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**Your summary should comment on the following 5 bullet points with no more than 2 paragraphs each, entirely in your own words:**

**Summary (What were the major ideas and results described by the speaker?)**

The major ideas were the development of cave exploration robots. The speaker described how his team took inspiration from the missions of the robots that were going to Mars in order to get ideas for robotic designs that were good for that type of environment. The team the speaker was leading was competing the DARPA challenge of subsurface exploration on earth. The main challenge was to create robots that would explore and use geometric mapping to map a cave and find objects in a cave, giving the locations of them. The first challenge was the need for a robot that could have a long battery life (90 minutes) and could move up and down vertical shafts. There was also localization challenges such as it being dark, and dusty. Another challenge was the problem of communication. The environment made communication difficult so the team's plan was to use low cost disposable robots to act as communication links, with resiliency through redundancy. The team planned to use three methods to help meet this challenge of robust and risk-aware motion planning: SMAP (simultaneous mapping and planning), SLAP (simultaneous action and planning), and SLAM (using math to solve all the positioning and planning at the same time).

**Strengths of the work (What were the noteworthy technical contributions presented in the seminar?)**

The strengths of the work are the robustness and versatility of the robot; it is able to roll and save battery, but it can also fly when it must be able to fly to navigate vertical shafts. Another strength is how the team tackled their communication issues, specifically how they are able to use disposable robots to act as links to bridge bad communication. Another strength is how they solved the SNAP problem: discretizing the space and then using a controller that takes into account the confidence of what its reading and using that to determine the truthfulness of this reading. Another strength is the approach of using the sensor-cause model to create the map as they go.

**Weaknesses of the work (What were some technical shortcomings of the material presented?)**

One of the technical shortcomings of this work is that they must use a communication bridge to make sure that they can communicate with their robots within the cave. The communication bridge made of small robots leads to more points of failure, which can cause more problems for the system as a whole. Another technical shortcoming of the work is that the team is depending heavily on not having to fly their robot much in order to save battery. This may be a problem if the terrain they encounter necessitates a lot of flying - their battery may not last the entire 90 minutes.

**Opportunities for future work (Describe some ideas for follow-on projects based on the material presented.)**

One idea for future work for this would be to explore improving the communication bridge they are planning on making out of their robots. Such a bridge could be used to improve communications in many difficult to reach areas, such as the caves they are exploring. Such a technology could be standardized and made available to a wide range of applications. Another area that could be used in future work is the SMAP prediction of map evolution using sensor readings. Such a technology could be used to improve self-driving cars and how they predict how the environment around them will change.

**Presentation style (What did you like or dislike about the manner in which the speaker presented?)**

The presenter conveyed the information well with slides and did not overcrowd the slides, which was a strength of the presentation. However, the presenter did not manage time well and was forced to rush at the end of the presentation, effectively meaning that the information was not conveyed very well for the second half of the presentation. Finally, the presenter sometimes did not speak loudly and clearly, making it difficult to understand.