Possibility of Education Project based on CanSat

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ABSTRACT

This paper explores the new type education based on CanSat (CanSatellite) and shows its potential through the field experiments. CanSat is the miniaturized can-sized satellite and its project promotes peoples to learn space technology for the educational purpose. Since such an educational promotion succeeded in many events including ARLISS (A Rocket Launch for International Student Satellites), this paper explores other educational aspects and focuses on education of decision making through CanSat because decision making in space mission is very critical. In order to investigate the potential of the proposed education, we carried out the field experiments in Noshiro space event and ARLISS. Through the empirical experiments, the following implications have been revealed: (1) the proposed education provide pseudo planetary exploration experience; and (2) **** through a process where children in a different area can control our CanSat after rocket launch by using UI; (3) Our system may learn the importance of distribution of roles for efficient decision-making; (4) The proposed education may promote their discussion and develop their cooperative;

1 INTRODUCTION

In recent years, many educational programs were proposed to promote children to develop their deep thinking. For example, many junior or high schools in Japan change to evaluate their children by measuring not only mathematical ability and reading comprehension, but also logical thinking. As the needs of such education for children increase, these educational programs are recognized as an important for promoting children to motivate to learn and to increase an ability of finding a keen insight.

In times of accelerating change, we have to properly understand the ever-changing needs of education. For this issue, we provide educational project which help to develop their inside through CanSat educational program since we fulfills needs for education.

CanSat is the miniaturized satellite which is created to educate space technology. Since CanSat can be created inexpensive comparatively, many competitions which directed at student are held in the world (ARLISS, Noshiro Space Event). The sizes of CanSat differ on the competitions. Small CanSat is limited to fit inside the soft drink can (66mm diameter and 115mm height) typically and it have a mass below 350g. Large CanSat called “Open Class” is limited to 146mm diameter and 240mm height, it have a mass below 1050g. CanSat is used to teach space technology. Even CanSat is motivated to aim educational activity through space theology, it is not the main idea that CanSat is used to aim promoting children to motivate to learn and to increase an ability of finding a keen insight.

In this paper, we promote Education program based on CanSat (Edu-CanSat project). Edu-CanSat is the educational project which teaches children space technology through pseudo planetary exploration experience to children. The aim of our project is helping children to develop their inside (such as cooperativeness, imaginations, creativity) through the pseudo planetary exploration experience which we provide. In order to provide the experience to children, we created CanSat and user interface (UI) which can operate the CanSat on web browser. Our CanSat have some modules as follow; (1) moving web camera which can grow taller and look around, (2) moving stabilizers which is assembled with back and forth. Our CanSat can transmit steady video to UI by controlling them. Our UI includes the video, a display which shows status of the CanSat, buttons which control CanSat action. Children can control our rover freely by using UI. Since our UI is developed on web browser, Children can control our CanSat everywhere, every time. In addition, we let the users achieve the some mission using our system. In order to achieve mission using our system, they have to find a keen insight, then they have to cooperate through discussion against problem. In order to investigate our system, we carry out filed experiments in Noshiro space event and ARLISS. The aim of the experiments are development solving ability, motivation to learn and increasing an ability of finding a keen insight through discussion and cooperation in mission.

This paper is organized as follows. Section 2 starts to explain the concepts of our educational project which is called Edu-CanSat and Section 3 describes the detail of Edu-CanSat. Section 4 proposes the detail of filed experiments. In Section 5, we discuss about results of filed experiments and effectiveness of our

project. Finally, our conclusion is given in Section 6.

2 Educational project based on CanSat

2.1 CONCEPT

Edu-CanSat which is our educational project is motivated to help children's inside such as problem solving ability, motivation to learn and a keen insight into the nature of things. To help to develop their inside, we employs system which are comprised CanSat and UI as teaching materials. We provide a pseudo planetary exploration experience for them using system. It needs prediction capability for problem on the environment and solving ability for planetary exploration. In pseudo planetary exploration experience, children need to have willingness to learn independently. In some cases, they may discuss about solution strategy for problem each other. In order to achieve planetary exploration, they have to get variable abilities.

1.

