Moreover, the two servo-motor move together to avoid any friction with the rotor. On the other side, we use a nema 17 stepper motor and its A4988 driver to rotate the rotor because of its high precision. Moreover, they are coupled with a belt instead of gears in an attempt to reduce the propagation of vibration and thus achieve greater accuracy. Finally, we cover one face of the support's mirror with a "mirror effect" film and we attached everything to a board that was also printed as well as a ball bearing to ease the rotation.

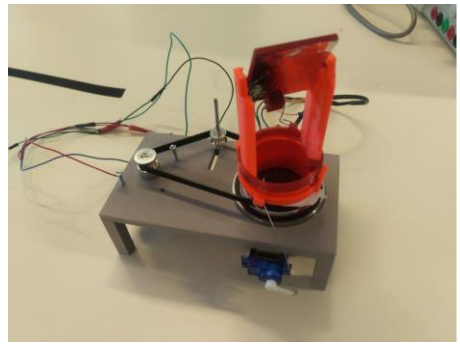

Fig 3. The stacked ring and synchronizer on the rotor.

Everything is controlled using an Arduino UNO on which runs a straightforward program. First, we rotate the stepper motor by a step, then we get the distance using the LIDAR sensor. Once received, we convert those coordinates into cartesian coordinates using basic trigonometry and send them to the computer. We repeat this process until the rotor makes one turn and then we slightly increase the servo-motor pitch before repeating the same process.

IV. Conclusion

In conclusion, we realized a wooden frame, a wheel ensemble consisting of a wheel, a 12V motor, a 5V servomotor, a suspension and wooden support pieces. We also made a program allowing the robot to turn when an obstacle is detected by ultrasound sensors.
Also, The LIDAR module offers 3D scan capability with variable speed even though it suffers from a badly designed synchronizer that does not enable the mirror to pitch properly and some inaccuracy due to the mirror's film not being flat enough.

References

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