2.2 EDU-CANSAT

In this section, we describe the detail of system in Edu-Cannsat. In the system, children can know the local information through UI which displays video and map based on GPS by CanSat. In addition, they can operate the CanSat freely. They try to run toward the finish line by using CanSat and UI. In order to arrive at goal, they comprehend the state of CanSat based on limited information, and make efforts to tackle the challenges. In the course of challenging the pseudo planetary exploration experience, they can learn some skills such as solving ability, motivation to learn and a keen insight into the nature of things. In order to provide the pseudo planetary exploration experience, we have to develop at least the technologies which are CanSat information delivery technology and CanSat Remote operating technology. Each technologies are described in detail in the following chapters.

2.3 Develoed CanSat

CanSat constitutes GPS, sensors, actuators, MCU and radio adapter. CanSat has the camera which can be extended and the camera used by an image in the air and around the CanSat. CanSat has the stabilizer which can move to escape from stuck. This stabilizer is operated by a servo motor and pushes the ground when getting stuck in the sand. Since the servo which a camera has can adjust only left or right angle of a camera image, the stabilizer can adjust upper and lower angle of it. A stabilizer is attached in front of the body. Since this CanSat has a front of the centre of gravity, the stabilizer can prevents the CanSat from roll of the body. The tire was made of carbon and this tire is about thirty percent lighter than that made of polyacetal resin which is a conventional tire.

Since the CanSat is operated through the camera image in the mission, it has the camera which can be moved and extended .it can take an image around the CanSat except behind. If the camera is attached the body, the tires prevent the camera from capturing an image on the left and right side. To tackle this problem, the camera can be extended on the upper side to observe over a wide range. To shot the image more freely, we fix a servo motor on the camera and the CanSat can take images on right and left side without turning this body. Thus, this can get the surroundings quickly.

Figure 1 : Developed CanSat

2.4 User Interdace

A man operates the CanSat based on the information that has been sent by the CanSat with User Interface (UI). In this section, we illustrate the basic function of UI.

UI receives GPS, angle of the CanSat, falling detection through a server every one second. This information is analyzed in the UI and is reflected. The CanSat can detect turnover of the body and over turn. It is difficult to realize turnover of the CanSat only on the UI and a user feel frustrated. For example, an image from the CanSat is dark when turnover of it and the camera touches the ground. A user should judge whether communication failure or turnover of the CanSat. To deal with the problem, we implement two buttons. One is flashed on and off during the turnover of the CanSat, the other is the button that the CanSat return from the rollover if the user push this button. As this function, we realize the reduction of the burden for the user.

Button for the operation of the CanSat

There are nine buttons for operation of the CanSat as following *Table 1*;

Table 1: *Nine buttons in UI*

1	Move forward
2	Move backword,
3	Right turn,
4	Left turn,
5	Check the right side through the camera image,
6	Check the left side through the camera image,
7	Recover from turnover
8	Recover from rollover
9	Receive from the image.

Figure 2: Developed UI

3 THE FIELD EXPERIMENTS.

3.1 Noshiro space event

The Noshiro Space Event conducts the launch of the rocket which is made by students and the competition of autonomous control of the rover. This event is the largest space event in Japan. The aims of the event are the spread of space education and regional vitalization. In Noshiro Space Event, we provid an opportunity which children can operate our CanSat by using UI. To verify the operation of remote control, we set a situation that children in Noshiro control the CanSat in Tokyo. In this situation, we let them achieve the mission which they founds the landmark in the limited space using our system. The limited space is a simple maze of about total length five meter. If CanSat goes straight, then turn right, they can found the landmark from real time video on UI. Since UI does not have a map about the maze, they need to control from only video and the point towards which a CanSat or thing faces. However, since the camera which CanSat have is set to low towards wall, many of the videos which they can get it with UI are information about wall of maze. In this case, the user cannot understand how it is about situation around CanSat. In order to above this case, we set arrows which guide to the goal on the wall. We let them arrive at the goal while following the signpost and information with UI.

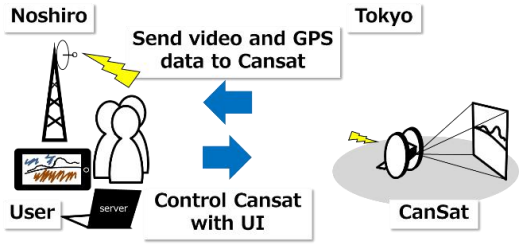

Figure 3: Image of mission in Noshiro space event

Figure 4: Photograph of the users in Noshiro space event

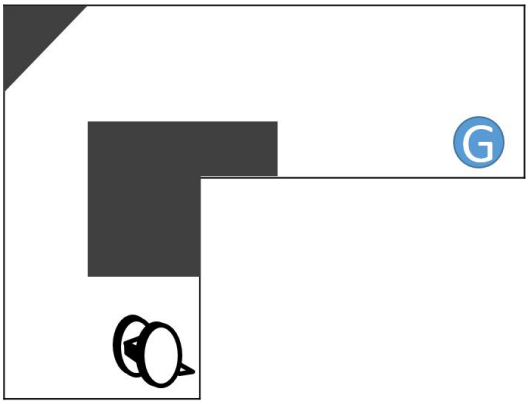

*Figure 5:*Image of maze in the mission

Figure 6: Photograph of the CanSat and maze in Noshiro space event

3.2 ARLISS

The ARLISS is a competition which is supported by faculty at Stanford University Space Systems Development Program and other educational institutions, and high power rocketry enthusiasts in Northern California, to build, launch, test and recover prototype satellites, miniaturized to fit inside a soft drink can (hence "CanSats") in preparation for an Earth orbit or Mars orbit space launch. In ARLISS, we can conduct rocket launched experiment by AeroPac in Black Rock Desert. Students try to attain their mission and compete each other. In ARLSS, we validated the possibility of our project in more challenging situation.

In this section, we describe in detail our mission sequence which provides the pseudo planetary exploration experience to User in ARLISS. Our mission start at rocket launch like basically mission sequence. After rocket launch, our mission is mission sequence as follows;

1) After landing on the ground, the CanSat get its location information used by GPS, and send information which are video and GPS data to UI. UI creates virtual map based on GPS data. This virtual map is within a radius of 100 meters. There are three points which the user have to get in this map, each points called, checked points 1, checked point2, goal.
2) Since the user may not understand the goal from only information on the map, we put a landmark on the goal point.
3) The User can freely explore the map by operating the CanSat with UI. The main purpose of User is arriving at goal, the User needs to get two points (point 1 and point 2) while arriving at goal.

In this mission, there are two persons which called main operator and sub operator, each person discuss how to solve the problem around CanSat to arrive at the goal and get the each checked points.

Figure 7: Photograph of the user in ARLISS

Figure 8: Photograph of the Cansat the user operated in ARLISS

4 DISCUSSION

4.1 Noshiro Space Event

In the Noshiro space event, in order to investigate our project, we carried out filed experiments to the users. The users complete our mission which they arrive at goal in the simple maize with 5 to 10 minutes.

The time which the users complete our mission was unexpected since the mission which the user arrive at goal while contoling the CanSat with our UI is harder than we thought.

We measure our project performance from a different viewpoint. We measure our project from viewpoints. The viewpoints are the time which the user arrive at the goal and how the user make a decision processes what to arrive at the goal. In addition, we compare decision processes by one person with decision processes by two persons.

Table 2: the detail of mission the users tackled in Noshiro space event

User	One	Two
The age of	23	9

main operator		
The age of Sub operator	-	35
Mission time	504s	111s
Mission completed	Not completed	Completed
Actions	20	18

The case of decision processes by one person, the age of main operator is 23. Mission time is 504s. This user could not arrive at the goal. The actions until this user retired is 20 actions. Mission time is 504s. Since the user can not arrive at the goal, the mission is failed. Since the operator cannot discuss how environment around CanSat with another person, he cannot know the factors of problem around CanSat, and operate CanSat to solve these problem.

The case of decision processes by two persons, the age of main operator is nine, the age of sub operator is 35. Mission time is 111s. This users could arrive at the goal. The actions to arrive at the goal is 18 actions. From these results, the decision processes what to arrive at the goal are depended on communication between main operator and sub operator. When such decision processes can be achieved, the number of actions tends to descend. Since the operators discuss how to solve the problem around CanSat each other, they can complete mission. It may be one of the causes which they can complete mission.

In the mission, there are some cases that the CanSat get stuck since its whole is caught by wall. Despite the users experience similar cases, they produce different results. One reason for this results is a balance between try & error and intelligence gathering. Main operators tend to hang on the video and arrows. Since main operators are into video, they reduced vigilance against information without arrows. On the other hand, Sub operators tend to focus on the point towards which a CanSat or thing faces. In such case, Since they can have a clear distinction between the role of main operator and sub operator, they can complete mission. Our system may learn the importance of distribution of roles for efficient decision-making.

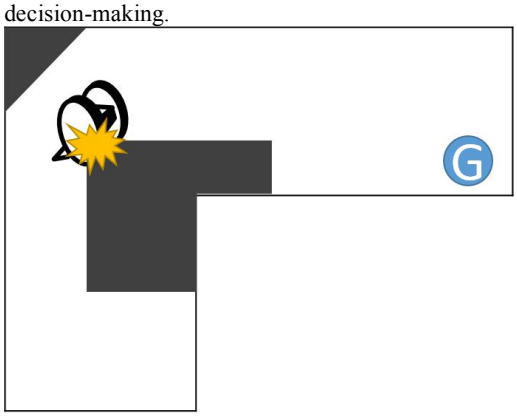

Figure 9: Examples of Stack in the mission

4.2 ARLISS

In this section, we describe the result of mission in ARLISS. We focus on how users discuss about action decision which they tend to arrive at the goal. Results of the Noshiro space event show that if as the number of users grows, mission tends to be completed. The results we compared shows the case of one user may not find solutions for the problem of environment which is surrounding CanSat, since argument cannot be developed with anyone. As the comparison of two cases, it shows our system may be effective as tool which helps the discussion.In ARLISS, we compare also the case of one user with the case of two users.

The age of main user is 20, the age of sub user is 23. The total Mission time is 900s. The mission time which the users arrive at Checked point 1 is 390s. The mission time which the users arrive at Checked point 1 is 100s. Then the users try to go to the goal, they cannot reach. In mission, CanSat they contorted cannot arrive at the goal, Since the CanSat gets stuck in a rutted road. In ARLISS, they get information through UI which has video and map. However, there are some differences how to understand the information. We focus on the differents between the two users.

In the case of that video the screen displayed goes black, they takes different guess. Main operator take guess that something must be wrong with the camera. Sub operator take guess that video the screen displayed goes black since the CanSat keeps state of falling down. They discusses which of the guess is correct. Through discussion between two, they reached the correct result which the guess sub operator insisted. As a result, they control CanSat to reset a falling-down state to a normal attitude state. Since CanSat can send the video to the user, the user can get enough information for the problem of environment which is surrounding CanSat. Therefore, we let the users try to achieve mission without video. In this case, they gets information from only maps. They have to control CanSat discussing the problem around CanSat more than ever.

In fact, main operator and sub operator have different guess against problem. Since they they can discuss having cooperativeness, they reached point 1 and point 2. Our system can help discussion and having cooperativeness.

Table 3: the detail of mission the users tackled in ARLISS

User	Two
The age of main operator	20
The age of Sub operator	23
Mission completed	Not Completed
Total time of Mission time	900s
Time of Checked point 1	390s

Time of Checked point 2	100s
Time of Goal	-

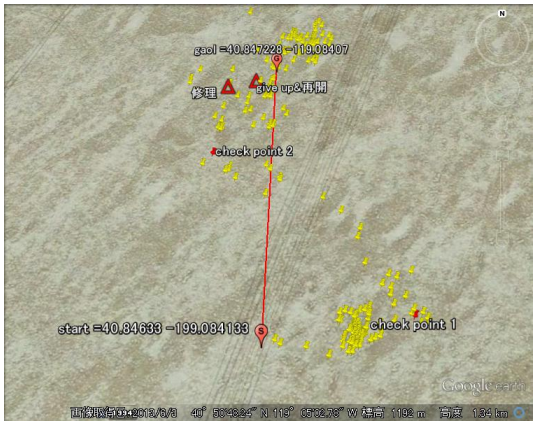

Figure 9: the result of mission in ARLISS

5 CONCLUSION

This paper propose Edu-CanSat which is the new type education based on CanSat (CanSatellite). This paper focuses on education of decision making through CanSat because correct decision making in space mission is very critical. In order to investigate the potential of the proposed education, we carried out the field experiments in Noshiro space event and ARLISS. Through the empirical experiments, the following implications have been revealed: (1) the proposed education provide pseudo planetary exploration experience; and (2) through a process where children in a different area can control our CanSat after rocket launch by using UI; (3) Our system may learn the importance of distribution of roles for efficient decision-making; (4) The proposed education may promote their discussion and develop their cooperative;

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